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# Study of vibration behavior of misalignment and its impacts on the operation of the electric motor and on the energy consumption

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## Abstract

*Condition monitoring by vibration analysis is effective tool for detecting misalignment defect. The misalignment is a major cause of reduced life of the equipments (couplings, bearings, gears ...); it causes a malfunction to the engine and increases the consumption of electrical energy. To solve this problem, a test bench was developed in our laboratory, will allow us to study the impacts of a misalignment of the engine operation and the electric energy consumption.*

**Keywords:** Conditional Maintenance, Vibration Analysis, Alignment Fault

## 1. INTRODUCTION

When you submit your paper print it in two-column format, including figures and tables. In addition, designate one author as the “corresponding author”. This is the author to whom proofs of the paper will be sent. Proofs are sent to the corresponding author only.

The misalignment is the relative position deviation of the shaft from the collinear axis of rotation when the machine is running under normal operating conditions.

### The Misalignment can affect:

- Two shafts linked by a coupling: the axes of the two rotors may have an angular misalignment at the coupling or a parallel misalignment (lack of concentricity) or a combination of both.
- Two bearings supporting the same axis: the axes of the two bearings of the same machine body are not concentric.

This anomaly can be the cause of a mounting defect, also a bad fitting of the fixing lugs, and a loosening of the fixing lugs of a machine or a deformation of the frame.

- It generates the creation of the efforts that lead the fast deterioration of the coupling system and the deterioration of the bearings.
- In this article the study is divided into two parts:

- The detection of the misalignment by vibratory analysis.
- The impacts of misalignment on the operation of an electric motor and on energy consumption.

## 2. THEORETICAL STUDY

### 2.1 Temporal Representation

The temporal representation of a misalignment is a periodic function type complex sinus.

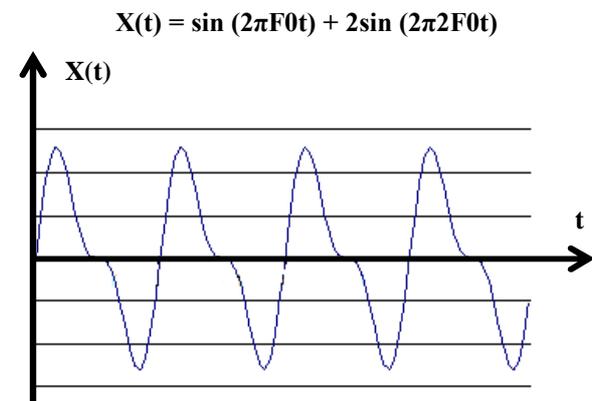


Figure 1 Temporal representation of a complex sinus

### 2.2 Frequency representation

The frequency representation of a function periodic complex sinus is as follows

$$X(F) = j/2 [d(F+F_0) - d(F-F_0)] + j[d(F+2F_0) - d(F-2F_0)]$$

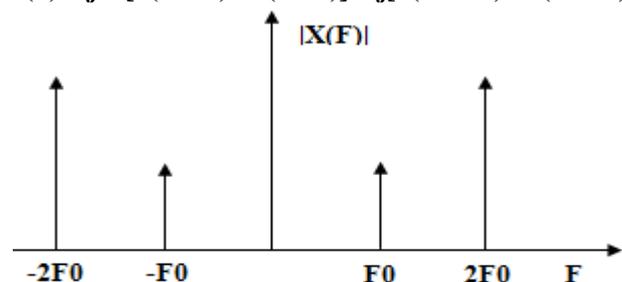


Figure 2 Frequency representation of a complex sinus

### 3. PRESENTATION OF THE EXPERIMENTAL STUDY

#### 3.1 Introduction

To study the misalignment, we performed a test bench in our laboratory figure (3).



**Figure 3** Misalignment Test Bench

The bench consists of:

- Single-phase electric motor 0.5 KW; 1500 RPM.
- Rigid ball bearings 6005-2Z.
- Elastic coupling.

#### 3.1.1 Measurement of global vibrations

##### ➤ Flawless

By measuring N.G. we found 0.578 mm/s.

##### ➤ With misalignment

By measuring NG we found 1,235 mm/s.

#### 3.1.2 Measurement of spectral vibrations

Frequency band: the researched fault belongs to the low frequency range, so the maximum frequency  $FM \geq 4 \times Fr$ , ( $4 \times Fr$  Corresponds to a shaft fault). So  $FM \geq 100$  Hz.

Number of lines: in order to have a good resolution of the defect peaks, it is necessary to determine the number of lines allowing the distinction between the two nearest peaks. IN this case it is the peak of 0,5 Fr (mechanical gap) and Fr (misalignment).

$$\Delta F = Fr - 0,5 Fr$$

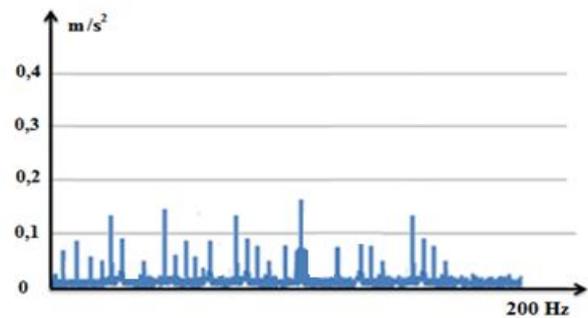
The number of lines is obtained by the relation:

$$NL \approx \frac{FM \times B}{\Delta F} = 64.$$

We will take  $NL = 100$ .

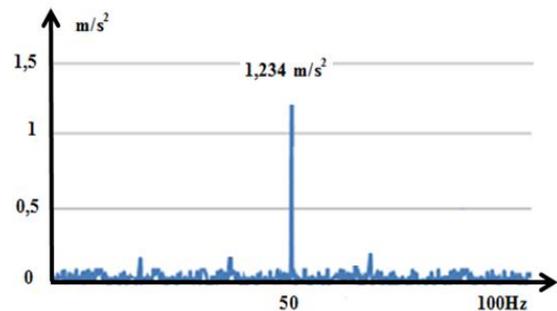
After the parameterization of the device, a measurement was made on the bearing on the coupling side.

##### ➤ Spectrum without defect



**Figure 4** Spectrum recorded

##### ➤ Spectrum with misalignment



**Figure 5** Spectrum recorded

#### 3.1.3 Remark

For a defect of misalignment, we notice:

- The increase of the global level at low frequency compared to the reference state.
- The appearance of the peak twice frequency of rotation ( $2Fr$ ).

### 4 THE IMPACTS OF MISALIGNMENT ON THE OPERATION OF AN ELECTRIC MOTOR AND ON ENERGY CONSUMPTION

#### 4.1 Introduction

In this section we will study the impacts of a misalignment on the operation of the electrical motor and on the consumption of electrical energy. For this we used the test bench Figure (3).

We carried out the following tests:

- The motor is started for 10 minutes to read the temperature, the active power P, the reactive power Q and the cosp in the normal or healthy state.
- The motor is stopped until it returns to the initial temperature.
- We make the first attempt but this time with a misalignment of one degree.
- The motor is stopped until it returns to the initial temperature.
- The first attempt was repeated for the second time but this time with a misalignment of two degrees.

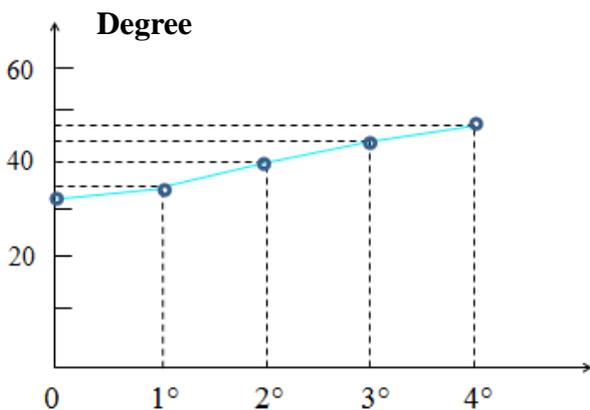
- The motor is stopped until it returns to the initial temperature.
- The first attempt was made for the third time but this time with a misalignment of three degrees.
- The motor is stopped until it returns to the initial temperature.
- The first attempt was repeated for the fourth time but this time with a misalignment of four degrees.
- The temperatures of the various tests are taken by a thermal camera and the values of the powers and  $\cos \rho$  are taken by an analyzer of the electrical network.

The results are presented in the following table:

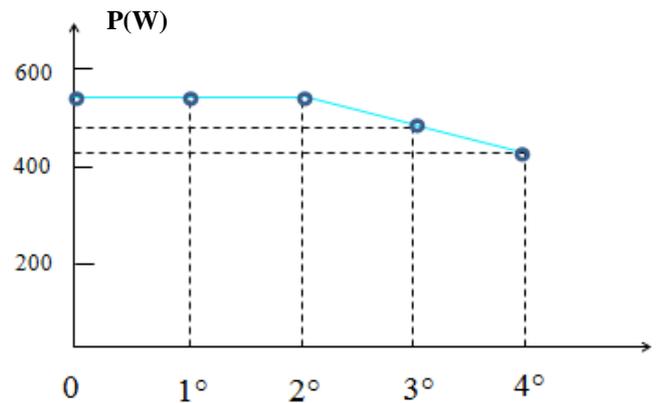
**Table 1:** Summary table of thermal and electrical tests

Test	Temperature °C	P(W)	Q (VAR)	Cos $\rho$
Motor stop	29,2	0	0	0
Motor start without misalignment	33,9	465	84,43	0,98
with a misalignment 1°	37,5	465	84,43	0,98
with a misalignment 2°	40,2	465	84,43	0,98
with a misalignment 3°	42,8	430	136	0,92
with a misalignment 4°	45,8	416,7	219,3	0,88

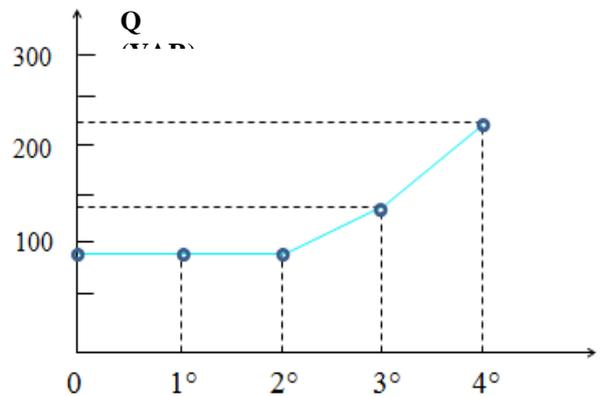
**4.2 Graphs**



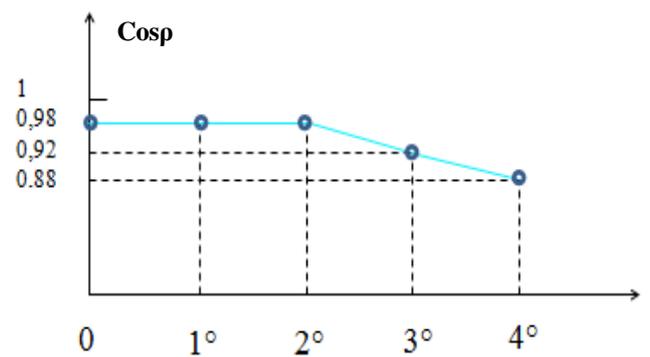
**Figure 6** Temperature diagram as a function of misalignment



**Figure 7** Active power graph as a function of misalignment



**Figure 8** Reactive power graph as a function of misalignment



**Figure 9** Graph of  $\cos \rho$  as a function of the misalignment

**4.3 Remark**

We noticed that when the degree of misalignment is increased:

- -The increase of temperature.
- The increase of reactive power only when the misalignment reaches 2°.

- The decrease of active power only when the misalignment reaches  $2^\circ$ .
- And the Cosp, also decreases only when the misalignment reaches  $2^\circ$ .

## **5 CONCLUSION**

According to the tests realized, it is observed that the misalignment is manifested by:

- The increase of the global level in low-frequency in relation to the state of reference.
- The appearance of the peak twice frequency of rotation (2Fr) in spectral analysis.

### **The misalignment causes:**

- An increase in the temperature of the electric motor, which can cause damage to the electrical cables at the stator and rotor, thus reducing the service life of the bearings.
- A reduction in the active power which is useful for the conversion of the electrical energy to the mechanical energy, what means a reduction in the torque  $C$  and / or speed of rotation  $\omega$ , provoking thus a malfunction of an industrial installation driven by an electric motor.
- An increase in the reactive power used to supply the magnetic circuits means an increase in losses in the electrical installation.
- A reduction in the power factor  $\cos \rho$ , that is to say, the current intensity called is high but the active power is low, thus a loss in energy consumption.

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## ***Une nouvelle caractérisation des parties stables***

### ***atomiques pour une relation d'ordre partiel.***

#### ***Application au problème d'ordonnement à une machine.***

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#### **Résumé :**

Un ensemble  $E$  muni d'une relation d'ordre partiel  $R$  peut être décomposé en sous ensemble appelés "parties stables atomiques" pour  $R$ , totalement ordonnés. Ces parties stables atomiques sont les classes d'équivalence d'une relation d'équivalence  $T(\otimes)$  [Bap.et al 91].

En fait si  $S(x)$  est l'atome contenant  $x$  ( $x \in E$ ) et  $E$  muni de la relation d'ordre partiel  $R$ , alors  $Cl(x)$  est la classe d'équivalence de  $x$  pour la relation d'équivalence  $T(\otimes)$  définie par :

$\forall x,y \in E^2, x \otimes y \iff \text{non}(x R y \text{ ou } y R x)$  ;  $\otimes$  est une relation symétrique par construction. Sa fermeture transitive  $T(\otimes)$  est une relation d'équivalence [Bar.70].

Dans cet article nous proposons une nouvelle caractérisation des parties stables atomiques pour  $R$ . La démarche consiste à définir une matrice carrée  $\mathbf{B}$  appelée matrice des "Rangs" à partir de la relation  $R$  dont les coefficients sont booléens ( $b_{ij} = 0$  ou  $1$ ) [AMA.et al.92a , AMA et al.92b, AMA. et al.93 AMA95]. Cette matrice  $\mathbf{B}$  représente **un graphe biparti  $G$ .**

Une interprétation des composantes canoniques du graphe biparti nous permettra de caractériser les parties stables atomiques de l'ensemble  $E$  muni de  $R$ . On montre en effet que dans les sous graphes irréductibles  $G_i$  de  $G$  ( $G_i(S_i, T_i ; A(G_i))$ ), les sous ensembles  $S_i$  de  $E$  ( $i=1, \dots, k$ ) sont les parties stables atomiques pour la relation d'ordre partiel  $R$ .

Une application est proposée pour la décomposition temporelle du problème d'ordonnement à une machine.

**Mots clés :** Relation d'ordre, parties stables, graphe biparti, composantes canoniques, sous-graphes irréductible, matrice des rangs, ordonnancement

## I. Position du problème et rappel de certains résultats [Bap. et al. 91]

Soit E un ensemble d'éléments muni d'une relation d'ordre partiel R.

Soit a une partie de E

et notons

$$a^- = \{ x \in E / \forall y \in a, x R y \text{ et } x \neq y \}$$

$$a^+ = \{ x \in E / \forall y \in a, y R x \text{ et } x \neq y \}$$

Nous avons évidemment :

$$a^- \cap a^+ = a^- \cap a = a \cap a^+ = \emptyset.$$

### Définition :

Une partie a de E est stable pour R si :

$$a^- \cup a^+ \cup a = E$$

Soit A l'ensemble de toutes les parties stables de E .

A est stable pour l'intersection ensembliste, c'est à dire :

$$\forall (a_1, a_2) \in A^2 \text{ alors } a_1 \cap a_2 \in A$$

On définit sur l'ensemble A la relation d'ordre classique : l'inclusion (C)

(A, C) est un treillis

$a \in A$  est un atome  $\Leftrightarrow a$  est sup-irréductible

Rappelons que dans un treillis possédant un élément nul, on appelle atome tout élément couvrant directement l'élément nul ( $\emptyset$  pour C) [Bar.70] .

Soit S l'ensemble des atomes pour l'inclusion dans A.

S forme une partition de E sur laquelle on peut définir une relation d'ordre total R' de la façon suivante [Bap. et al. 91] :

$$\forall (s_1, s_2) \in S^2, \exists (x, y) \in s_1 \times s_2 / x R y$$

$$\Rightarrow s_1 R' s_2$$

En fait si S(x) est l'atome contenant x ( $x \in E$ ) et E muni de la relation d'ordre partiel R), alors Cl(x) est la classe d'équivalence de x pour la relation d'équivalence T( $\otimes$ ) définie par :

$\forall x, y \in E^2, x \otimes y \Leftrightarrow \text{non } (x R y \text{ ou } y R x)$  ; ( $\otimes$  est une relation symétrique par construction. Sa fermeture transitive T( $\otimes$ ) est une relation d'équivalence [Bar.70].

Ce qui se traduit également par :

$\forall (S_i, S_j)$  tel quel que  $S_i R' S_j$  alors :

$$\forall (x, y) \in S_i \times S_j \Rightarrow x R y.$$

## II. Matrice des rangs [Ama .92a], [Ama .92b], [Ama .93], [Ama .95] :

### II.1. Notion de rang d'un élément x de E

Soit  $\pi$  une permutation sur E (séquence des éléments de E) et  $\pi(x)$  la position de x de E dans  $\pi$  (E est supposé fini et de cardinal n).

**Définition :** une permutation  $\pi$  sur E est dite compatible avec R (ou admissible) si :

$$\forall (x, y) \in E \times E, x R y \Leftrightarrow \pi(x) \leq \pi(y).$$

( le signe " $\leq$ " désigne la relation d'ordre habituelle).

Si  $\pi'$  est une autre permutation admissible on a :

$$\forall (x, y) \in E \times E, \pi(x) < \pi(y)$$

$$\Leftrightarrow x R y \Leftrightarrow \pi'(x) < \pi'(y).$$

On dit alors que x précède y dans toute permutation admissible.

On notera  $\pi(\mathbb{R})$ , l'ensemble des permutations admissibles.

**Remarque :**

$\forall \pi \in \pi(\mathbb{R})$  si  $x \mathbb{R} y$  alors  $\pi(x) < \pi(y)$

$\forall (x, y) \in (S_i \times S_k) / S_i \mathbb{R}' S_k$  alors

$$\pi(x) < \pi(y)$$

( $\mathbb{R}'$  est la relation d'ordre totale définie sur l'ensemble  $S$  des parties stables atomiques.

Associons à chaque élément  $x$  de  $E$  trois sous-ensembles :

$$E^+(x) = \{ y \in E / x \mathbb{R} y \text{ et } x \neq y \}$$

$$E^-(x) = \{ y \in E / y \mathbb{R} x \text{ et } x \neq y \}$$

$$E^0(x) = \{ y \in E / \text{non} (x \mathbb{R} y \text{ ou } y \mathbb{R} x) \text{ et } x \neq y \}$$

La figure 1 ci-dessous représente le graphe de précedence de  $x$  par rapport à

$E^+(x)$ ,  $E^-(x)$  et  $E^0(x)$ .

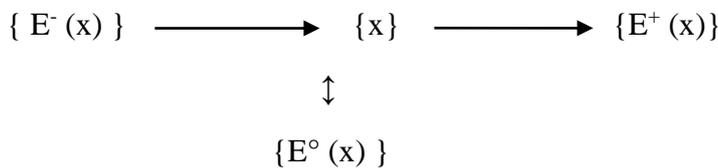


Fig. 1.

**Remarques :**

- a) Si  $E^0(x) = \emptyset$ , alors :
  - i) Le singleton  $\{x\}$  est une partie stable et de surcroît atomique.
  - ii)  $\forall \pi \in \pi(\mathbb{R});$   
 $\pi(x) = |E^-(x)| + 1$   
 Ou  $\pi(x) = |E| - |E^+(x)|$

- b) Si  $E^0(x) \neq \emptyset$ , alors :

$$\forall \pi \in \pi(\mathbb{R}); |E^-(x)| + 1 \leq \pi(x) \leq |E^0(x)| + 1 + |E^-(x)| = |E| - |E^+(x)|$$

On notera alors :

$$\begin{aligned} Rg(x) &= |E^-(x)| + 1 \text{ (pour rang gauche de } x) \\ Rd(x) &= |E| - |E^+(x)| \text{ (pour rang droit de } x) \\ \text{et donc : } Rg(x) &\leq \pi(x) \leq Rd(x), \\ &\forall \pi \in \pi(\mathbb{R}) \end{aligned}$$

$$Ra(x) = \{ \alpha / \alpha \in \mathbb{N} \cap [Rg(x), Rd(x)] \}$$

$Ra(x)$  est l'ensemble des positions que peut prendre  $x$  dans toute permutation admissible.

Remarquons que c'est un intervalle fermé.

$\forall \pi \in \pi(\mathbb{R})$  et  $\forall x \in E$  alors

$\pi(x) \in Ra(x)$ . (la réciproque n'est pas toujours vérifiée)

De la même manière on définit pour toute partie  $a$  de  $E$  :

$$Rg(a) = \min(Rg(x), x \in a)$$

$$Rd(a) = \max(Rd(x), x \in a)$$

$$L(a) = Rd(a) - Rg(a) + 1.$$

**II.2. Matrice des rangs B(n,n)**

La matrice des rangs  $B$  est une matrice carrée à coefficients 0 ou 1 :

$$B = (b_{ij}) \quad i=1, \dots, n \quad ; \quad n = |E| \\ j=1, \dots, n$$

Où la ligne  $i$  correspond à l'élément  $x_i$  de  $E$  et la colonne  $j$  correspond à la position (rang)  $j$  et où :

$$b_{ij} = 1 \quad \text{ssi } j \in Ra(x_i)$$

$$b_{ij} = 0 \quad \text{sinon}$$

Exemple :

Considérons l'ordre partiel  $\mathbb{R}$  défini sur l'ensemble  $E$  de neuf

éléments et donné par son diagramme de Hasse (Figure 2).

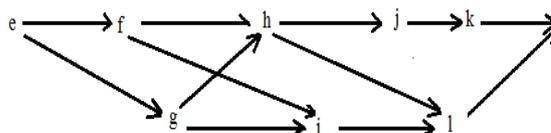


Figure 2.

Nous ne donnons ici que les caractéristiques de l'élément h à titre démonstratif pour ne pas allonger la liste.

$$E^-(h) = \{e, f, g\}, E^+(h) = \{j, k, l, m\}$$

$$E^0(h) = \{i\}, Rg(h) = 3+1=4$$

$$Rd(h) = 3+1+1 = 9-4 = 5$$

$$Ra(h) = \{4, 5\}$$

Matrice des rangs B(9,9)

	1	2	3	4	5	6	7	8	9
e	1	0	0	0	0	0	0	0	0
f	0	1	1	0	0	0	0	0	0
g	0	1	1	0	0	0	0	0	0
h	0	0	0	1	1	0	0	0	0
i	0	0	0	1	1	1	1	0	0
j	0	0	0	0	1	1	1	0	0
k	0	0	0	0	0	1	1	1	0
l	0	0	0	0	0	1	1	1	0
m	0	0	0	0	0	0	0	0	1

Figure 3

### III. Caractérisation des parties stables atomiques par la matrice des rangs :

Soit E un ensemble de n éléments muni d'une relation d'ordre partielle R et a une partie de E

$$a^- = \{ x \in E / \forall y \in a, x R y \text{ et } x \neq y \}$$

$$a^+ = \{ x \in E / \forall y \in a, y R x \text{ et } x \neq y \}$$

$$Rg(a) = \min(Rg(x), x \in a)$$

$$Rd(a) = \max(Rd(x), x \in a)$$

$$L(a) = Rd(a) - Rg(a) + 1.$$

**Proposition 1:**

**Une partie a de E est stable pour R si et seulement si  $L(a) = |a|$**

**Montrons d'abord que si a est un atome alors  $L(a) = |a|$**

Supposons que l'ensemble E est partitionné en K classes d'équivalence

( les atomes  $S_i ; i = 1 \text{ à } K$  sont totalement ordonnées par la relation d'ordre totale  $R'$  telle que  $S_i R' S_j \iff \forall (x, y) \in S_i \times S_j$  alors  $x R y$  ).

Supposons que les atomes  $S_i$  sont ordonnés par  $R'$  dans l'ordre de leurs indices comme suit :

$$S_1 R' S_2 R' \dots R' S_i R' S_{i+1} R' \dots R' S_k$$

On dira que deux atomes successifs  $S_j$  et  $S_{j+1}$  sont adjacents.

Il est évident que:

1) La réunion de plusieurs atomes adjacents forme une partie stable

$$S^-_i = \{ S_1 \cup S_2 \cup \dots \cup S_{i-1} \}$$

$$S^+_i = \{ S_{i+1} \cup S_{i+2} \cup \dots \cup S_k \}$$

$$S^-_i \cup S_i \cup S^+_i = E$$

$$|S^-_i| + |S_i| + |S^+_i| = |E| = n.$$

Dans toute permutation

$$\pi \in \pi(R)$$

tous les éléments de  $S^-_i$  sont placés avant ceux de  $S_i$

$$(\forall (x, y) \in S^-_i \times S_i);$$

$\pi(x) < \pi(y)$ ) et donc :

$$Rg(S_i) = |S^-_i| + 1$$

tous les éléments de  $S^+_i$  sont placés après ceux de  $S_i$

$$\forall (x, y) \in S_i \times S^+_i;$$

$\pi(x) < \pi(y)$  et donc :

$$Rd(S_i) = n - |S^+_i|$$

$$\begin{aligned}
L(S_i) &= \text{Rd}(S_i) - \text{Rg}(S_i) + 1 \\
&= |S_i^-| + 1 - (n - |S_i^+|) + 1 ; \\
L(S_i) &= n - (|S_i^-| + |S_i^+|) = |S_i|.
\end{aligned}$$

Et par conséquent, deux atomes consécutifs (adjacents)  $S_i, S_{i+1}$  vérifient :

$$\begin{aligned}
L(S_i \cup S_{i+1}) &= |S_i \cup S_{i+1}| \\
&= |S_i| + |S_{i+1}|.
\end{aligned}$$

**Montrons maintenant que si  $L(a) = |a|$  alors  $a$  est stable pour  $R$ .**

Supposons  $a$  non stable

$a^- \cup a^+ \cup a \neq E$  et donc

$$a^- \cup a^+ \cup a = E - F$$

$$\begin{aligned}
\text{ou encore } |a^-| + |a^+| + |a| &= |E| - |F| \\
&= n - |F|
\end{aligned}$$

$$\text{Rg}(a) \geq |a^-| + 1$$

$$\text{Rd}(a) \leq n - |a^+|$$

$$L(a) = \text{Rd}(a) - \text{Rg}(a) + 1$$

$$L(a) - 1 = \text{Rd}(a) - \text{Rg}(a) \leq n - |a^+| - (|a^-| + 1)$$

$$\begin{aligned}
L(a) = \text{Rd}(a) - \text{Rg}(a) &\leq n - |a^+| - |a^-| \\
&= n - (|a^+| + |a^-|)
\end{aligned}$$

$$\begin{aligned}
\text{Par ailleurs } |a^+| + |a^-| + |a| &= |E| - |F| \\
= n - |F| \Rightarrow |a^+| + |a^-| &= n - |F| - |a|
\end{aligned}$$

$$\begin{aligned}
L(a) &\leq n - (|a^+| + |a^-|) = n - (n - |F| - |a|) \\
&= |F| + |a|
\end{aligned}$$

$$L(a) \leq |F| + |a|.$$

Or  $L(a) = |a|$  et donc  $|F| = 0$

$\Rightarrow F = \emptyset$ , ce qui assure la stabilité de  $a$ .

Si de plus  $a$  ne contient aucune autre partie stable, elle est atomique.

#### IV. Interprétation des parties stables atomiques en terme des composantes canoniques d'un graphe bipartie :

Supposons que la matrice des rangs est disposée de telle sorte que les éléments de  $E$  apparaissent dans l'ordre croissant de leurs rangs gauche ( $\text{Rg}(e_i)$ ). On notera cette matrice  $B$ .

La matrice des rangs  $B$  représente le graphe bipartite  $G(E, R; A)$  où :

$E = \{e_1, e_2, \dots, e_n\}$  l'ensemble  $E$  muni de la relation d'ordre partiel  $R$

$R = \{1, 2, \dots, n\}$  l'ensemble des rangs ou  $n^\circ$  des colonnes de  $B$ .

$A = \{ (e_i, k) / e_i \in E, k \in R \text{ et } b_{ik} = 1 \}$ .

Il existe  $k$  tel que  $E$  et  $R$  sont décomposables en  $k+2$  parties (Figure 4), vérifiant [Dul. et al.58]:

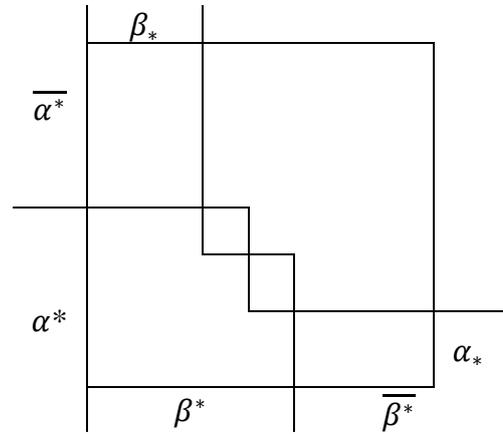


Figure 4.

$$E = \alpha_* \cup s_1 \cup s_2 \cup \dots \cup s_k \cup \bar{\alpha}_*$$

$$R = \bar{\beta}_* \cup T_1 \cup T_2 \cup \dots \cup T_k \cup \beta_*$$

$$S_i \cap \alpha_* = \emptyset \quad \text{pour } i = 1, 2, \dots, k$$

$$S_i \cap \bar{\alpha}_* = \emptyset \quad \text{pour } i = 1, 2, \dots, k$$

$$S_i \cap S_j = \emptyset \quad \text{pour tout } i, j \text{ et } i \neq j$$

$$T_i \cap \beta_* = \emptyset \quad \text{pour } i = 1, 2, \dots, k$$

$$T_i \cap \overline{\beta^*} = \emptyset \quad \text{pour } i = 1, 2, \dots, k$$

$$T_i \cap T_j = \emptyset \quad \text{pour tout } i, j \text{ et } i \neq j$$

$$|S_i| = |T_i|$$

$(\alpha_i, \beta_i)$  est un support extérieur minimal (SEM).

$$\alpha_i = \alpha_* \cup s_{1i} \cup s_{2i} \cup \dots \cup s_{ki}$$

$$\beta_i = T_{i+1} \cup T_{i+2} \cup \dots \cup T_k$$

Cette décomposition est toujours possible et est unique.

Les sous graphes  $G_i = (S_i, T_i; A_i)$  où  $A_i = A \cap (S_i \times T_i)$  sont irréductibles et leurs uniques SEM sont  $(S_i, \emptyset)$  et  $(\emptyset, T_i)$  [Dul. et al.58]:.

Dans un graphe disjoint complet [Dul. et al.58]:

$$\overline{\alpha_*} = \emptyset \quad \text{et} \quad \overline{\beta^*} = \emptyset$$

Par construction de la matrice des rangs B, le graphe  $G(E, R; A)$  est un graphe disjoint parfait et donc

$$\overline{\alpha_*} = \emptyset \quad \text{et} \quad \overline{\beta^*} = \emptyset$$

Les seules parties de la décomposition qui restent sont :

$$s_1 \cup s_2 \cup \dots \cup s_k = E$$

$$T_1 \cup T_2 \cup \dots \cup T_k = R$$

Avec  $S_i \cap S_j = \emptyset$  pour tout  $i, j$  et  $i \neq j$

$$T_i \cap T_j = \emptyset \quad \text{pour tout } i, j \text{ et } i \neq j$$

$$|S_i| = |T_i|$$

$|T_i|$  représente le nombre de positions (rangs) consécutives qu'occupent les éléments du sous ensemble  $S_i$  de E c.à.d.  $|T_i| = L(S_i)$

On peut donc conclure que du fait que les  $G_i = (S_i, T_i; A_i)$  sont irréductibles et d'après la proposition 1, les parties

$S_i$  ( $i = 1, 2, \dots, k$ ) de l'ensemble E sont des parties stables atomiques.

En fait les parties stables atomiques sont les blocs diagonaux de la matrice des rangs B (Figure 5.).

	1	2	3	4	5	6	7	8	9
e	1	0	0	0	0	0	0	0	0
f	0	1	1	0	0	0	0	0	0
g	0	1	1	0	0	0	0	0	0
h	0	0	0	1	1	0	0	0	0
i	0	0	0	1	1	1	1	0	0
j	0	0	0	0	1	1	1	0	0
k	0	0	0	0	0	1	1	1	0
l	0	0	0	0	0	1	1	1	0
m	0	0	0	0	0	0	0	0	1

Figure 5

On reconnaît ici les parties stables atomiques :  $\{e\}$  ;  $\{f, g\}$  ;  $\{h, i, j, k, l\}$  ;  $\{m\}$ .

## V. Application à la décomposition temporelle du problème d'ordonnancement à une machine

Une machine est toujours disponible pour exécuter un ensemble de n tâches  $J = \{J_1, J_2, \dots, J_n\}$ .

Chaque tâche  $J_i$  est exécutable à partir de l'instant  $r_i$ , appelé date d'arrivée ou de disponibilité de la tâche  $J_i$ .

Chaque tâche  $J_i$  a un délai  $d_i$  (date de fin au plus tard souhaitée).

La tâche  $J_i$  a une durée d'exécution  $p_i$ .

$$\forall J_i \in J, r_i + p_i \leq d_i.$$

Certaines tâches de J peuvent ne pas être indépendantes et doivent respecter une certaine contrainte de précédence de gamme (telle que la tâche  $J_1$  doit

être exécutée avant la tâche  $J_k$  par exemple, qu'on notera  $J_i < J_k$ .

Posons  $m_{ij} = (d_j - p_j) - (r_i + p_i)$ , la marge entre les tâches  $J_i$  et  $J_j$

Les données  $(r_i, p_i, d_i)$  permettent de définir une autre contrainte de précedence temporelle à partir du paramètre  $m_{ij}$ .

La tâche  $J_i$  doit être exécutée avant la tâche  $J_j$  si :

$m_{ij} \geq 0$  et  $m_{ji} < 0$  qu'on notera également  $J_i < J_j$

La relation " $<$ " définie sur l'ensemble des tâches  $J$  (à partir des deux contraintes de précédences) est antisymétrique et n'est pas toujours transitive.

Pour utiliser le résultat développé précédemment (matrice des rangs et ses composantes irréductibles), il suffit de construire la fermeture transitive  $T(<)$  de la relation " $<$ " qui devient une relation d'ordre partiel sur l'ensemble  $J$ , et d'analyser la matrice des rangs qui en découle.

## VI. Exemple illustratif :

On se donne le problème à 6 tâches défini par le tableau suivant :

	$J_1$	$J_2$	$J_3$	$J_4$	$J_5$	$J_6$
$r_i$	13	11	20	30	0	30
$p_i$	6	7	4	3	6	2
$d_i$	27	29	32	45	36	53

Figure 6.

Avec en plus la contrainte de gamme  $J_2 < J_5$

Le calcul des marges  $m_{ij}$  nous donne la matrice des marges  $M$  suivante:

	$J_1$	$J_2$	$J_3$	$J_4$	$J_5$	$J_6$
$J_1$		3	9	23	11	32
$J_2$	3		10	24	12	33
$J_3$	-3	-2		18	6	27

$J_4$	-12	-11	-8		-3	18
$J_5$	15	16	22	36		45
$J_6$	-11	-10	-4	10	-2	

Figure 7.

A partir des contraintes de gamme et temporelles on dresse la table des rangs  $B$  suivante :

	1	2	3	4	5	6
$J_2$	1	1				
$J_1$	1	1	1			
$J_5$		1	1	1		
$J_3$			1	1		
$J_4$					1	1
$J_6$					1	1

Figure 8.

D'où l'on déduit les deux parties stables atomiques :

$\{J_2, J_1, J_5, J_3\}$  et  $\{J_4, J_6\}$

## Conclusion :

Dans cet article nous avons proposé une méthode originale permettant de caractériser les parties stables atomiques pour une relation d'ordre partiel. Son application au problème d'ordonnement à une machine permet de décomposer le problème global en sous problème indépendants et de taille réduite et qui peut être très utile dans un contexte d'aide à la décision

Un deuxième niveau de simplification apparaît dans la matrice des rangs de chaque problème local du fait de la limite et de la connaissance des positions (rangs) de chaque tâche.

Dans l'exemple présenté ici, le problème local  $\{J_2, J_1, J_5, J_3\}$ , compte tenu de l'analyse de la matrice des rangs conduit à seulement dix séquences possibles au lieu de vingt quatre (4 !)

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*Recherche de gammes communes à, une famille de produits*

*Décompositions temporelles d'un plan de production et du*

*problème à une machine.*

*Université Mohammed Premier ;*

## Towards increasing feedbacks and widening the diffusion of information in Social Network

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**Abstract:** The aim of this document is to make sure that our two strategies which allowed the increase the feedbacks and the widening of diffusion of information on social networks. starting by determine the problem thanks to a survey which we have put on line and which also look out to assist searchers at the domain of understanding precipitation the behavior of users for adopting the possible improvement. The passing of information received has been done with an experimentation which allowed to start the types of postings had a reach rate the most increasing. among the outcome of this study ,there have resolution the problem of the non satisfaction of social network' users and the increase of diffusion of middle information our two strategies, this book based on the nature of posting and the other is automatic which takes into consideration the notion of collaborative working.

**Keywords:** Social network, Feedbacks, Diffusion of information, Facebook.

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### INTRODUCTION

Nowadays, we may have stressed that social networks such as Facebook, Twitter and others are omnipresent. It is in the beginning of the years 2000 which the communication will largely transformed with the coming f of firsts social networks such as Facebook and MYSPACE .Therefore at this moment even the real biggest social network is without any doubts Facebook. The great increase of Subscribers at social networks is alarming. Taking for example the Facebook website which had for five years more than 14 083 and more than 800 million users (Park 2015). So we can say that this numbers show the extent that social networks are implanted in our life style. That's why it should be in measure to evaluate repercussions. Starting by positive repercussions of these technologies, evidently the global social network using many advantages which are widely known. Therefore it is easy for using, little bit expensive, generally for free, it allowed a quick exchange specially with these technologies, it is possible now to join the best people instantly other ways we say engendered social networks with many advantages for people emotionally health specially meeting new friends and reconnect with the old and new view's sharing, knowledge exchange and helping people.

Therefore, social networks remain the uncountable tools of communication they enter quietly by the great gate, to the individual daily life and to the company field. What we see now is a huge potential as a tools of communication and of collaboration inside organizations. and according to "Alexa internet" the most known website which gave statistic concerning the referencement web which calculate the global web traffic of all websites (Vaughan et al. 2013), we can

classify tens of websites of social networks according to the number of visitors to some countries, it has to do with a study which will do the object of our research future work and according to this study Facebook is the world leader of social networks, and this is the raison which this paper focus on this social network.

In this document we will analyze some frequent questions and attempt to find answers to certain problems that social network's users especially Facebook subscribers, lots of questions actually can be formulated so here are the principles do the users are satisfied of feedbacks looking at their posting? Dose the rate of "see" is fixed or variable according to the number of fans? Or yet does have a lot of fans means have a rate of "see" more increased? we also introduce an experimentation which can explain the big difference between the rate of "see" different types of posting and which can help us to determine the most effective type in Facebook pages .we also suggest in this document two strategies which allowed to increase the feedback advantages at the on line posting and widening its diffusion .the first says manual and it s based on 4 setting "title", "photo", "identify" and "fans motivation" and the second is automatic and it is based on the collaborative working.

The rest of this paper is structured as follows. In section 2 presents materials and methods, the section 3 talks about results and discussion and we end with Conclusion & perspectives in the last section.

### MATERIALS AND METHODS

Several researches are conducted in the social networks field, some of them have unveiled some problems either theoretical or technical, and if we take for example "Facebook" which is the most visited

social network in the world, talking about Facebook, this social network offers three services "pages", "profiles" and "groups". Facebook can be updated by issuing publications, organizing events, and adding applications, etc... However, we can find contradictions with what was said and statements of Facebook especially the one with its title "Business Generating Results on Facebook". We have concluded with this statement that if you want your publication to be readable in news feed of fans, you have to pay.

At present the companies seek to maximize the dissemination of the publication, as the latter is useful for companies for two main elements the first is "win the trust of customers" and second is "make more money". In part against the customer seeks information disseminated by the company or by online services because it is accessible and available at all places and all times, especially that social networks are used almost everywhere, at home, at work, at school and in different platforms, such as mobile phones and tablets.

Figure 1 show the business customer relationship, and show that the company to achieve these above objectives, it must target customer interested in the products. This company customer relationship requires to pose some questions: Is publications attend users? In time? The right user? Are the types of publications having the same diffusion strategy? Are Facebook users satisfied about interactions on their publications? How to increase interaction and expand the diffusion? How to increase the reach rate? Is the reach rate fixed or variable depending on the number of fans? Does having many fans mean having a higher reach rate?

In relation with the subject of customer-company, and according to all of researchers in the engineering field, a system is reliable when the probability to fulfill its mission in a period corresponds to that specified as required. If we fall this definition to the require of a manager page Facebook, the reliability for it, is to have a satisfactory number of "Reach". Especially now Facebook with its new strategy allow the administrators of Facebook pages view detailed statistic of each publication including the exact number of "Reach".

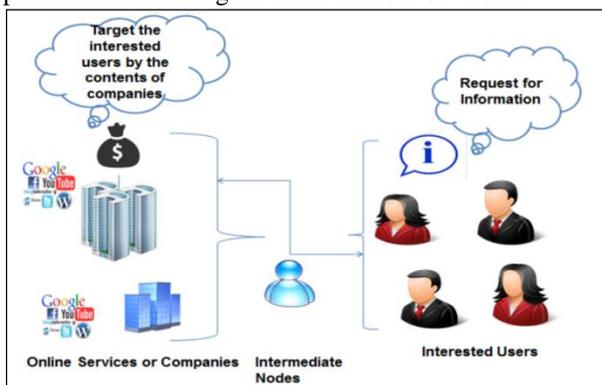


Figure 1 – business customer relationship

The number of "Reach", requires us to ask some questions and to ascend certain number of remarks. As an example: How can we have the number of "Reach"? The number of "Reach" is it proportional to the type of publication (Photo, Link, Status)? Or type of interactions (Share, Like, Comment)? Or that depends on fans of a Facebook page?.

## RESULTS AND DISCUSSION

To find answers to various questions in "3. Problems", on one hand we have launched a survey using "Google Doc", in order to receive what users think about social networks and especially Facebook. On the other hand, we conducted an experiment to measure the reliability of published content.

### 1 Online Survey

#### 1.1 Methods

To analyze some problems, we felt it necessary to set up an online survey. Indeed we have put an open survey in a period from November 17, 2014 to November 21, 2014, with "Google doc" and the survey was open to people from different countries of the world mainly to the students with a 1000 sample respondents and as a prerequisite the surveyed must have a Facebook account and should be as well "fans" to some Facebook pages.

Here are the elements of the technical file of the survey on-line:

- Organization Committee: LARI Laboratory
- Number of questions: 11 questions
- Number of interviewees: 1000 persons
- Nature of interviewees: persons from different countries.
- Tools: Google Doc
- Starting date: November 17th, 2014
- End date: November 21st, 2014
- Political sharing: on Facebook pages, with an email and on electronic journal.
- Requirements: All interviewees have a Facebook account.
- Language used: French easy level.

The questions are as follow:

1. Which type of post do you like to share?
2. Why do you share these posts?
3. What do you expect from sharing them?
4. If your posts are not reliable, what do you do?
5. How do you fill when your posts get a lot of likes?
6. Do you put like on a post that you appreciate?
7. When you share a post, what do you prefer?
8. Give a mark from 1 to 5 for each Facebook options.
9. Are you an owner of a Facebook page?
10. Are you satisfied from fans feedback?

11. If you have 1000 fans, how much of "reach" are satisfying for you?

### 1.2 Results

Here are some results found that we concern in this paper.

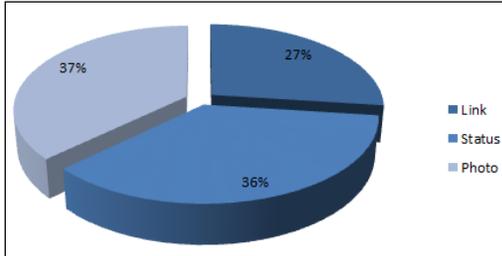


Figure 2 - The type of the most shared publications

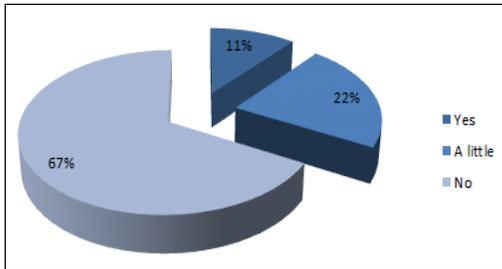


Figure 3 - Satisfaction fans interactions

Figure 2 show the result from question 1 of the our survey, according to this results 27% of people share "Links", 37% of people share "Photo" and 36% of people share "Status".

Figure 3 show the result of satisfaction to fans interactions asked at question 10, and from these results 67% of respondents are not satisfied with the interaction of their fans 22% said "somewhat" and 11% persons say that they are satisfied. At this question we also asked for explanations for those choosing "not satisfied" or "somewhat" to understand the reason for their dissatisfaction, here are the main answers: There are those who speak of lack of interaction and they aspire to much more; There are people who like the page but do not interact in content.

The Figure 4 show the results found on Question 6, that 731 participants (73%) said "yes", 71 participants (7%) say "no", and 198 participants (20%) say "this depend of his relationship with the owner of the page".

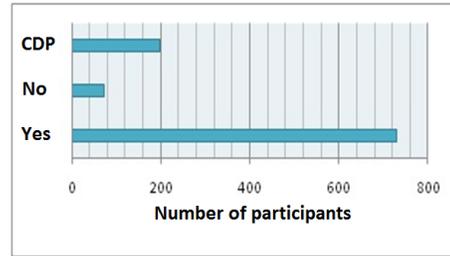


Figure 4 – Result of the question: do you put like on a post that you appreciate?

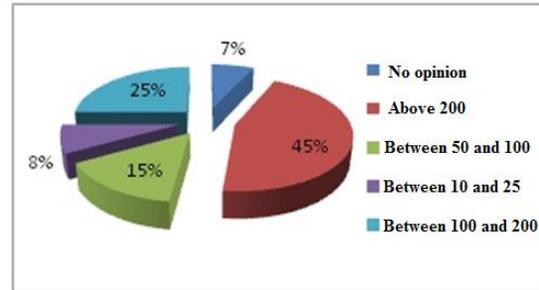


Figure 5 – Result of the question: If you have 1000 fans, how much of "reach" are satisfying for you?

Figure 5 show the results found on question 11 of our survey, including 71 participants (7%) say "No opinion", 77 participants (8%) say "Between 10 and 25", 148 participants (15%) say "Between 50 and 100", 253 participants which represents 25% of respondents say "Between 100 and 200" and finally 451 participants (45%) say "above 200".

What we can deduce according to the results found, and the above remarks, that there primarily two major problems, the problem of the number of interactions and problem of the number of "reach".

## 2 Experiments

### 2.1 Methods

To answer the questions asked in the previous paragraph, we made a test, by publishing a single publication on Facebook pages that we manage and leave for 24 hours using all three types of publications (links, photo and status). Figure 6 show the six Facebook pages that we manage and show the number of fans for each page (example: BC2 page contains 42,784 fans).

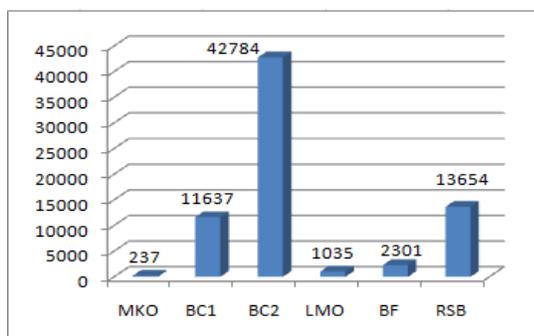


Figure 6 - Fans number for each facebook page used in this experience

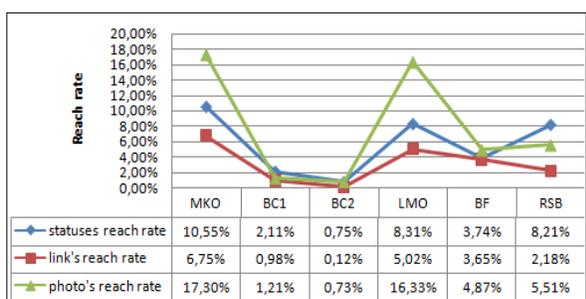


Figure 7 - The reach rate for each post types

It should be noted that the MKO, BC1, BC2, LMO, BF and RSB are the abbreviations of the pages name that we manage.

## 2.2 Results:

As for our experience, we started first with the case (1) sharing a "Status" publication, then the case (2) sharing a "Link" publication and we have completed the case (3) by sharing a "Photo" publication. Tables (Table I, Table II and Table III) present the results collected after 24 hours of launching each publication.

### Case (1): Sharing Status

Table 1. Results Analysis of « reach » in facebook pages sharing a status

Page Name	MKO	BC1	BC2	LMO	BF	RSB
Fan Number	237	11637	42784	1035	2301	13654
Likes	0	1	5	0	2	45
Comments	0	0	3	2	1	20
Shares	0	0	0	0	0	1
Reach	25	246	323	86	86	1121
Reach Rate	10,55%	2,11%	0,75%	8,31%	3,74%	8,21%

### Case (2): Sharing Link

Table 2. Results Analysis of « reach » in facebook pages sharing a link

Page Name	MKO	BC1	BC2	LMO	BF	RSB
Fan Number	237	11637	42784	1035	2301	13654
Likes	0	1	0	1	0	10
Comments	0	0	0	1	2	2
Shares	0	0	0	0	0	1
Reach	16	114	53	52	84	298
Reach Rate	6,75%	0,98%	0,12%	5,02%	3,65%	2,18%

### Case (3): Sharing Photo

Table 3. Results Analysis of « reach » in facebook pages sharing a photo

Page Name	MKO	BC1	BC2	LMO	BF	RSB
Fan Number	237	11637	42784	1035	2301	13654
Likes	5	7	22	18	5	102
Comments	1	1	6	1	1	13
Shares	0	0	0	0	0	1
Reach	41	141	311	169	112	752
Reach Rate	17,30%	1,21%	0,73%	16,33%	4,87%	5,51%

**NB:** The reach rate is calculated according to this formula:

$$\text{Reach Rate} = \text{Reach Number} / \text{Fan Number}$$

According to the results see Tables (Table I, Table II and Table III) and Figure 7 that summarizes these tables, we can now answer some questions asked before, and thus extract a lot of information and some facts we did not have before, including:

- As long as the number of fans increases, the reach rate decreases.
- As long as the number of interactions increases, the reach rate increases.
- The reach rate of "Photo" publication type is the highest.
- The reach rate of "Link" publication type is the lowest.

### 3 Satisfaction results

The comparison between the survey results see "1 Online Survey" and the experimentation results see "2 Experiments" show the following results:

- At question 11 of the survey, 45% of respondents would like to have a number of reach more than 200, and 25% want to have it between 100 and 200, and therefore we can say that 70% of respondents want a number of reach greater than 100 when it concerns a 1000 fans page.

- At the level of experimentation for the page having a number of fans almost 1000 fans the case of the "LMO" page with 1035, we found that the number of reach differs according to type of publication, due to "Status" publication we found 86 "Seen", also 52 "Seen" in "Link" publication, and we found 169 "Seen" in case of "Photo" publication.

- If we compare the survey results with the results of the experimentation, we can say that the "photo" publication type respond well to the demands and needs of owners and managers of Facebook pages, unlike the "link" publication type which they represent a large satisfaction challenge among owners of Facebook pages.

### 4. Strategies: Methods, Application and Results

According to the results described in the previous paragraph, we can conclude that the publication type "Link" is the weakest of publications either the interactions or the reach rate, while several Facebook

pages especially those owned websites, webmasters created Facebook pages just to share links.

In this article, we propose two strategies, one called a manual and the other one automatic, they enable to increase the interaction and extend the dissemination of information

#### 4.1 Manual strategy

##### 4.1.1 Methods

The manual strategy that we propose, it is based on four parameters, "Image", "Title", "Identify" and "Fans Motivation". But it is first necessary that the publications of a page are correct and true so that the Facebook page can be a source of information and next to this, gain the fans' confidence. However the "Image", and "Title" are two important elements that can bring a lot of users if they appear attractive, but it must pass a publication type "Link" to a publication type "Image" to benefit from "Identify" mechanism that has become a necessary element to bring more people to the subjects (especially when we know that the subject interests them) and therefore probably have more interactions. Finally the last thing that is interesting and gives more reputation to the Facebook page is the "Fans Motivation".

Image: the image plays a very important role for a publication to be attractive and can bring about a lot of interactions.

Title: a publication must be projected so that the title makes him want to "click", to "like" or "share" your publication. So always write a title that will attract the author himself.

Identify: Identify a person to a publication, it is a request action to people, and so this will make you easily increase interaction to your publications.

Fans motivation: fans motivation is above all respond to the questions posed in the comments of your fans, it proves that you are listening to fans and you are receptive to their comments. Also, we must propose topics to discuss, organize competitions (Best photo) etc.

##### 4.1.1 Application & results

After application of a strategy as described above, we took the case of LMO page by transmitting a publication type "Link" to a publication type "Photo" and then we identified 30 people to this publication.

Table 4. Result of feedbacks sharing a "photo" in LMO page

Page Name	LMO
Fan Number	1035
Likes	36
Comments	17
Shares	2
Reach	1865
Reach Rate	180.19%

Table IV describes the results found after sharing a publication type "Image" on the LMO page, and as you

can see very the considerable value of reach rate that has seen increased significantly, arriving at 180.19% instead of 16,33% that we found previously (see Figure 7), now the reach rate exceeds the fans number of our LMO page and also we see the interesting interactions (36 likes, 17 comments, 2 shares) instead of (18 likes and 1 comment), coming either from the fans of the page, people identified or friends of those identified

##### 4.2 Automatic strategy

Our second contribution is the establishment of a system to increase any kind of feedback and interaction between users in social networks, using the notion and the concept of collaborative work in a reliable, credible and transparent way. Thus, the notion of collaborative work today means a work that is no longer based on the traditional hierarchical organization, and more specifically a new work mode (possibly integrated into an economic production model), where many people work together through the information and communications technology (Grassineau 2009). It is based on a logical communication facilitated by the internet (Genthon et al. 1999) or of mutual interest. In the software field, it has for example accelerated and improved efficiency many tools (Horn 1999), in the thanks part to the "passage of the Copyright Copyleft" (Zimmerman 1999)..

In the governance, there are various studies have concluded that some collaborative tools or collaborative approaches could enhance participative democracy, "adaptive approaches" and even allow new forms of socio-ecosystem resilience (Berkes et al. 2003) via an "adaptative co-management" companies (Berkes et al. 1998) and their environment, particularly in light of ecological and climatic context changeable (Berkes et al. 2001), uncertain or restored (Olsson 2001) or with natural resources (overfishing (Berkes 1998), deforestation, erosion and soil degradation, etc.) possibly by drawing on local and ancestral knowledge (Berkes et al. 2002). Adaptive and collaborative co-management is one of the solutions (Buck et al. 2001) proposed for efficient management of biodiversity.

##### 4.2.1 Architecture

Figure 8 show the architecture of our system that we have entitled S2AF, which is based on n-tier architecture. Orientation to this architecture was driven by several aspects. Indeed, in such a system, many subscribers can access to the database which made it vulnerable, suddenly with a multi-tier architecture. The database access is performed only by the application server, it is possible to manage security at the application server, for example by maintaining a list of users with their passwords and their rights of access to system functions without changing the overall structure.

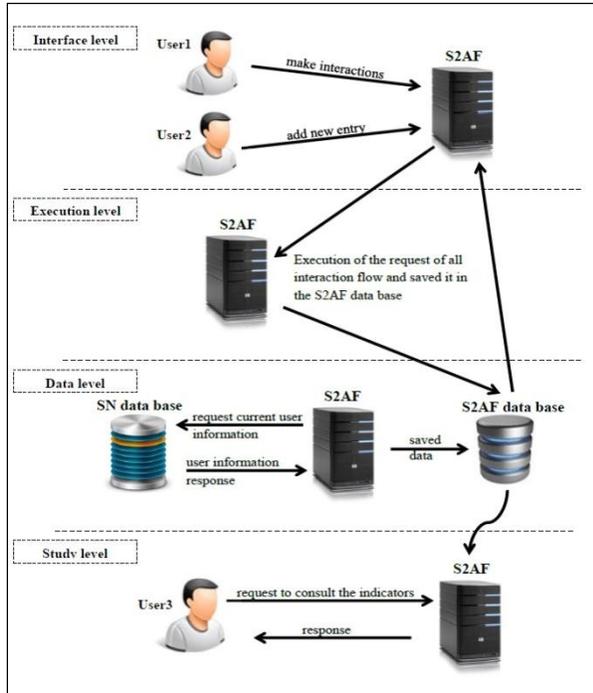


Figure 8 - Architecture of our system S2AF

**Interface Level:** At this level, the S2AF system provides communication between the user and the machine with a simple graphical interface. It is the main access to our system, the interface is divided into two windows, one for the monitoring and management of publications supplied by the user himself, and the second to deal with interactions on publications put by others in a collaborative spirit.

**Execution Level:** At this level, the system performs requests once that an interaction is set up by a user by retrieving the identifier of the user and in affecting him a "+1" if the operation is successful, if not "0", and for the receptor interaction, we remove "-1" from his score once receiving an action of the interaction as shown in Figure 11. The applications run by S2AF to a record in the database with all the information of the user and the interactions he has made and taking into consideration the calculation of indicators.

**Data Level:** In this level, the system is responsible for the collection of data using intermediate tools, for example for Facebook we use "Facebook App". It is also at this level that made the construction of the database and collects the data interactions in social networks and the injection of these data in the database of our system in a pattern well defined. The wildcard S2AF imposes a choice of data common to the most social networks.

**Study Level:** At this level, the system show in well defines schemas as diagrams and curves, the calculation results of the indicators whether those of satisfaction or

those of content, S2AF also presents the content and the process of activity done by users.

#### 4.2.2 Objectives and functioning

The indicators calculated by our system are divided into three categories: Content publications Indicators, Satisfaction indicators and Feedbacks Performance indicators. The data extracted by S2AF for the calculations of indicators are those related to the identified user (identifier, name, email address...), its interactions (like, share, comment...) and its publications (image, link, status).

**Content publications Indicators:** Indicators content publications indicate information on the types of publications and social network use. These indicators concern user interactions related to the task and content of the activity performed.

**Satisfaction Indicators:** These indicators refer to satisfaction with interactions and collaborations realized. Among the indicators having a relatively high value interpretation, we can note those who provide a state of satisfaction with the goals, while calculating the degree of presence of the user interface on S2AF whether transmitter or receptor state.

**Feedbacks Performance indicators:** These indicators refer to the modes or the quality of feedback and collaboration. Among the indicators having a relatively high value interpretation, we can note those who realize the quality of collaboration during interactions, those who provide state of relations established between users.

Regarding the choice of indicators calculated by our S2AF system, we have adopted an incremental approach; we started by determining some indicators in order to test the architecture of our system, and as necessary we can incorporate other indicators that stakeholders (user, administrator, webmaster,...) consider relevant. The Figure 9, show the hierarchical diagram of the goals of our system and integrated indicators.

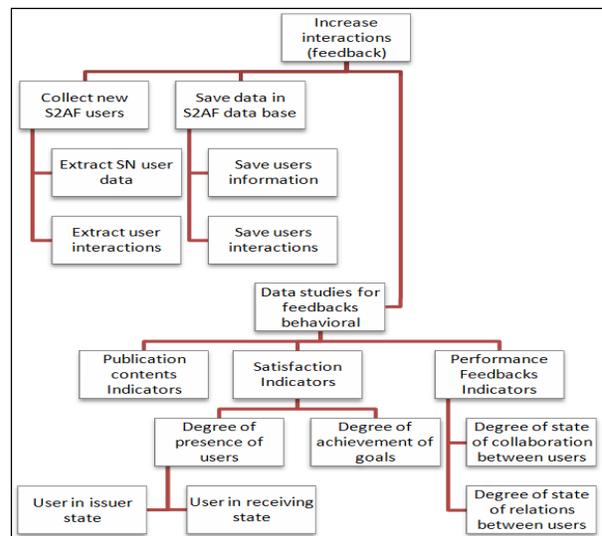


Figure 9 - Hierarchical diagram goals of S2AF

For the development and specification of our S2AF we used the process 2TUP (2 Tracks Unified Process), it belongs to the category of processes that meets the characteristics of the unified process. The 2TUP process provides a response to continual change constraints on information systems. In this sense, it strengthens control over the evolution and correction capabilities of such systems.

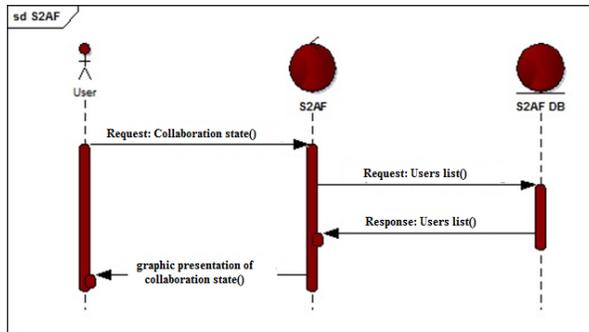


Figure 10 - Sequence Diagram providing the performance indicator Feedback: the state of collaboration between users

We have defined several use cases, according to the tasks that the system is required to perform. We present below (see Figure 10) an example sequence diagram relating to the case of use of the performance indicator feedback "state of collaboration between users". This use case describes the process executed by the system when the solicitation of information regarding the performance of feedback and especially the state of collaboration between the S2AF users.

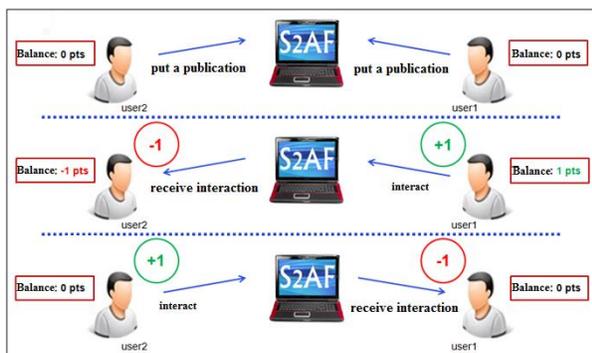


Figure 11 - functioning of S2AF system

Indeed the request is initiated by the user of S2AF system, it launches a new request to access to the database in order to return a list of users who interact on publications posted by other users. The result is returned to the system that performs the graphic presentation of the indicator as a tree.

Figure 11 show the operation of our system; for the case of two users logged on the system, delivering their first contact with the S2AF interface, they must connect and subsequently they are either seeking to put a publication or to interact with publications mailed by others. The balance of each user will be incremented by "1" point when it interacts with a publication and will be decremented by "1" point when it receives interaction. But it remains to note that the constraints is that the publication of a user with a "-1" balance never be displayed to others

### 4.2.3 Application & results

In order to test the performance of our system we found it necessary to create a community based on the social network Facebook. This community has 5 real users (Hassan, Sami, Driss, Farid and Kamal) see Figure 12.

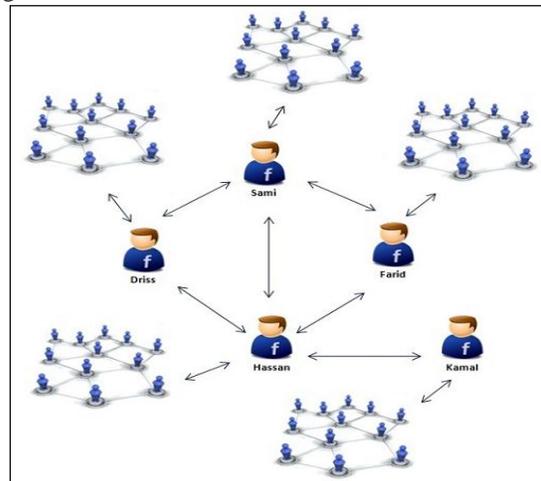


Figure 12 - Example of a real social network on Facebook with 5 real users

The relationship of this community is as follow: Hassan has 4 known friends (Sami, Driss, Farid and Kamal), Sami has 3 known friends (Driss, Hassan and Farid), Driss has two known friends (Sami and Hassan), Farid has two known friends (Sami and Hassan) and Kamal has one known friend (Hassan).

**Before or after using S2AF:** how many people interacted overlooked a publication?

To do this, we executed the following cases:

- Case 1: Hassan, Sami, Driss, Farid and Kamal share a publication as "image" type.
- Case 2: Hassan, Sami, Driss, Farid and Kamal share a publication as "status" type.
- Case 3: Hassan, Sami, Driss, Farid and Kamal share a publication as "link" type..

### Results « Before using S2AF »

The following tables (see Table V, Table VI and Table VII) describe the interactions made between the actual users of social network Facebook (Hassan Sami,

Farid, and Kamal Driss). The information in these shares is collected after 24 hours of the launch of the publication by these users.

Case 1: Sharing a publication as "image" type. As described in the previous table (see Table V), for example when Hassan shared a publication, he has some interactions from (Sami, Driss and Kamal). Sami and Driss they had one interaction from (Hassan). Farid has been a single interaction (Sami). Finally Kamal has never interaction to its publication. So the total of interactions is 6 on 12, which means 50% of the expected interactions.

Table 5. Case 1 : sharing « Photo » publication Before using S2AF

Emet/Réce	Hassan	Sami	Farid	Driss	Kamal
Hassan	-	1	0	1	1
Sami	1	-	0	0	N/A
Farid	0	1	-	N/A	N/A
Driss	1	0	N/A	-	N/A
Kamal	0	N/A	N/A	N/A	-

Case 2: Sharing a publication as "status" type. As described in Table VI, for instance when Hassan shared a publication, he has some interactions from (Sami and Kamal), Sami and Driss had a single interaction from (Hassan), Farid has a single interaction form (Sami) and Kamal has never interaction to its publication. So the total of interactions is 5 on 12, which means 41.67% of the expected interactions.

Case 3: Sharing a publication as "link" type. As described in Table VII, for example when Hassan shared a publication, he has a single interaction from (Farid). Sami received never interaction, Farid and Driss had a single interaction from respectively (Sami and Hassan), and Kamal has never interaction. So the total of interaction is 3 on 12, which means only 25% of the expected interactions.

Table 6. Case 2 : sharing « Status » publication Before using S2AF

Emet/Réce	Hassan	Sami	Farid	Driss	Kamal
Hassan	-	1	0	0	1
Sami	1	-	0	0	N/A
Farid	0	1	-	N/A	N/A
Driss	1	0	N/A	-	N/A
Kamal	0	N/A	N/A	N/A	-

Table 7. Case 3 sharing « Link » publication Before using S2AF

Emet/Réce	Hassan	Sami	Farid	Driss	Kamal
Hassan	-	0	1	0	0
Sami	0	-	0	0	N/A
Farid	0	1	-	N/A	N/A
Driss	1	0	N/A	-	N/A
Kamal	0	N/A	N/A	N/A	-

**Legend :**

Emt : Transmitter  
Réce : Receiver

N/A : Not Applicable.

**Results « After using S2AF »**

According to this experiment made for three cases cited before, it was found that the same case was redone but this time with the user of our S2AF system and found the following results:

Case 1: Sharing a publication as "image" type. As described in Table VIII, such as when Hassan shared a publication he has some interactions from these known friends (Sami Farid, Driss and Kamal), the same for others. So the total interactions are 12 on 12, which mean 100% of the expected interactions.

Table 8. Case 1 : sharing « Photo » publication After using S2AF

Emet/Réce	Hassan	Sami	Farid	Driss	Kamal
Hassan	-	1	1	1	1
Sami	1	-	1	1	N/A
Farid	1	1	-	N/A	N/A
Driss	1	1	N/A	-	N/A
Kamal	1	N/A	N/A	N/A	-

Case 2: Sharing a publication as "status" type. As described in Table IX, as when Hassan shared a publication he has some interactions from these known friends (Sami Farid, Driss and Kamal), the same for others. So the total interactions are 12 on 12, which mean 100% of the expected interactions.

Case 3: Sharing a publication as "link" type. As described in Table X, for example, when Hassan shared a publication he has some interactions from these known friends (Sami Farid, Driss and Kamal), the same for others. So the total interactions are 12 on 12, which mean 100% of the expected interactions.

Table 9. Case 2 : sharing « Status » publication After using S2AF

Emet/Réce	Hassan	Sami	Farid	Driss	Kamal
Hassan	-	1	1	1	1
Sami	1	-	1	1	N/A
Farid	1	1	-	N/A	N/A
Driss	1	1	N/A	-	N/A
Kamal	1	N/A	N/A	N/A	-

Table 10. Case 3 : sharing « Link » publication After using S2AF

Emet/Réce	Hassan	Sami	Farid	Driss	Kamal
Hassan	-	1	1	1	1
Sami	1	-	1	1	N/A
Farid	1	1	-	N/A	N/A
Driss	1	1	N/A	-	N/A
Kamal	1	N/A	N/A	N/A	-

**Comparative table of results:** Table XI, represents a comparative table of results found, and as you'll see our S2AF method participates in a reliable way to increase interaction toward publications in social networks. The goal without the use of S2AF will

not exceed 38.89% but using S2AF system we can attend 100%.

Table 11. Comparative table of results "Before" and "After" S2AF

Publication/method	Before S2AF	After S2AF
Photo	50%	100%
Status	41,67%	100%
Link	25%	100%
Average	38,89%	100%

## CONCLUSION

We saw in this paper the different types of publication, we also determined the type of the most popular publication among Facebook users with the survey we developed, and also the most effective based on experimental implementation. We also highlighted the dissatisfaction of the owners of Facebook page toward interactions fans' and reach rate, proposing a strategy and methods say static that help to increase interactions and thus reach rate.

In this document, we also showed our S2AF system whose objective is to help users of social networks to increase the feedbacks in a collaborative work. We have also shown the architecture of S2AF, indicators that can be calculated, and we showed on detail manner the results generated.

Regarding our perspectives, we expect to realize a case study for a large community, through the development of a multi-agent system that will help us generate users with an automatic way, aims to achieve this objective and validate thereafter the conformity of our system in case of corrective or progressive interventions.

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# Introduction Au Langage Lambda Pour la Programmation des Machines

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**Keywords :** Lambda-calcul, Base Logique, Programmation

**MSC Classifications:** 68P15, 18C20, 18D30

**Resumé:** Le Lambda-calcul est un langage introduit par Church en 1930 visant à construire une base logique pour les mathématiques et la logique combinatoire. L'utilisation du Lambda-calcul par Kleene comme un codage pour les fonctions calculable a donné naissance du premier langage de programmation abstrait, tel que la machine de Turing comme première machine programmée. Par son simple syntaxe, ce langage constitue un cadre général pour l'étude des propriétés de calcul. Le calcul lambda est la base de tous les raisonnements : Mathématiques qui est compatible avec les principes de F. Codd pour la construction d'un modèle relationnel à une Big Data.

En anglais : Lambda-calculus

Le calcul lambda est un système formel qui fonde les concepts de fonction et d'application. Il a été le premier formalisme utilisé pour

définir et caractériser les fonctions récursives. Alors il a une grande importance dans la théorie de la calculabilité, les machines de Turing et le modèle de Herbrand-Gödel. Depuis, il a été un langage de programmation théorique et aussi un métalangage pour la démonstration formelle assisté par ordinateur.

## 1-Approche du Peintre

Appliquer la consigne Peindre en couleur en utilisant le ROUGE :

**Appliquer la consigne à la couleur**  $\rightarrow$  **Peindre en couleur**  
 $\rightarrow$  **En utilisant le rouge.**

Equivalente à : **Peindre en rouge**

Traduction en lambda-langage:

$\lambda x \rightarrow$  Peindre en  $x \rightarrow$  En utilisant le rouge.

Ecriture en lambda-calcul :

$(\lambda x . \text{peindre en } x) \text{ rouge} \iff \text{peindre en rouge}$

Niveau	Mise en cascade
Un seul niveau	Application : $(\lambda \text{ couleur peindre en couleur l'objet } ) \text{ rouge}$ Réduction : peindre en <b>rouge l'objet</b>
Deux niveaux	Application : $(\lambda \text{ objet. } \lambda \text{ couleur peindre en couleur l'objet } ) \text{ rouge } ) \text{ mur}$ Rduction 1: $(\lambda \text{ couleur peindre en couleur le mur } ) \text{ rouge}$ Rduction 2: peindre en <b>rouge le mur</b>

**N.B** : Avec ces seules instructions, applications et réductions, sur des variables. Il est possible de reformuler tous les fonctions mathématiques et même, le raisonnement dans tous les domaines : linguistiques, mathématiques, informatique. De même qu'en informatique, on a imaginé des langages de plus haut niveau, plus faciles à manipuler en lambda calcul que écrire des programmes fastidieux en binaire.

## 2- Tour d'Horizon

-Le lambda-calcul est une sorte de langage à syntaxe élémentaire qui permet d'exprimer toutes les fonctions calculables.

-Le lambda-calcul est considéré comme la base mathématique de tous les langages de programmation.

-Formalisation développée par Alonzo Church et Stephen Kleene en 1932.

-Etudié comme langage universel par Jean-Louis Krivine.

-Le langage correspond à l'application d'une fonction à ses arguments.

-Toute entité est formalisée par :

i)- soit une variable

ii)- soit l'application d'une fonction à une autre

iii)- soit comme l'abstraction (réduction) d'une fonction

**Exemples :**

Une variable x	égale 7
Une fonction de x dite $\lambda x$	Egale à $3x+5$
Lambda expression	$\lambda x.3x + 5$
Une application (abstraction)	$(\lambda x.3x + 5)7 = 26$
Sa réduction (calcul)	$(3x+5)[7 /x]= 26$

- Le lambda-calcul est la base, surtout, des langages fonctionnels comme : LISP, Haskell (logod'-), Miranda, ML, OCaml.

- Il est aussi utilisé comme métalangage pour obtenir des définitions formelles.

- Langage fonctionnel : programmation en écrivant des fonctions qui appellent d'autres fonctions, qui appellent des fonctions.. (Lisp pur, Miranda, Haskell.).

- Langage impératif : langage de programmation décrivant le parcours d'un algorithme précis (Pascal, C++ ..)

- Langage impératif fonctionnel : Lisp, ML

### 3- Rudiments de Langage

#### - Un niveau

Variable objet	Mur	$x=a$
Fonction	Peindre en bleu	$f$
Lambda-fonction	$\lambda$ objet . Peindre en bleu l'objet	$\lambda x.f$
Lambda-abstraction	$(\lambda$ objet . Peindre en bleu l'objet) mur	$(\lambda x.f)a$
Réduction	Peindre en bleu le mur	$f[a / \text{objet}]$

#### -Deux niveaux en cascades

Données	Variable objet Variable couleur Fonction	Mur Rouge Peindre en couleur l'objet	$x=a$ $y=b$ $f$
Lambda de premier niveau	Lambda-fonction  Lambda-abstraction  Réduction	$\lambda$ couleur. $\lambda$ objet . Peindre en couleur l'objet  $(\lambda$ couleur. $\lambda$ objet . Peindre en couleur l'objet) rouge Peindre en rouge l'objet	$\lambda y.\lambda x.f$  $(\lambda y.\lambda x.f)b$  $\lambda x.f[b/\text{couleur}]$
Lambda avec les deux niveaux	Application complète  Réduction d'un niveau  Nouvelle application	$((\lambda$ couleur. $\lambda$ objet . Peindre en couleur l'objet) rouge) mur  $(\lambda$ objet . peindre en bleu l'objet) mur Peindre en bleu le mur	$((\lambda y.\lambda x.f)b)a$  $(\lambda x.f[b/\text{couleur}])a$  $f[b/\text{couleur}, a/\text{objet}]$

### 4- Calcul

#### -Alpha Réduction

$$\lambda x.E \implies \lambda zz/xE$$

Dans la fonction  $E$ , tous les  $x$  peuvent être remplacés par  $z$ .

#### -Bêta Réduction

$$(\lambda x.P)Q \implies P[Q/x]$$

Dans la fonction  $P$ , tous les  $x$  peuvent être remplacés par  $Q$ .

#### Exemple :

$$((\lambda x.\lambda y.x)\text{chat})\text{cacahuète} \longrightarrow ?$$

#### Calcul :

En effet, il faut remplacer dans la fonction  $x$  tout ce qui est  $x$  par cacahuète :

$$((\lambda x.\lambda y.x)\text{chat})\text{cacahuète} \longrightarrow (\lambda y.\text{cacahuète})\text{chat}$$

Dans la fonction cacahuète nous devons remplacer tous  $y$  par chat. Or il n'y pas chat dans cacahuète, donc la fonction ne peut pas être réduite en une expression en chat . Alors elle reste dans son état général de cac-

ahuète.

$(\lambda y.cacahuète)chat \longrightarrow cacahuète$

## 5- Quelques Formulations

### -Fonctions duales

L'application sur  $a$  qui donne toujours  $a$ , c'est la fonction vraie :

$$((\lambda x.\lambda y.x)b)a \longrightarrow (\lambda y.a)b \longrightarrow a$$

L'application sur  $a$  qui donne toujours  $b$ , c'est la fonction fausse :

$$((\lambda x.\lambda y.y)b)a \longrightarrow (\lambda y.y)b \longrightarrow b$$

Alors:

$$VRAI = (\lambda x.\lambda y.x)$$

$$FAUX = (\lambda x.\lambda y.y)$$

### -Définition des nombres entiers:

La formulation fait allusion à la répétition de l'application:

$$0 = \lambda f.\lambda x.x$$

$$1 = \lambda f.\lambda x.(f)x$$

$$2 = \lambda f.\lambda x.(f)(f)x$$

$$3 = \lambda f.\lambda x.(f)(f)(f)x$$

## 6- Propriétés

-Thèse de Church : Toute fonction calculable peut l'être avec un ensemble réduit d'instructions et une affirmation philosophique indémontrable, base de toute l'algorithmique.

-Théorème de Church-Rosser : Le

résultat final de substitutions lors des réductions ne dépend pas de l'ordre dans lequel ces substitutions sont effectuées.

-Modèle de calcul universel : Tout calcul exprimable en machine de Turing est aussi exprimable en lambda-calcul.

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6

# Web-Marketing 3.0 In Social Network using MDA Approach and Pulse detector.

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**Abstract**—In this paper we have focused on the evolution of the Web-marketing meaning the passage of the Web-marketing 2.0 to 3.0, baptized " Semantic Web-marketing ", the main idea being to make easier to the Internet user to use a huge and disrupting stream of information and make it organized and easily accessible.

As so, we have chosen to use the N-tiers applications and the MDA (Model Driving Architecture) transformation. In this paper we are going to present a model-driven approach to the development of N-tiers web applications based on the UML class diagram. The transformation language is the MOF 2.0 QVT (Meta-Object Facility 2.0 Query-View-Transformation) standard which defines the meta-model for the development of model transformation.

Then we introduced a webcam-pulse-detector to detect the heart beat of the clients by an imaging solution using ambient light for catching their preferences.

**Keywords:** *Web-Marketing, Transformation by modeling, N-tiers architecture, Transformation rules, MOF 2.0 QVT, Meta-model, webcam-pulse-detector, ambient light.*

## I. INTRODUCTION

The Webmarketing 3.0 is the way to attract the clients by different ways, as so we introduced a innovated technique called "Detection of the cardio-vascular pulse wave" and can be done by means such as variations in air pressure, impedance, or strain. Photo-plethysmography (PPG)[1], introduced in the 1930's using light reflectance or transmission and is the least expensive method and simple to use. PPG is based on the principle that blood absorbs light more than surrounding tissue so variations in blood volume affect transmission or reflectance correspondingly. Applications of PPG include monitoring of oxygen saturation (pulse oxymetry), heart (HR) and respiration (RR) rates, blood pressure, cardiac output, assessment of autonomic functions and detection of peripheral vascular diseases. Remote, non-contact pulse oxymetry and PPG imaging have been explored only relatively recently [2, 3]. In this work we are going to transform an UML Model concerning an advertisement in a social network to generate a source code.

In a recent work [21], the authors have developed a source and a target meta-models. The first was a PIM meta-model specific to class diagrams. The second was a PSM meta-model for MVC2 (Model-View-Controller) web applications (particularly Struts), then they have elaborated a transformation rules using the approach by programming. The purpose of our contribution is to produce and generate an N-tiers PSM model, implementing MVC2, DI (Dependency Injection) and DAO (Data Access Object) patterns, from the class diagram. In this case, we elaborate a number of transformation rules using the approach by modeling and MOF 2.0 QVT[4], as transformation language, to permit the generation of an XML file that can be used to produce the required code of the target application. The advantage of this approach is the bidirectional execution of transformation rules[5].

## II. MODEL DRIVEN ARCHITECTURE (MDA)

In November 2000, OMG, a consortium of over 1 000 companies, initiated the MDA approach. The key principle of MDA is the use of models at different phases of application development. Specifically, MDA advocates the development of requirements models (CIM), analysis and design (PIM) and (PSM) code [6].

The MDA architecture is divided into four layers. In the first layer, we find the standard UML (Unified Modeling Language), MOF (Meta-Object Facility) and CWM (Common Warehouse Meta-model). In the second layer, we find a standard XMI (XML Metadata Interchange), which enables the dialogue between middlewares (Java, CORBA, .NET and web services). The third layer contains the services that manage events, security, directories and transactions. The last layer provides frameworks which are adaptable to different types of applications namely Finance, Telecommunications, Transport, medicine, E-commerce and Manufacture, etc.).

The major objective of MDA is to develop sustainable models, those models are independent from the technical details of platforms implementation (J2EE, DotNet, PHP

or other), in order to enable the automatic generation of all codes and applications leading to a significant gain in productivity. MDA includes the definition of several standards, including UML [8], MOF [12] and XMI [14].

### III. N-TIERS ARCHITECTURE

N-tiers application architecture provides a model for developers to create a flexible and reusable application and provides some advantages that are vital to the business continuity of the enterprise. Typical features of a real life N-tiers may include the Security, Availability, Scalability, Manageability, Easy Maintenance and Data Abstraction. To most people, an N-tiers application is anything that is divided into discrete logical parts. The most common choice is a three-part breakdown presentation, business logic, and data access although other possibilities exist. In this paper, we are using the following layers:

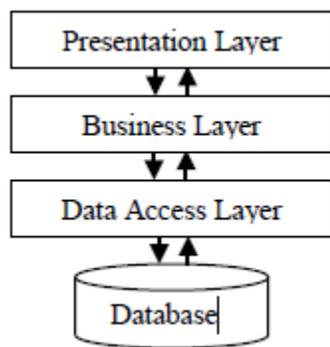


Fig.1 N-tiers Layers

Each Layer can be developed independently of the other provided that it adheres to the standards and communicates with the other layers.

#### A. The presentation Layer with MVC2 pattern

Along time ago, web applications were very simple and the technology that was used to develop them was Common Gateway Interface (CGI). As applications became more complex, the defects and limits of this technology have emerged. Slowness and considerable consumption of memory. Therefore, the J2EE platform applies the architecture MVC2 [7]. In this paradigm, the model represents the information system consisting of javaBeans. The view represents the HTML pages returned to the user, and consists of JavaServerPage (JSP). The Controller is the glue between the two and it is composed of servlets. In short, during the early 80's with smalltalk, MVC was widespread in the field of object development. Many frameworks that implements MVC2 pattern have emerged, among them: Struts [1], PureMVC [19], Gwittir [14], SpringMVC [15], Zend [18], ASP.NET MVC2 [5]. Struts remains the most mature solution that has earned the trust of most developers, that is why we have taken it into account in our source meta-model.

#### B. The Business layer with Data Transfer Object and Dependency Injection patterns

In an article written in early 2004, Martin Fowler asked what aspect of control is being inverted. He concluded that it is the acquisition of dependent objects that is being inverted. Based on that revelation, he coined a better name for inversion of control: dependency injection [19]. In other words, Dependency Injection is a worthwhile concept used within applications that we develop. Not only can it reduce coupling between components, but it also saves us from writing boilerplate factory creation code over and over again. Many frameworks that implements DI pattern have emerged, among them: Spring [15], Symphony dependency injection [17], Spring.NET [6], EJB, PicoContainer [13]. (We have used some Spring classes in our source meta-model).

### IV. THE WEBCAM-PULSE-DETECTOR PROCESS

A python code that detects the heart-rate of an individual using a common webcam or network IP camera. Tested on OSX 10.7 (Lion), Ubuntu 13.04 (Ringtail), and Windows 7. Inspired by reviewing recent work on Eulerian Video Magnification, with motivation to implement something visually comparable (though not necessarily identical in formulation) to their pulse detection examples using Python and OpenCV. This goal is comparable to those of a few previous efforts in this area (such as <https://github.com/mossblaser/HeartMonitor>). This code was developed at NASA Glenn Research Center in support of OpenMDAO, under the Aeronautical Sciences Project in NASA's Fundamental Aeronautics Program, as well as the Crew State Monitoring Element of the Vehicle Systems Safety Technologies Project, in NASA's Aviation Safety Program. A list of other open-source NASA codes can be found at [code.nasa.gov](http://code.nasa.gov).

This application uses OpenCV to find the location of the user's face, then isolate the forehead region. Data is collected from this location over time to estimate the user's heart rate. This is done by measuring average optical intensity in the forehead location, in the subimage's green channel alone (a better color mixing ratio may exist, but the blue channel tends to be very noisy). Physiological data can be estimated this way thanks to the optical absorption characteristics of (oxy-). With good lighting and minimal noise due to motion, a stable heartbeat should be isolated in about 15 seconds. Other physiological waveforms (such as Mayer waves) should also be visible in the raw data stream. Once the user's heart rate has been estimated, real-time phase variation associated with this frequency is also computed. This allows for the heartbeat to be exaggerated in the post-process frame rendering, causing the highlighted forehead location to pulse in sync with the user's own heartbeat.

Support for detection on multiple simultaneous individuals in a single camera's image stream is definitely possible, but at the moment only the information from one face is extracted for analysis.

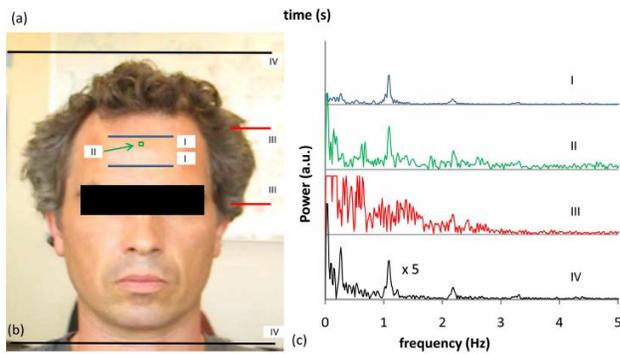


Fig 2. Signals corresponding power spectra

### V. Transformation process from UML to N-tiers implementation

CRUD operations (Create, Remove, Update, and Display) are most commonly implemented in all systems. That is why we have taken into account in our transformation rules these types of transactions. We first developed EMOF models corresponding to our source and target meta-models, and then we implemented the algorithm using the transformation language QVT Operational Mappings. To validate our transformation rules, we conducted several tests. For example, we considered the class diagram (see Figure 7). After applying the transformation on the UML model, composed by the classes User and advertisement, we generated the target model.



Fig. 4 UML instance model

This Figure represents the first part of the code of the transformation of UML model source to N-tiers target model.

```

1 transformation UML2CRUD(in umlModel:UML, out crudModel:N7TIER)
2
3 main() {
4   umlModel.objects().forEach {UmlPackage} =>map UmlPackage2CrudProjectPackage {
5     |
6     }
7     mapping UmlPackage2DaoPackage2CrudProjectPackage ( : CrudProjectPackage |
8       name := 'crud' +uml.name
9       daoPackage := object DaoPackage {
10        name := 'dao' +uml.name
11        pojo := umlModel.objects().forEach {Class} =>map class2Pojo {}
12        dao := umlModel.objects().forEach {Class} =>map class2Dao {}
13        daoImpl := umlModel.objects().forEach {Class} =>map class2DaoImpl {}
14      }
15
16      bPack := object BusinessPackage {
17        name := 'business' +uml.name
18        dao := crudModel.objects().forEach {Pojo} =>map pojo2DTO {}
19        services := umlModel.objects().forEach {Class} =>map class2Service {}
20        serviceImpl := umlModel.objects().forEach {Class} =>map class2ServiceImpl {}
21      }
22
23      vPack := object ViewPackage {
24        name := 'presentation' +uml.name
25        view := object ViewPackage {
26          name := 'view' +uml.name
27          view := umlModel.objects().forEach {Class} =>map class2View {}
28        }
29        ctrl := object ControllerPackage {
30          name := 'controller' +uml.name
31          actionMapping := object ActionMapping {
32            name := 'action' +uml.name
33            actions := umlModel.objects().forEach {Class} =>map class2Action {}
34          }
35        }
36      }
37    }
38  }

```

Fig 3. A transformation code UML2CRUD

The entry point of the transformation is the method 'main'. This method makes the correspondence between all the elements of the UMLPackage type of the input model and the element of the CrudProjectPackage type of the output model. The objective of the second part of this code is to transform a UML package into N-tiers package, by creating the elements of type package 'Dao', 'Business' and 'Presentation. It is a question of transforming each class of package UML to Jsp page and Action in the View package, to DTO, IService and ServiceImpl in the Business package, and to Pojo, IDao and DaoImpl in the Dao package, without forgetting to give names to the different packages.

**B.Result:**

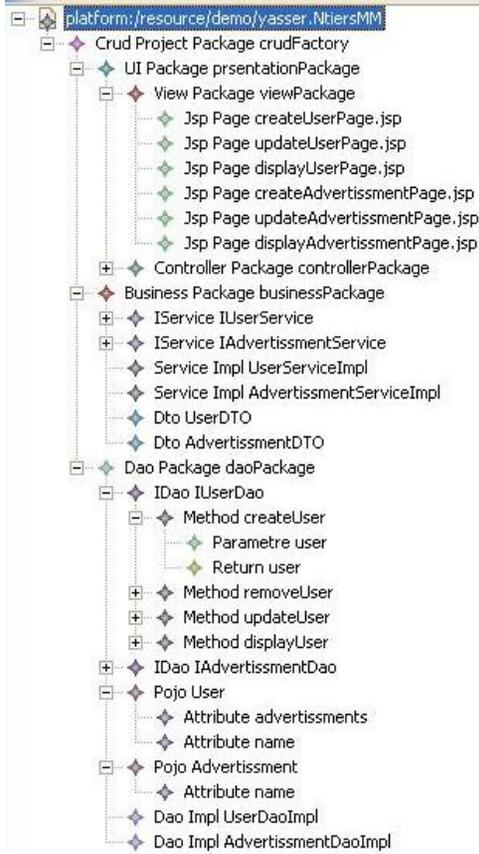


Fig. 5 Generated PSM N-tiers Web model

The first element in the generated PSM model is UIPackage which includes viewPackage that contains the JSPs, namely DisplayUserPage.jsp, Display-AdvertisementPage.jsp, CreateUserPage.jsp, CreateAdvertisementPage.jsp, UpdateUserPage.jsp, and UpdateAdvertisementPage.jsp. Since the operation of the removal requires any form, we'll go to the controllerPackage element, which contains a single element ActionMapping. The latter contains eighteen delegating action proxy whose names are respectively DisplayXAction, CreateXAction, UpdateXAction, RemoveXAction, CreateXEndAction, UpdateXEndAction, where X should be replaced by User, and Advertisement. Operations for creation and update, add forms to enter new values. For this reason, we add CreateXEndAction and UpdateXEndAction. The second element in the generated PSM model is businessPackage which includes three services' interfaces, three services' implementations and three Dtos' objects correspond to the two objects 'User' and 'Advertisement'. The last element in the generated PSM model is DaoPackage which contains three Pojos' objects that contains their attributes, three Daos' interfaces that contains methods with their parameters and their implementations.



Fig. 6 Sample of the generated Web site

**VI. Conclusion**

In this paper, we applied the MDA approach to generate the N-tiers web application based on UML class diagram to generate a skeleton of a social network and create appropriate advertisements to the users in function of them profiles. This involves developing all meta-classes needed to be able to generate an N-tiers application respecting a MVC2, DI and DAO patterns, then we applied the approach by modeling and used the MOF 2.0 QVT standard as a transformation language. The transformation rules defined allow browsing the source model instance class diagram, and generating, through these rules, an XML file containing layers of N-tiers architecture according to our target model. This file can be used to produce the necessary code of the target application. The algorithm of transformation manages all CRUD operations. Moreover, it can be re-used with any kind of methods represented in the UML class diagram. In the future, this work should be extended to allow the generation of other components of Web application besides the configuration files. For instance, we will be able to provide part of user interface. Afterward we can consider integrating other execution platforms like PHP and DotNET.

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# Big Data and Finance

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**Abstract—** In this paper, we discuss the exploitation of Big Data in finance, particularly, we discuss financial opportunities to better management and challenges related to the emergence of big data. We review various works putting big data at the service of finance using analytical or predictive techniques. Furthermore, we recall some methods suitable to handle and extract relevant information from big data.

**Keywords—** Big Data; Data analytics; HFT; Risk management; Finance; Capital Market; Machine learning; Statistical learning; Prediction.

## I. INTRODUCTION

Finance is based on a compromise between the risk taken and the expected profitability. Good management is required to ensure the sustainability of financial institutions. This good management is mainly result of sufficient information and robust models, to take suitable decisions.

The concept of “too big to fail” was until 2008, with the fall of Lehman Brothers, one of the most “repeated” assumptions in debates around financial risks. The 2007 crisis highlighted that the size of a financial institution was not a more important factor than the risk management itself.

According to Diebold, the word “big Data” emerged From the mid 1990s [1]. In the same work, Diebold makes the difference between big data as phenomenon, term and as a discipline. Thereby, big data is a difficult concept to define. Nevertheless, big data is often defined as the three V's corresponding to volume, variety, velocity [2]. Another V has been added to the list by some academics over the last few years; veracity, which relates to measurement or labeling of the integrity or quality of the data being processed or stored; thus a reflection of the rising importance of data transparency [12]. To give a simple definition, even simplistic, we can say that Big Data is a large or very large amount of data, structured and unstructured, from different numerical sources whose handling require the implication of several disciplines.

With the internet and the emergence of social media, blogs and discussion platforms as well as intelligent devices, financial institutions have new information sources, new challenges and opportunities. Manpreet Singh [13] analyzed the growing need of Big Data technology in financial domain, especially in Capital Markets. Further, he pointed out that the financial risk management and trading analytics were a major reasons for the connection made between finance and big data.

In order to exploit the power of this large data flows serving the financial activity as well as managing associated risks, works has been carried out, using and combining existing methods as well as by introducing new approaches analysis. Thus, In [14], authors take two approaches to prediction of financial markets using text data downloaded from web bulletin boards. The first uses maximum entropy text classification to predict, based on the whole body of text. The second uses a genetic algorithm to learn simple rules based solely on numerical data of trading volume, number of messages posted per day and total number of words posted per day. In [15], a discussion about how the big data predictive analytics is influenced in the financial market mainly in the stock exchange and financial volatility.

Most work linking finance and big data were focused on techniques of predictive big data analysis via the use of, especially, sentiment analysis. Indeed, in [4], authors study the effect of more than 1.5 million messages posted on Yahoo! Finance and Raging Bull about the 45 companies in the Dow Jones Industrial Average, and the Dow Jones Internet Index. They concluded that the stock messages help predict market volatility, but not stock returns. Moreover, authors of [5], based upon dataset of over 20 million posts made on the site LiveJournal, demonstrate that anxiety, worry and “fear from”, predict downward pressure on the S&P 500 index. They also confirmed this result using Monte Carlo simulation.

Another type of work which making connection between finance and big data is based on Twitter posts. In fact, a work done by Zhang *et al.* [6] makes prediction of stock market indicators such as Dow Jones, NASDAQ and S&P 500 by analyzing Twitter posts. Authors found that emotional tweet percentage significantly negatively correlated with these market indicators but displayed significant positive correlation to VIX. In [7], authors studied the problem of correlating micro-blogging activity with stock-market events, defined as changes in the price and traded volume of stocks using Twitter as a data source and found that the correlation is stronger with the traded volume than with the price of the stock. The authors of [3] have rather focused on the tweets credibility. Indeed, using stock tweets, showed that it is beneficial to distinguish expert users from non-experts on stock microblogs. Further, they found that distinguishing experts from non-experts combined with unsupervised learning allow us to predict stock price movement with high precision.

Other authors go further like E.D. Brown who concluded that Twitter can be used as a predictive tool for decision support for investing decisions [9].

Studies evolving in the same direction, but using Google Trends as source was done. In fact, authors of [10] provided a quantification of the relationship between changes in search volume and changes in stock market prices by analyzing changes in Google query volumes for search terms related to finance, and found patterns that may be interpreted as “early warning signs” of stock market moves. These results were confirmed by [11] in which authors showed that Google Trends contains enough exploitable information to improve trading performance, focusing on the fact that the choice of keywords is crucial.

In this work, we will show the usefulness of Big Data in finance including risks management, either for the retail banking or for investment institutions. Then we will discuss about high-frequency trading which is a result of big data emergence. Afterward, we will highlight the importance of big data analytics. Finally, we will recall some methods that can help to predict or extract information in the big data framework.

## II. BIG DATA AND FINANCE

### A. *Big Data in finance*

Business intelligence and analytics and the related field of big data analytics have become increasingly important due to their power to bring about solution in various fields [27]. Finance with its various forms is not the exception, on the contrary, big data technologies, analytics and solutions seem to interest more and more finance practitioners. In what follows, we focus on uses of the big data analysis.

One can consider that the craze of finance for big data as natural because the four V of big data are the core of financial activity. Indeed, data of financial institutions are increasing. In addition, the size of data available to an institution is considered as an essential source of information for good management. Then, the transmission speed of its large amounts of data plays an important role for adequate reactions of financial actors and the real-time is desired, especially in financial market. Big data offers also a wide variety of information extracted from a variety of data sources, encompassing data from mobile devices, social media applications, website, etc., that are advisable to integrate in every financial analysis because they help to have varied management elements. Veracity of big data plays a very important role in financial framework, maybe more than in other areas. In fact, The lack of veracity for financial management purposes in the context Big data leads to conclusions that can undermine the activity. So, when handling data extracted from web, in general, one must take into account the basic tenets "Anybody can say Anything about Any topic (AAA)" [28]. The importance of veracity is confirmed by [3] when authors have shown that when using stock tweets, it is beneficial to distinguish expert users from non-experts on stock microblogs.

According to [29] the needs of big data analysis in finance are different depending on the nature of the financial institution activity. Indeed, For retail banks, the big data analysis is mainly to attract new customers by operating on behavioral analysis and profiles of its customers. For investment banks the need of big data analysis is for increase the result in making good decisions, this requires the mastery of its exposure to financial risks.

The classical way to manage the financial risks faced by firms is based on the analysis of internal data, often quantitative. The 2007/08 crisis demonstrated that approaches in place to manage risks are relatively inadequate compared to most risks faced by banks today. So, risks management has requested far more advanced solutions. One of these solutions was the integration of big data analysis to prevent different risks. The concept of big data has been applied to a whole host of industries but the capital markets have been relatively slow to adopt these strategies. Big data in capital markets is a long way off being considered mature. However, Big data strategies have begun to make some impact in a select few areas of the capital markets over recent years, including within sentiment analysis for trading, risk analytics, and market surveillance [12].

*a) Trading analytics:* For trading purposes, the connection made between finance and big data is based mainly on the High volume of historical trading data stored, on the analysis of social networks including Facebook and Twitter, on site analysis of specialized blogs discussion, economic information website and emails, etc.; The analysis of these resources aims, principally, to build backtest strategies for financial models and to build also predictive models of stock market levels and trading volume. In terms of insight, this can be related to the identification of trading opportunities in the market, the running of market exposure analytics for portfolio managers and traders examining data on a real-time basis, running stressed scenarios via interactive scenario modeling, and responding to these results [12].

A reference work in this direction is that of Werner Antweiler and Murray Z. Frank [4] in which they found correlation between activity in Internet message boards, stock volatility and trading volume. However, to extract helpful insight from different information sources, the choice of suitable keywords well as the reputation of the publisher is crucial (see for example [11] and [3]) even if all internet messages are also important and can influence over the movements of financial market and so on trading activity. In fact, the effect of the internet rumors on exchanged volumes was studied in [8].

In addition to what we just discuss, Trading Analytics includes also various analytics areas in trading for High Frequency Trading (HFT), pre-trade decision, supporting analytics for frequent trades, sentiment measurement and temporal analytics, etc.[13]. We will return, later in this paper, to the HFT.

*b) Risk management:* Risk management is at the heart of the financial activity, not just to ensure the sustainability of financial institutions, but also to be in compliance with various

regulatory imposed over the previous decade. Financial institutions confront new regulations and are preparing for the upcoming regulations Like EMIR, Bale III, solvencyII, etc. Big Data technologies are needed in solving risk management issues. Indeed, the calculations can be performed while accessing the data. Whether cross-analysis or integration of information on risks and financial trends in order to adjust the returns and balance sheets. Further, Big Data technologies can help risk teams gain more accurate risk intelligence, drawn from a variety of data sources, in almost real time.

The figure below gives a non-exhaustive list of financial risks concerned with big data.

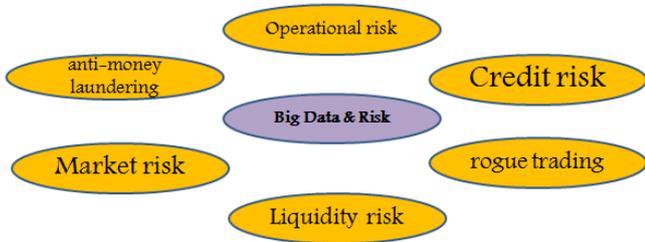


Fig. 1. kinds of financial risk for which big data can be used.

Big Data technologies are needed in solving risk management issues. Indeed, the calculations can be performed while accessing the data. Whether cross-analysis or integration of information on risks and financial trends are needed in order to adjust the returns and balance sheets. Further, Big Data technologies can help risk teams gain more accurate risk intelligence, drawn from a variety of data sources, in almost real time.

Note that credit risk and liquidity risk are intrinsically linked. Moreover, the credit risk was one of the principal causes of the recent financial crisis. The older models used to predict the credit worthiness of a company can be supplemented with input and analysis from big data. In fact, big data offers a wide variety of information; these variables can be integrated into more traditional credit rating models to identify hidden patterns that can lead to better predictive abilities regarding credit worthiness. This hybrid model would allow a more accurate way to apply credit ratings to financial companies [13].

An other example in which big data framework can be useful for credit risk: Credit Value Adjustment (CVA) calculations can take anywhere from 30 minutes to 30 hours or more to run for large over-the-counter (OTC) portfolios—clearly not something which fits into the required pre-trade category. In a typical CVA model, 5 to upwards of 50 million simulated values are calculated per trade. Large sell side portfolios consist of hundreds of thousands, if not millions, of outstanding OTC transactions. The resulting data size alone is in excess of 10 terabytes of data, making effective CVA a true Big Data problem [30].

For market risk, several works cited above assert that internet social media, etc. ; contain sufficient information to be able to predict market trends. Otherwise, in [15] authors argue

that financial volatility is predictable and deals with the historical data which are a time series model.

Note that an approach was proposed in [31], based on a Bayesian inference method, that allows for a combination of Internal data, relevant external data and expert opinion to estimate the parameters of the risk frequency and severity distributions. On another side, authors of [32] claimed to have built a fraud risk monitoring and management system, at Alibaba, based on real-time big data processing and intelligent risk models. It captures fraud signals directly from huge amount data of user behaviors and network, analyzes them in real-time using machine learning, and accurately predicts the bad users and transactions. Recently, in [33], authors consider that "the risk of risks" is reputation risk, and this is why companies should develop better tools and analysis methods for utilizing their internal big data for identifying reputation risks.

### B. Algorithmic trading and High-Frequency Trading (HFT)

Among the most important innovations in the domain of market finance brought by the use of big data is algorithmic trading. This is a type of trading using electronic platforms for entering trading orders by leaving an algorithm decide the moment of opening or closing (the timing), the price or volume of the order. The algorithm can be created with structured and unstructured data, incorporating real-time news, social media and stock data coupled with mathematical models. A kind of algorithmic trading is called high-frequency trading (HFT) in which computers take complex decisions to issue orders on the basis of information which is received through electronic way, before that human operators are capable of processing the information they observe. Often, The terms "algorithmic trading" and "high-frequency trading" mixed up in the public debate. In contrast to traditional trading strategies, high-frequency traders do not aim to establish and hold long-term positions. Rather, they enter into short-term positions and end the trading day "flat", i.e. without carrying over significant positions to the next business day. Algorithmic trading strategies, on the other hand, typically aim at reducing the adverse market impact of large-sized, institutional orders (see [34]). for the classification of HFT strategies, the reader is advised to consult [35].

Both courteous and criticized, In 2014, for example, the New York Stock Exchange allowed its members to place an order, using the HFT, every 37 microseconds [36]. The same year, the THFs (specialized firms and THF banking activity) accounted for between 24% and 43% of volumes on European equities. They represented an even higher proportion of the number of orders, from 58% to 76%. Many of these orders are canceled: nearly one in two has a lifespan of less than 0.2 seconds [37].

The fact of using analysis of big data extracted from different information sources, HFTs predict price changes occurring a few seconds in the future [40]. however, the HFT is often criticized. In fact, in [34], authors warned against the allegedly harmful effects in the event of adverse market conditions and claimed that regulators are currently putting strong emphasis on subjecting high-frequency trading to

prudential and organisational requirements and to supervision by a competent authority.

We think these criticisms are founded, since the use of HFT can lead to risks of large losses such as those of the "Flash Crash" (May 6, 2010). That day, the Dow Jones Industrial Average lost about 998.52 points before regaining 600 points, between 14h42 and 14h 52 at the New York Stock Exchange (NYSE). A decrease of 9.2% in the space of 10 minutes was unprecedented in history. This incident has revealed the involvement of high-frequency trading, which now accounts for two-thirds of NYSE stock market transactions [38]. Adding to this event, losses suffered by Knight Capital (KCG) in 2012. Indeed, this global financial services firm specialized in HFT has nearly blew up the market and the firm lost \$ 440 million in 45 minutes because of a computer bug. [39].

One can say that the fusion of big data technologies and finance has given birth to the HFT which is a very fast speculation method but must be used "sparingly".

### III. SOME BIG DATA ANALYTICS TOOLS

Business intelligence and analytics and the related field of big data analytics have become increasingly important due to their power to bring about solution in various fields [27]. Finance with its various forms is not the exception, on the contrary, big data technologies, analytics and solutions seem to interest more and more finance practitioners.

In this section, we focus on the methods and processes dedicated to explore big data finance. Data which are used by financial institutions can be categorized into two different types. Structured data, which are easily identifiable and codified (price, date, temperature, stock information, etc.). These data can be analyzed qualitatively or quantitatively. With the advent of social media, Financial institutions have access to a large variety of new data. These new data are unstructured Arising from multiple origins. In most cases, this is textual data extracted from blogs, social media, E-mail, etc. sometimes this data are in form of videos, images, audio, etc. The processing and analysis of such data require, often, machine learning techniques.

The need to explore these data in finance is motivated by several reasons, we quote: uncovering of hidden patterns and unknown correlations, market trends, backtesting of financial models or the measurement of the risk of granting a credit via the scoring method. Therefore, this requires robust analytical techniques and statistical models that offer a high prediction quality.

#### A. Exploratory Data Analysis and predictive Statistic

Note that conventional statistical methods of data analysis such as principal component analysis, correspondence factor analysis and canonical-correlation analysis remain valid in the context of big data (see [16]). Furthermore, Given the large volume of data, parallelization of tasks is needed: Data is divided into nodes, each associated with a processor or computer connected to others through a broadband network into a cluster.

A recent snapshot on statistical analysis with big data that exceed the memory and computing capacity of a single computer is done in [18]. The presented methodologies were grouped into three classes: subsampling-based, divide and conquer, and online updating for stream data.

Note that methods of data mining and text mining are also unavoidable in the big data analysis (see [14] and [41]). Furthermore, the various types of regression and time series, including the autoregressive (AR) model, autoregressive conditional heteroscedasticity (ARCH) and generalized autoregressive conditional heteroscedasticity GARCH ones are very useful for building predictive models starting from big financial data (see [23] and [24] for financial volatility prediction in big data context).

In the context of the statistical study of data, the most important parameters to consider are  $n$ , the sample size (number of observations) and  $p$ , the number of observed variables on this sample. When particularly  $p$  is greater than  $n$ , the conventional statistical methods are vulnerable and the use of modern methods of statistical learning becomes a more efficient alternative [17].

Statistical learning is divided into two distinct categories:

- Supervised statistical learning has predictive purposes, it is related to regression cases or classification problem (Decision Tree, neural networks, logistic regression, PLS regression, Ridge, etc.).

Given a training set consisting of data observations of input-output type:  $\mathcal{d}_1^n = \{(x_1, y_1), \dots, (x_n, y_n)\}$ , with  $x_i \in X$  (often  $\mathbb{R}^p$ ),  $y_i \in Y$  for  $i = 1, \dots, n$ .

The goal is to build, from the training sample, a model that will help predict the output  $y$  associated with a new input  $x$  (predictor variable).

- Unsupervised statistical learning: the aim in the unsupervised case is exploratory, usually used to group data into homogeneous classes but as dissimilar as possible. It is a clustering problem that uses the methods of hierarchical clustering, dynamic allocation algorithms (k-means) or self-organizing map (SOM), etc.

#### B. Sentiment analysis or opinion mining

In addition to statistical methods or analysis cited above, a majority of academic works has focused on analyzing the content of messages posted online, also called « sentiment analysis » or « opinion mining » [19]. Sentiment analysis comes refine predictive models based only on the volume of messages.

Sentiment analysis is based on machine learning algorithms. The authors of [20] developed a semantic analysis system and have successfully predicted the evolution of the Dow Jones Industrial Average with 4 days in advance in 86.7% of cases [21]. Observing this ability to anticipate accurately the evolution of stock prices, several investment funds were established. Derwent Absolute Return manages a fund of 40 million \$, based on the work of [20] but also on

messages exchanged on Facebook. MarketPsy capital was interested in the investors sentiment about approximately 6 000 companies and got a yield of 45% during 2008 [22].

As we have shown previously, works around this kind of analysis applied to the financial case are many. Overall, the sentiment analysis is based on the subjectivity of the content of text data collected as comments posted on social media, discussion blogs or economic news. Especially, Peter M. Clarkson et al. [8] stated that the returns and trading volumes are very sensitive to takeover rumors postings in the hotcopper internet discussion site.

According to Pang and Lee [19], sentiment analysis from texts, whether written or electronic, consists of several steps. In designing an autonomous system of automatic sentiment analysis, it is important that it is able to follow the different stages of the analysis independently. First, subjective texts must be distinguished from neutral texts or objectives. Then, the system must detect paragraphs or sentences with evaluative judgments. Finally, all information must be presented in a comprehensive analysis of the sentiments expressed in the text. Generally, there are two different methods to accomplish automated sentiment analysis. The first method is based on a lexicon built from existing dictionaries (lexicon-based approach). The second method is based on corpus containing evaluative texts whose language is generally subjective (corpus-based approach) (see [25]).

A supervised machine learning uses a trained label set to classify the sentiment on data. It involves the development of two corpora: a corpus learning and a test corpus. The method is called «supervised» because the automatic system is trained to handle a database based on a training corpus which contains models already treated. In contrast, unsupervised learning traditionally uses the lexicon based approach. These methods uses sentiment lexicon to identify entire document's sentiment polarity [15]. unsupervised method requires only a corpus. The method implies that the autonomous system must structure, itself, the information within the corpus by dividing them into groups. Thus, it must organizes the database of such so that the most similar data are combined in a group and data different in another.

- Support Vector Machine (SVM) is a classification and regression model used for data analysis. It constructs a set of hyper planes used for linear classification and regression. It uses kernel mapping for non linear classification which is used for erroneous classification. It produces more accurate results on both classification and regression than other machine learning techniques [15].
- Naïve Bayes classification method is simple method and comparatively produces good results with sensible accuracy. It uses a bag of words for classifying the subjectivity of the content. It is based on Naïve Bayes rule assuming conditional independence which is a main drawback of this classification [42].

## IV. CONCLUSION

In this work, we highlighted the connection with finance, in general, and data deluge. This work does not purport to be exhaustive, but we made an overfly about a wide variety of techniques and possible uses. We also focused on the fact that predictive analysis with a good use of 4V's which characterize big data, applied to collected data can improve risk management models. Note that there is no standard methods of big data analytics. big data analytics are flexible and must be adapted to the considered problem and practitioners may adapt methods according to their need.

The advantage of integrating more of business intelligence techniques in financial management has become insistent and falls within consolidation of the competitiveness of financial institutions. Only the future and new innovations in terms of regulations and technological advances will lighten us more.

Until now, technological advances related to big data have not brought as solutions, but also many challenges as in the case of algorithmic trading. Certainly, this type of practice has limited human intervention in trading which is always biased by fatigue, inattention, nervousness, etc. However, the repetitive use of a strategy may make this strategy vulnerable as stated by Eugene Fama (1970) in his famous theory of market efficiency introduced in his article entitled "Efficient Capital Markets: a Review of Empirical and Theoretical Works".

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# *A novel classification system for numeral recognition*

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**Abstract**— This paper proposes a new method of features extraction for handwritten, printed and isolated numeral recognition. It consists of scanning the image row by row, for each row the positions of two first black white transitions in columns were detected, so the first attribute vector is defines from these positions, after, the image was scanned column by column, the positions of two first transitions in row was defined, so the second vector is defines from these positions, so the concatenation of the two vectors determined the attribute vector of the particular numeral. Numeral recognition is carried out in this work through  $k$  nearest neighbors and multilayer perceptron. The recognition rate obtained by the proposed system is improved indicating that the numeral features extracted contain more details.

**Keywords**- *features extraction; Numeral recognition; k nearest neighbors; multilayer perceptron*

## I. INTRODUCTION

The pattern recognition is a very active subjects, it plays a very crucial role in various technical domains such as postal sorting, bank check reading, order form processing, robotics etc.

The Recognition system requires three important steps which are: preprocessing, features extraction and classification.

The preprocessing phase improves the shape of the image by binarization and adjusts the size and position of the image by normalization and cropping.

The Numeral features extraction is a delicate process and is crucial [1] for a good numeral recognition. It consists of converting the image into a vector whose elements characterize the image of a discriminated way, this vector called attribute vector. The choice of the attribute vector is very important; the wrong choice leads to terrible recognition.

Classification is the step of decision, which realizes the recognition. It consists of partitioning a set of data entity into separate classes according to a similarity criterion. Different methods are proposed in this context including neural networks, support vector machines [7],  $k$  nearest neighbors,  $k$ -means, etc.

In this study, a database of 600 numerals, printed and handwritten, provided by various categories of writers is used. The used database is divided into two sets, 400 numeral images for learning and 200 numeral images for test.

This paper is planned as follows: Section 2 presents the different methods of features extraction. In section 3, the  $k$  nearest neighbors and MLP techniques of classification are presented. The proposed system for numeral recognition is discussed in section 4. The result of simulations and comparisons are introduced in section 5. Finally, a conclusion.

## II. NUMERAL FEATURES EXTRACTION

Features extraction is an essential task in any recognition system of forms. The main objective of features extraction is to represent objects by a vector of characteristics of fixed size and to keep only characteristics which contain the most relevant and the most discriminating information.

The set of features also called attributes, form a space of representations of data. The features must be as discriminate as possible. When the data are positioned in the representation spaces, the different classes formed must be the most compact and most separate as possible. Various types of features have been used in the literature. There is the profile projection, the loci characteristics...., all have been used with image classification and recognition, for that purpose, we chose the profile projection and the Loci as statistical methods.

### A. *Projection de profil*

Profil projection is a statistical method widely used in numeral recognition [7], Chinese characters [8], bar codes of products [9], etc.

Before extraction feature, the image must be binarized which is presented in color, cropped and resized to a predefined size.

This technique calculates the number of background pixels between the left, bottom, right, top edge of the image until the first black pixel met on this row or column. The dimension of

the obtained attribute vector is twice the sum of the number of rows and columns associated to the image of the numeral.

### B. Loci characteristics

Loci characteristic method has initially been proposed by Gluksman in 1967 [1, 2, 7]. The method has been widely used because of its many advantages. It is insensitive to small perturbations, robust to variations in styles and fonts, and has obtained good results in recognizing handwritten numerals [7].

The method is based on the pixels background rather than the numeral pixels themselves. The loci characteristics are generally defined on horizontal and vertical directions. They are computed with respect to the number of white to black transitions in the right, down, left and up directions for each background pixel of the image. For each background pixel, a number of four digits is obtained, called a loci number (figure.1)

A scanning of all the image background pixels is carried out, an attribute vector element is constituted by the total number of background pixels having the same loci number [5, 8].

We begin this approach by cropping the numeral from its background, which only leaves the interesting part of the image. Traditional CL limits for each background pixel, the number of transitions to two, the size of the attribute vector is  $3^4=81$

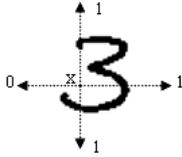


Fig 2: Loci number for background pixel's 'x', the pixel code is (1,1,0,1)

## III. CLASSIFICATION METHODS

### A. K Nearest Neighbors (KNN)

KNN is a widely used method for data classification. Proposed in 1967 by Cover et al. [12], it has been used in handwritten numerals recognition [9] for its simplicity and its robustness [14]. KNN is a method which was inspired from the closest neighbor rule, it is based on the hypothesis that only the closest neighbor has most influence on the classification decision approach. KNN is based on computing the distance between the test data and the different learning data samples [9] and then attribute the test sample to the k nearest neighbors.

Algorithm 1 : K nearest neighbors
<ul style="list-style-type: none"> <li>- Let <math>L = \{(x', c)/x' \in \mathbb{R}^N, c = 1,2,\dots, C\}</math> the learning set.</li> <li>- Let <math>x</math> the example to determine its class.</li> </ul>
<p>1: <b>For each</b> object <math>x'</math> of the set <math>L</math></p> <ul style="list-style-type: none"> <li>- Compute the distance between the object <math>x</math> and the object <math>x'</math>, <math>d(x, x')</math>.</li> </ul> <p style="padding-left: 20px;">- Classify the different distances in increasing way.</p>
<p><b>End</b></p> <p>2: <b>For every</b> <math>\{x' \in KNN(x)\}</math> <b>do</b> :</p> <ul style="list-style-type: none"> <li>- Identify the most frequent class.</li> </ul>
<p><b>End</b></p> <p>3: Assign to <math>x</math> the identified class.</p>

### B. Multilayer Perceptron (MLP)

MLP are defined as mathematical models inspired from human brain and how the human neurons function [14]. It have been usually used for data classification, pattern recognition,

MLPs are forward propagation networks where the two closest layers are fully connected. The structure of an MLP is an input, an output and a certain number of hidden layers. In this work one hidden layer is used. The number of neurons in the hidden layer has been determined heuristically or by trial and error.

The *MLP* is characterized by its ability to learn and gradually improve its performance through a learning process. Learning is a phase where the behavior of the network is modified by modifying the synaptic weights until a desired output pattern is obtained. There are three principal learning types, gradient backpropagation algorithm, hebb rules and competitive learning.

In this work, we have used the gradient backpropagation algorithm, the objective is to minimize the squared error between the desired and computed output of the *MLP*. Figure 4 shows the different steps of the gradient backpropagation algorithm.

Algorithm 1 : MLP
<ul style="list-style-type: none"> <li>Randomly initialize the synaptic weights between -1 and 1.</li> <li>Randomly apply a realization vector of an object to the input layer and its corresponding known output to the output layer.</li> <li>Compute the network output and error <math>E</math> between computed and desired outputs.</li> </ul>
<p>Adjust the weights by the gradient method :</p> $W^{(r)}(t+1) = W^{(r)}(t) - \eta \frac{\partial E}{\partial W^{(r)}}$
<p><math>\eta</math> is the learning rate, which is in general a value between 0.1 and 0.9. <math>r = 1, 2</math>.</p>
<p>Go to 2 as long as the network does not show satisfactory performances.</p>

Algorithm convergence is achieved when the synaptic weights remain almost steady and the computed outputs are close enough to the desired ones.

#### IV. PROPOSED SYSTEM

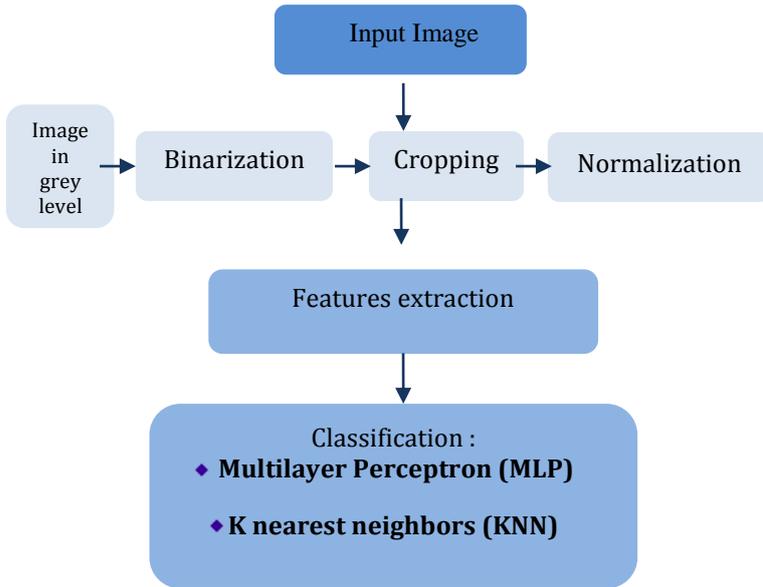


Fig 3: Proposed scheme for numerals recognition.

The preprocessing stage consists of initially binarizing the numeral input image which is presented in color, setting out a threshold value against which the image pixels are compared, if the pixel value is greater than the threshold, it is set to one, it is set to zero otherwise.

The next step is the cropping; it consists of preserving only the numeral position in image, by eliminating all white space outside of the numeral.

Final step is the normalization; it consists of fixing the size of the entire cropped numeral images.

After this operation the numeral image is ready for features extraction, this stage consists of scanning the image row by row, for each row the two first black white transitions were coded by their positions in columns, so the first attribute vector is formed by these positions, after, the image was scanned column by column, the first transitions were coded by their positions in row, so the second vector is defines from these positions, so the concatenation of the two vectors determined the attribute vector of the particular numeral. The dimension of the obtained attribute vector is twice the sum of the number of rows and columns associated to the image of the numeral.

Finally, the numeral recognition is carried out through k nearest neighbors and multilayer perceptron.

#### V. RESULT AND DISCUSSION

In this present study, we compared our method with statistical methods which are most used in the numeral recognition as the profile projection and loci characteristics using KNN and PMC as classification methods, for that purpose the recognition rate was calculated according to the size of normalization

TABLE 1: ARABIC NUMERAL RECOGNITION BY KNN.

		20x20	30x30	30x25	40x40
Profile Projection	Recognition rate	94.5	96.5%	96.5%	95.5%
	Number of attribute	80	120	110	160
Loci characteristics	Recognition rate	95.5	95.5%	95.5%	95.5%
	Number of attribute	81	81	81	81
Proposed system	Recognition rate	95	<b>95.5%</b>	95.5%	95%
	Number of attribute	80	120	110	160

The rate of recognition of different features extraction methods by KNN, is obtained by changing the parameter K from 1 to 9 and we used the parameter K having the best recognition rates.

From the table 1, we notice that the Loci characteristics is independent of the normalization size, the recognition rate is equal 95.5%. The recognition rates of the profile projection and the proposed system are almost similar, they varied according to the normalization size, and it is equal 96.5% for PP and 96% for proposed system.

Concerning the MLP, Several experiments were carried out to determine the best recognition rate; the simulations were involved according to the number of hidden neurons.

Table 2 illustrates the influence of this number on the recognition rate using the proposed system as feature extraction, and 30x25 as normalization size. The structure of the MLP used is; an input layer with  $2 \times (\text{nombre de ligne} + \text{nombre de colonne}) = 110$  neurons, an output layer with 10 neurons where each of them represents a numeral from 0 to 9. Therefore only the number of neurons in the hidden layer needs to be determined.

TABLE 2: NUMBER OF NEURONS IN THE HIDDEN LAYER WITH RESPECT TO THE RECOGNITION RATE OF NUMERALS

Number of neurons in the hidden layer	Recognition rate (%)
15	95.5
<b>20</b>	<b>97.5</b>
30	96.5
40	96.5
80	95.5
100	95.5

Table 2 highlights the fact that a number of 20 neurons in the hidden layer obtains good recognition rate performance of isolated numerals.

The same procedure is carried out for others techniques PP and LOCI, table 3 illustrates the different recognition rates obtained.

TABLE 3: ARABIC NUMERAL RECOGNITION BY MLP.

Feature extraction	Recognition rate by MLP
Profil Projection	98%
LOCI	97%
Proposed system	97.5%

From this table, we noticed that the proposed system has a recognition rate comparable with the most popular methods it equal 97.5%, and the proposed system presents less algorithmic complexity than other methods.

### Conclusion

In this work we have presented a new approach features extraction for numerals recognizing, it consists of scanning the image row by row, for each row the positions of two first black white transitions in columns were detected, so the first attribute vector is defines from these positions, after, the image was scanned column by column, the positions of two first transitions in row was defined, so the second vector is defines from these positions, so the concatenation of the two vectors determined the attribute vector of the particular numeral. Numeral recognition is carried out in this work through k nearest neighbors and multilayer perceptron. Different techniques were compared with the proposed system, the recognition rate obtained by the proposed system is good indicating that the numeral features extracted contain more details and it presents a less algorithmic complexity. That confirms the performance of our proposed system for numeral recognition.

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## Fixed Point Calculus for $\phi$ -Contractive Mappings In Modular Space by some Iterative Schemes and Stability

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**Abstract:** Recently, several results have been done in extending the convergence and the stability for fixed point iteration procedures to modular spaces, as Khamsi [2], khamsi, Kozłowski and Riech [3] and Marzouki [5], to prove a fixed point theorem for contractive mapping in modular space. So after claiming fixed point for  $\phi$ -contractive mappings in modular space in A. Mbarki et al.[9], here we will study the convergence and stability of some fixed point iteration procedures in this case (see A. Mbarki and I. Hadi [10]). In the present work we will examine the convergence, the satability and Error estimate of some iteration procedures for fixed point of  $\phi$ -contractive mappings in modular space.

**Key word:** Fixed point,  $\phi$ -contractive mappings, Modular space, Iterative procedures

### 1 Introduction to Modular or Orlicz Space

**Definition 1.1** (see [7]) Let  $X$  be an arbitrary vector space.

(a) A functional  $\rho : X \rightarrow [0, \infty]$  is call a modular if for arbitrary  $x, y$  in  $X$ ,

(i)  $\rho(x) = 0$  iff  $x = 0$ ,

(ii)  $\rho(\alpha x) = \rho(x)$  for every scalar  $\alpha$  with  $|\alpha| = 1$ ,

(iii)  $\rho(\alpha x + \beta y) \leq \rho(x) + \rho(y)$  if  $\alpha + \beta = 1$  and  $\alpha \geq 0, \beta \geq 0$ .

(b) If (iii) is replaced by

$$\rho(\alpha x + \beta y) \leq \alpha \rho(x) + \beta \rho(y) \text{ if } \alpha + \beta = 1 \text{ and } \alpha \geq 0, \beta \geq 0,$$

we say that  $\rho$  is a convex modular.

A modular  $\rho$  defines a corresponding modular space, i.e. the vector space  $X_\rho$ , given by

$$X_\rho = \left\{ x \in X : \rho(\mu x) \rightarrow 0 \text{ as } \mu \rightarrow 0 \right\}.$$

**Definition 1.2** Let  $X_\rho$  be a modular space.

(a) A sequence  $\{x_n\}$  is called  $\rho$ -convergent to  $x$  if and only if

$$\rho(x_n - x) \rightarrow 0 \text{ as } n \rightarrow \infty.$$

(b) A sequence  $\{x_n\}$  is called  $\rho$ -Cauchy whenever

$$\rho(x_n - x_m) \rightarrow 0 \text{ as } n, m \rightarrow \infty.$$

(c) The modular space  $X_\rho$  is called  $\rho$ -complete if any  $\rho$ -Cauchy sequence is  $\rho$ -convergent.

(d)  $\rho$  is said to satisfy the  $\Delta_2$  condition if

$$\rho(2x_n) \rightarrow 0 \text{ whenever } \rho(x_n) \rightarrow 0 \text{ as } n \rightarrow \infty.$$

(e) The modular  $\rho$  is said to have the Fatou property if

$$\rho(x) \leq \liminf_{n \rightarrow \infty} \rho(x_n) \text{ whenever } x_n \rightarrow x.$$

(f) A subset  $B$  of  $X_\rho$  is said to be  $\rho$ -closed if for any sequence  $\{x_n\} \subset B$   $\rho$ -convergent to  $x \in X_\rho$ , implies that  $x$  belongs to  $B$ .

(g) A subset  $B$  of  $X_\rho$  is called  $\rho$ -bounded if  $\sup\{\rho(x - y) : x, y \in B\} < +\infty$ .

**Example 1.3** We consider the vector space  $X$  defined by

$$X = \left\{ f : [0, 1] \rightarrow \mathbb{R} \text{ measurable} \right\},$$

we define in  $X$  the following modular:  $f \in X$ , we put

$$\rho(f) = \int_0^1 \varphi(t, |f(t)|) dt$$

where  $\varphi : [0, 1] \times \mathbb{R}^+ \rightarrow \mathbb{R}$  satisfies:

- $\varphi$  is continuous, increasing and convex with respect to second variable.
- $\lim_{x \rightarrow +\infty} \varphi(t, x) = +\infty$ ,  $\varphi(t, 0) = 0$  and  $\varphi(t, x) > 0 \forall x > 0$ .
- $\varphi$  is measurable with respect to the first variable.

Then it is known (see for example J. Musielak [7]) that  $\rho$  is a convex modular.

-  $L^\rho = \left\{ f \in X : \lim_{\eta \rightarrow 0} \rho(\eta f) = 0 \right\}$ , is a modular space.

-  $L^\rho$  is  $\rho$ -complete.

-  $L^\rho$  is a Banach space equipped with the Luxembourg norm defined by

$$\|x\|_\rho = \inf \left\{ \alpha : \rho\left(\frac{x}{\alpha}\right) \leq 1 \right\}.$$

-  $\rho$  satisfies the  $\Delta_2$  condition and Fatou property.

$$\lim_{n \rightarrow +\infty} \|x_n - x\|_\rho \iff \lim_{n \rightarrow +\infty} \rho(x_n - x) = 0,$$

note that for an arbitrary modular in which  $\rho$  does not satisfy the  $\Delta_2$  condition, we have

$$\lim_{n \rightarrow +\infty} \|x_n - x\|_\rho \iff \lim_{n \rightarrow +\infty} \rho(\alpha(x_n - x)) = 0 \quad \forall \alpha > 0.$$

As, many examples on some subsets of modular functions spaces have been given in Khamsi et al. [3] to prove a fixed point property for mapping with a strict contraction with respect to the modular. So, in modular spaces and for more general class of maps with a  $\phi$ -contraction, we will claim the same result. we introduce this class of maps by the definition belong:

## 2 $\phi$ -Contractive Mapping and Fixed Point

**Definition 2.1** Let  $X_\rho$  be a modular space,  $B$  be a nonempty and  $\rho$ -bounded subset of  $X_\rho$  and let  $\phi : [0, \infty) \rightarrow [0, \infty)$  be an upper semi-continuous function such that  $\phi(0) = 0$  and  $\phi(s) < 2s$  for  $s > 0$ . In this context a mapping  $T : X \rightarrow X$  is  $\phi$ -contractive if

$$\rho(2(Tx - Ty)) \leq \phi(\rho(x - y)) \quad \forall x, y \in B.$$

**Theorem 2.2** Let  $B$  be a  $\rho$ -closed and  $\rho$ -bounded subset of a  $\rho$ -complete modular space  $X_\rho$ , and  $T : B \rightarrow B$  be a  $\phi$ -contractive mapping, we suppose also that  $\rho$  is convex, then  $T$  has a unique fixed point. Moreover, the Picard iterative scheme  $x_0 \in X_\rho$   $x_{n+1} = Tx_n$  converges to this fixed point

**Example 2.3** Let  $X = [0, \infty)$  be a vector space,  $\rho$  be an application defined as follows:

$$\begin{aligned} \rho & : X \rightarrow X \\ & t \rightarrow t^2 \end{aligned}$$

So, we can see that  $\rho$  is not a norm but is a modular since the function  $t \rightarrow t^2$  is convex. Then the associated modular space is  $X_\rho = [0, \infty)$  by continuity of the modular  $\rho$ .

Now, take the function  $\phi : [0, \infty) \rightarrow [0, \infty)$ , such that  $\phi(t) = \frac{t}{1+t}$ , which is clearly continuous,  $\phi(0) = 0$  and  $\phi(t) < t$  for every  $t > 0$ .

Consider  $B = [0, 1]$  the closed interval in  $[0, \infty)$  which is  $\rho$ -closed,  $\rho$ -bounded and  $\rho$ -complete, since  $\rho$  is continuous. Then the following map

$$\begin{aligned} T & : B \rightarrow B \\ & t \rightarrow \frac{1}{2} \frac{t}{1+t} \end{aligned}$$

is  $\phi$ -contractive. Consequently, by the Theorem 2.1, it has a unique fixed point in  $B$  which is the point 0.

In the sequel,  $B$  is a  $\rho$ -closed subspace of  $X_\rho$  and  $\rho$  is with values in  $[0, \infty)$ .

### 3 Iterative Schemes for $\phi$ -contractive maps

We shall now investigate the convergence of other iterative procedures applied to  $T$ .  
The Mann iterative scheme is defined by

$$x_0 \in X_\rho, \quad x_{n+1} = (1 - \alpha_n)x_n + \alpha_n T x_n, \quad n \geq 0, \quad (a)$$

where  $0 \leq \alpha_n \leq 1$  for each  $n$ .

**Theorem 3.1** Suppose the hypotheses of Theorem 2.1 are satisfied and also that  $\phi$  is continuous. Then the Mann iterative scheme (a), with (i)  $0 \leq \alpha_n \leq 1$  and (ii)  $\sum \alpha_n = \infty$ , converges to the unique fixed point of  $T$

The Ishikawa iteration scheme is defined by

$$\begin{aligned} x_0 \in X_\rho, \quad x_{n+1} &= (1 - \alpha_n)x_n + \alpha_n T y_n \quad (2a) \\ y_n &= (1 - \beta_n)x_n + \beta_n T x_n, \quad n \geq 0, \end{aligned}$$

where  $0 \leq \alpha_n, \beta_n \leq 1$  for all  $n$ .

**Theorem 3.2** Suppose the hypotheses of Theorem 2.2 are satisfied. Then the Ishikawa iterative scheme, with (i)  $0 \leq \alpha_n, \beta_n \leq 1$  and (ii)  $\sum \alpha_n \beta_n = \infty$ , converges to the unique fixed point of  $T$

Let  $X_\rho$  be a modular space,  $T$  a self-map of  $X_\rho$ . Then, for a fixed integer  $N$  the map  $S$  is defined by

$$S = \sum_{i=1}^N \alpha_i T^i, \quad \text{where each } \alpha_i \geq 0, \quad \sum_{i=1}^N \alpha_i = 1, \quad \text{and } \alpha_1 \neq 0. \quad (3a)$$

Then the function iteration scheme of Kirk [4] is defined as follows.

$$x_0 \in X_\rho \quad x_{n+1} = S^n x_0.$$

**Theorem 3.3** Suppose the hypotheses of Theorem 2.1 are satisfied. Then the iterative scheme  $\{S^n x_0\}$ , converges to the unique fixed point of  $T$

The function iteration process of Massa [6] is defined by:

$$S = \sum_{i=1}^{\infty} \alpha_i T^i, \quad \text{where each } \alpha_i \geq 0, \quad \sum_{i=1}^{\infty} \alpha_i = 1, \quad \text{and } \alpha_j \alpha_{j+1} \neq 0. \quad (4a)$$

for at least one integer  $j$ . The iteration is then  $S^n x_0$  for any  $x_0$  in  $X_\rho$ .

If  $\rho$  has the Fatou property, then using the same proof as that of Theorem 3.3 yields the following. Suppose the hypotheses of Theorem 2.1 are satisfied and  $\rho$  has the Fatou property. Then for any  $x_0 \in X_\rho$  the iterative scheme  $\{S^n x_0\}$ , where  $S$  is defined by (4a), converges to the unique fixed point of  $T$

### 4 Stability and Error Estimate

Let  $f(T, x_n)$  be an iteration procedure involving  $T$  which yields a sequence  $\{x_n\}$  of point from  $X_\rho$ . For example  $f(T, x_n) = T x_n$  is an iteration procedure. Suppose that  $\{x_n\}$  converges to fixed point  $x$  of  $T$ . Let  $\{y_n\} \subset B(x, r) \subset X_\rho$ , and  $\varepsilon_n = \rho(y_{n+1} - f(T, y_n))$ . If  $\lim \varepsilon_n = 0$  implies that  $\lim y_n = x$ , then the iteration procedure  $x_{n+1} = f(T, x_n)$  is said to be  $T$ -stable. Where  $B(x, r)$  is a ball of center  $x$  and radius  $r$ .

**Theorem 4.1** Suppose the hypotheses of Theorem 2.1 are satisfied and  $\rho$  satisfies the  $\Delta_2$  condition. Then iterative scheme, defined by  $f(T, x_n) = T x_n$  is  $T$ -stable

**Theorem 4.2** Suppose the hypotheses of Theorem 2.1 are satisfied and  $\phi$  non-decreasing and  $\rho$  satisfies the  $\Delta_2$  condition. Then iterative scheme, defined by  $f(T, x_n) = S x_n$ , where  $S$  is defined as in (3a), is  $T$ -stable

**Theorem 4.3** Suppose the hypotheses of Theorem 2.1 are satisfied and  $\phi$  non-decreasing and  $\rho$  has the Fatou property and satisfies the  $\Delta_2$  condition. Then iterative scheme, defined by  $f(T, x_n) = S x_n$ , where  $S$  is defined as in (4a), is  $T$ -stable

**Theorem 4.4** Suppose the hypotheses of Theorem 3.1 are satisfied and  $t \mapsto t - \frac{1}{2}\phi(t)$  is non-decreasing function. The Mann iteration, with  $0 < \alpha \leq \alpha_n \leq 1$ , converges to the unique fixed point  $x$  of  $T$ , with error estimate

$$\rho(x_{n+1} - x) \leq \psi^{-1}(\psi(\rho(x_0 - x)) - \sum_{k=0}^n \alpha_k),$$

where  $\psi$  is defined

$$\psi(t) = \int \frac{dt}{t - \frac{1}{2}\phi(t)},$$

and  $\psi^{-1}$  is the inverse function of  $\psi$

**Theorem 4.5** Suppose the hypotheses of Theorem 3.1 are satisfied and  $t \mapsto t - \frac{1}{2}\phi(t)$  is non-decreasing function. The Ishikawa iteration, with  $0 \leq \beta_n$ ,  $\alpha_n \leq 1$ ,  $\sum \beta_n \alpha_n = \infty$  converges to the unique fixed point  $x$  of  $T$ , with error estimate

$$\rho(x_{n+1} - x) \leq \psi^{-1}(\psi(\rho(x_0 - x)) - \sum_{k=0}^n \alpha_k \beta_k),$$

where  $\psi$  is defined

$$\psi(t) = \int \frac{dt}{t - \frac{1}{2}\phi(t)},$$

and  $\psi^{-1}$  is the inverse function of  $\psi$

#### Conclusion : Application to the integral equation of Volterra type

We look for a solution of the integral equation

$$x(t) = x_0(t) + \mu \int_0^1 K(t, s)R(x(s)) ds \quad (1)$$

in Orlicz space  $L^\varphi$ , where  $x_0(\cdot)$  and  $K(\cdot, \cdot)$  and  $R$  are given. To resolve the integral equation (1), we construct another complete modular space on which the operator  $T$  defined by

$$(Tx)(t) = x_0(t) + \mu \int_0^1 K(t, s)R(x(s)) ds$$

admit a fixed point which corresponds to a solution of (1).

So, we consider the vector space  $Y$  defined by

$$Y = \left\{ x : [0, 1] \rightarrow L^\varphi \text{ continuous with respect the norm } \|\cdot\|_\rho \right\},$$

we define on  $Y$  the functional  $\rho_\infty$  by  $\rho_\infty(x) = \sup_{t \in [0, 1]} \rho(x(t))$ , where  $\rho$  is the modular of  $L^\varphi$ , we can verify easily that  $\rho_\infty : Y \rightarrow [0, +\infty]$  satisfies all the properties of a convex modular, we obtain then the modular space

$$Y_{\rho_\infty} = \left\{ x \in Y : \lim_{\eta \rightarrow 0} \rho_\infty(\eta x) = 0 \right\}.$$

**Lemma 4.1** (See [5])

$Y_{\rho_\infty}$  is  $\rho_\infty$ -complete.

Now we return to the integral equation (1)

$$x(t) = x_0(t) + \mu \int_0^1 K(t, s)R(x(s)) ds$$

where  $0 < 2\mu < 1$ ,  $x_0 \in Y_{\rho_\infty}$ ,  $K : [0, 1] \times [0, 1] \rightarrow \mathbb{R}^+$  is continuous and  $R : L^\varphi \rightarrow L^\varphi$  satisfies  $\rho(Rx - Ry) \leq \alpha(\rho(x - y)) \forall x, y \in L^\varphi$  with  $\alpha : \mathbb{R}^+ \rightarrow \mathbb{R}^+$ , is upper semi-continuous and nondecreasing function such that  $\alpha(0) = 0$  and  $\mu\alpha(s) < s$  for  $s > 0$ , then we have the following result

**Theorem 4.6** we suppose also that:

- $\sup_{t \in [0, 1]} \int_0^1 K(t, s) ds \leq 1$ .
- There exists  $g_0 \in Y_{\rho_\infty}$  such that  $\rho_\infty(g_0 - Tg_0) < +\infty$ .
- $\rho(R(0)) < +\infty$  and  $\rho(\eta R(x)) \leq \rho(R(\eta x)) \forall x \in L^\varphi, \forall \eta$  with sufficiently small. Then we have
  - $\forall x \in Y_{\rho_\infty}, Tx \in Y_{\rho_\infty}$ .
  - $\rho_\infty(2(Ty - Tx)) \leq \phi(\rho_\infty(y - x))$ , for  $\phi = 2\mu\alpha$ .

We deduce that the operator  $T : Y_{\rho_\infty} \rightarrow Y_{\rho_\infty}$  has a fixed point, and consequently the equation (1) has a solution.

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# Using the Model Driven Architecture Approach To Manage the expenses

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**Abstract** --- This paper is about The conception and the realization of applications and Dashboard for the management of the spending and expenses of urban districts in Morocco.

As so, we have chosen to use the N-tiers applications and the MDA (Model Driving Architecture) transformation. In this paper we are going to present a model-driven approach to the development of N-tiers web applications based on the UML class diagram. The transformation language is the MOF 2.0 QVT (Meta-Object Facility 2.0 Query-View-Transformation) standard which defines the meta-model for the development of model transformation. The transformation rules defined in this paper can generate, from the class diagram, an XML file containing the layers of N-tiers web application respecting a MVC2 (Model-View-Controller), DI (Dependency Injection) and DAO (Data Access Object) patterns. This file can be used to generate the end-to-end necessary code of a web application

**Keywords** -- Transformation by modeling, N-tiers architecture, Transformation rules, MOF 2.0 QVT, Meta-model.

## 1. Introduction

In the years following the arrival of internet, many organizations begun to consider MDA (Model-Driven Architecture) as an approach to design and implement enterprise applications. As result, many new trends have appeared under the frameworks, changing the development of classical web applications.

These changes are present in MDA, and help transform a CIM (Computation Independent Model) into a PIM (Platform Independent Model) or to obtain a PSM (Platform Specific Model) from a PIM.

N-tiers (multi-tier) architecture provides a model for developers to create a flexible and reusable application. By breaking up an application into tiers, developers have to modify or add a specific layer only, rather than rewriting the entire application all over again. There should be a

presentation tier, a business or data access tier, and a data tier.

In this work we are going to transform an UML Model concerning an advertisement in a social network to generate a source code.

In a recent work [21], the authors have developed a source and a target meta-models. The first was a PIM meta-model specific to class diagrams. The second was a PSM meta-model for MVC2 (Model-View-Controller) web applications (particularly Struts), then they have elaborated a transformation rules using the approach by programming. The purpose of our contribution is to produce and generate an N-tiers PSM model, implementing MVC2, DI (Dependency Injection) and DAO (Data Access Object) patterns, from the class diagram. In this case, we elaborate a number of transformation rules using the approach by modeling and MOF 2.0 QVT, as transformation language, to permit the generation of an XML file that can be used to produce the required code of the target application. The advantage of this approach is the bidirectional execution of transformation rules.

This paper is organized as follows: We begin in the first section with an introduction. Related works are presented in the second section. The third section permits to develop MDA as architecture. The fourth section presents the N-tiers architecture, the MVC2, DI and DAO patterns and its implementation as frameworks. The approach by modeling and the transformation language MOF 2.0 QVT are the subject of the fifth section. In the sixth section, we have elaborated the UML and N-tiers meta-models. The transformation rules of UML source model to the N-tiers target model, the transformation algorithm and the results of this transformation are presented in the seventh section. The final section concludes this paper and presents some perspectives.

## 2. Related work

Many researches on MDA and generation of code have been conducted in recent years. The most relevant are [7][8][4][10][11][13][16][17][18][20][21][22][26][27][34].

The authors of the work [18], show how to generate JSPs and JavaBeans using the UWE [17], and the ATL transformation language [16]. Among future works cited, the authors considered the integration of AJAX into the engineering process of UWE.

Bezivin et al. [8] propose to use ATL transformation to transform PIMs defined by Enterprise Distributed Object Computing into PSMs for different web services platforms.

Billing et al. [7] define PIM to PSM transformation in the context of EJB by using QVT.

The authors of the work [27] show that the MDA can be considered as a software industrialization pattern (or a software factory). They propose an MDA Engine based on a real case study in an IT services company. It is a proposal for a framework to create custom MDA tools, based on XMI, XSLT and the Visitor Pattern.

The work [10] has proposed a model-driven development approach for E-Learning platform. The authors established the domain model (CIM) through the analysis of business logic, and then they established robustness diagram of the system after the robustness analysis. Then, they stratified on the PIM under the J2EE framework, and proposed the method of transformation from PIM to PSM layer by layer. The objective of the work [34] is to introduce a new framework for the design of secure Data Warehouses based on MDA and QVT, which covers all the design phases (conceptual, logical and physical) and specifies security measures in all of them.

One approach which has gained much attention in the web-based MDA community is the AndroMDA MDA generator [4]. This framework provides a PIM schemes to model and integrate a wide variety of scenarios and comes with a set of plugins, called cartridges.

Two other works follow the same logic and have been the subject of two articles [11] [13]. A metamodel of AJAX has been defined using the AndroMDA tool. The generation of AJAX code was made and illustrated by an application that manages CRUD operations of person. The meta-model is very important and we can join it to our meta-models for modeling AJAX user interfaces.

The objective of the work of Nasir et al. [26] is to generate the code of a DotNet application “Student Appointment Management System”. The method used is WebML. The code is generated, applying the MDA approach.

Recently, the work [22] was conducted to model Web MVC2 generation using the ATL transformation language. This paper aims to rethink and to complete the work presented in the articles [20][21], by applying the standard

MOF 2.0 QVT to develop the transformation rules aiming at generating the N-tiers web according to our target model. Actually, it is the only work for reaching this goal.

## 3. Model Driven Architecture (MDA)

In November 2000, OMG, a consortium of over 1 000 companies, initiated the MDA approach. The key principle of MDA is the use of models at different phases of application development. Specifically, MDA advocates the development of requirements models (CIM), analysis and design (PIM) and (PSM) code [6].

The MDA architecture is divided into four layers. In the first layer, we find the standard UML (Unified Modelling Language), MOF (Meta-Object Facility) and CWM (Common Warehouse Meta-model). In the second layer, we find a standard XMI (XML Metadata Interchange), which enables the dialogue between middlewares (Java, CORBA, .NET and web services). The third layer contains the services that manage events, security, directories and transactions. The last layer provides frameworks which are adaptable to different types of applications namely Finance, Telecommunications, Transport, medicine, E-commerce and Manufacture, etc.).

The major objective of MDA is to develop sustainable models, those models are independent from the technical details of platforms implementation (J2EE, DotNet, PHP or other), in order to enable the automatic generation of all codes and applications leading to a significant gain in productivity. MDA includes the definition of several standards, including UML [39], MOF [23] and XMI [40].

## 4. N-tiers architecture

N-tiers application architecture provides a model for developers to create a flexible and reusable application and provides some advantages that are vital to the business continuity of the enterprise. Typical features of a real life N-tiers may include the Security, Availability, Scalability, Manageability, Easy Maintenance and Data Abstraction. To most people, an N-tiers application is anything that is divided into discrete logical parts. The most common choice is a three-part breakdown presentation, business logic, and data access although other possibilities exist.

In this paper, we are using the following layers:

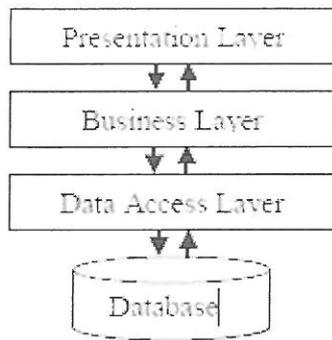


Fig.1 N-tiers Layers

Each Layer can be developed independently of the other provided that it adheres to the standards and communicates with the other layers.

#### 4.1 The presentation Layer with MVC2 pattern

The presentation layer of most applications is often critical to the application's success. After all, the presentation layer represents the interface between the user and the application back-end.

Along time ago, web applications were very simple and the technology that was used to develop them was Common Gateway Interface (CGI). As applications became more complex, the defects and limits of this technology have emerged. Slowness and considerable consumption of memory. Therefore, the J2EE platform applies the architecture MVC2 [3]. In this paradigm, the model represents the information system consisting of javaBeans. The view represents the HTML pages returned to the user, and consists of JavaServerPage (JSP). The Controller is the glue between the two and it is composed of servlets. In short, during the early 80's with smalltalk, MVC was widespread in the field of object development. Many frameworks that implements MVC2 pattern have emerged, among them: Struts [1], PureMVC [29], Gwittir [14], SpringMVC [35], Zend [38], ASP.NET MVC2 [5]. Struts remains the most mature solution that has earned the trust of most developers, that is why we have taken it into account in our source meta-model.

#### 4.2 The Business layer with Data Transfer Object and Dependency Injection patterns

Business logic layer is the Layer of abstraction between the presentation layer and persistence layer to avoid a strong coupling between these two layers and hide the complexity of the implementation of business processing to presentation layer. All business treatments will be implemented by this layer. The implementation of this layer is produced by the DTO pattern to render the result of running the service and the DI pattern to ensure a decoupling between objects.

In an article written in early 2004, Martin Fowler asked what aspect of control is being inverted. He concluded that it is the acquisition of dependent objects that is being inverted. Based on that revelation, he coined a better name for inversion of control: dependency injection [19].

In other words, Dependency Injection is a worthwhile concept used within applications that we develop. Not only can it reduce coupling between components, but it also saves us from writing boilerplate factory creation code over and over again. Many frameworks that implements DI pattern have emerged, among them: Spring [35], Symfony dependency injection [37], Spring.NET [36], EJB [30], PicoContainer [31]. (We have used some Spring classes in our source meta-model).

Recently, with the development of mapping o/r tools, it becomes easier to transfer a model object on the client layer (UI), and the distribution of the service layer, other advantage of the DTOs, is privileged in N-tiers modern architectures, that is why we have taken it into account in our work.

#### 4.3 The persistence Layer with DAO pattern

This layer is the entry point to the database. All operations required to create, retrieve, update, and delete data in the database are implemented in the components of this layer.

The Data Access Object (DAO) pattern is now a widely accepted mechanism to abstract the details of persistence in an application. In practice, it is not always easy to make our DAO's fully hidden in the underlying persistence layer. The advantage of this abstraction is that we can change the persistence mechanism without affecting the logic domain. All we need to change is the DAO layer which, if designed properly, is a lot easier to do than changing the entire logic domain. In fact we might be able to cleanly swap in a new data access layer for our new database or alternate persistence mechanism. Many frameworks that implements DAO pattern have emerged, among them: SpringDao [35], JPA [32], Hibernate [15], iBatis [2], NHibernate [28], EJB [30]. We have used Hibernate in our work because it is the most used solution within the java community.

### 5. The transformation of MDA models

MDA establishes the links of traceability between the CIM, PIM and PSM models due to the execution of the models' transformations.

The models' transformations recommended by MDA are essentially the CIM transformations to PIM and PIM transformations to PSM. In our work, we perform the second transformation PIM to PSM devoted to N-tiers web applications.

#### 5.1 Approach by modeling

Currently, the transformations of models can be written according to three approaches: Approach by Programming, approach by Template and approach by Modeling.

The approach by Modeling is the one used in the present paper. It consists of applying concepts from model engineering to models' transformations themselves. The objective is modeling a transformation, to reach perennial and productive transformation models, and to express their independence towards the platforms of execution. Consequently, OMG elaborated a standard transformation language called MOF 2.0 QVT [24]. The advantage of the approach by modeling is the bidirectional execution of transformation rules. This aspect is useful for the synchronization, the consistency and the models reverse engineering [9].

Figure 2 illustrates the approach by modeling. Models' transformation is defined as a model structured according to MOF2.0 QVT meta-model. The MOF 2.0 QVT meta-model express some structural correspondence rules between the source and target meta-model of a transformation. This model is a perennial and productive model that is necessary to transform in order to execute the transformation on an execution platform.

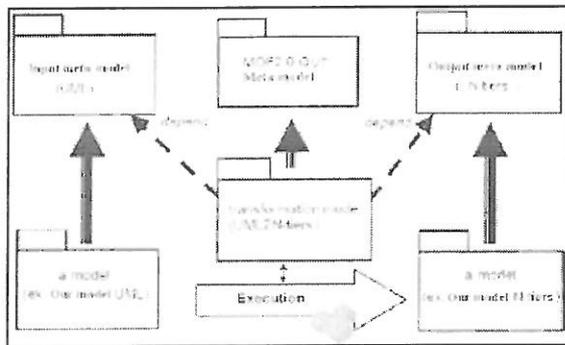


Fig 2 Approach by Modeling

## 5.2 MOF 2.0 QVT

Transformations' models are at the heart of MDA, a standard known as MOF 2.0 QVT being established to model these changes. This standard defines the meta-model for the development of transformation model. The QVT standard has a hybrid character (declarative / imperative) in the sense that it is composed of three different transformation languages.

The imperative style languages are better suited for complex transformations including a significant algorithm component. Compared to the declarative style, they have the advantage of optional case management in a transformation. For this reason, we chose to use an imperative style language in this paper.

The imperative QVT component is supported by Operational Mappings language. The vision requires an explicit imperative navigation as well as an explicit creation of target model elements. The Operational

Mappings language extends the two declarative languages of QVT, adding imperative constructs (sequence, selection, repetition, etc.) and constructs in OCL edge effect.

This work uses the QVT-Operational mappings language implemented by SmartQVT [33]. SmartQVT is the first open source implementation of the QVT-Operational language. The tool comes as an Eclipse plugin under EPL license running on top of EMF framework. This tool is developed by France Telecom R & D project and partially funded by the European IST Model Ware.

SmartQVT is composed of 3 components:

- **QVT Editor:** helps end users to write QVT specifications.
- **QVT Parser:** converts the QVT concrete textual syntax into its corresponding representation in terms of the QVT meta-model.
- **QVT Compiler:** produces, from a QVT model, a Java program on top of EMF generated APIs for executing the transformation. The format of the input is a QVT specification provided in XMI 2.0 in conformance with the QVT meta-model.

## 6. UML and N-tiers architecture meta-models

To develop the transformation algorithm between source and target model, we present in this section, the various meta-classes forming the meta-model UML source and the meta-model N-tiers target.

### 6.1 Meta-model UML source

The source meta-model structures a simplified UML model based on packages containing data types and classes. Those classes contain typed properties and they are characterized by multiplicities (upper and lower). The classes are composed of operations with typed parameters. Figure 3 illustrates the source meta-model.

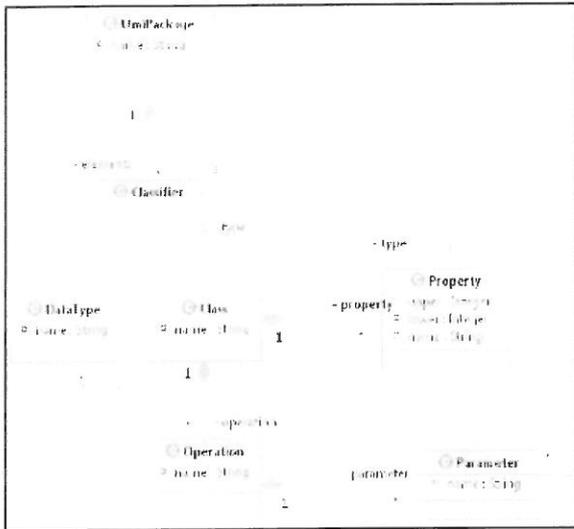


Fig. 3 Simplified UML meta-model

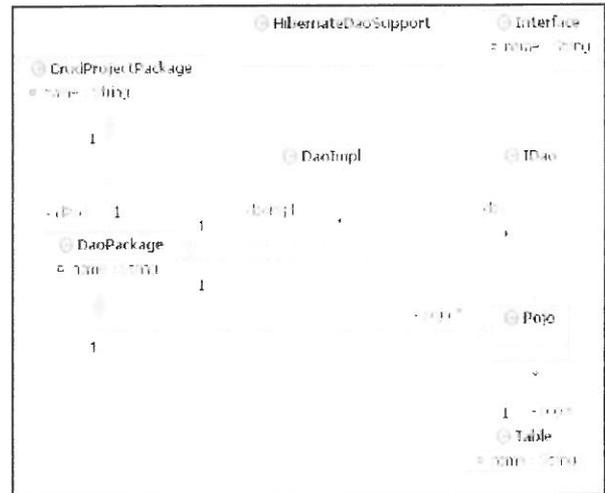


Fig. 4 Simplified meta-model of DaoPackage

- **UmlPackage:** is the concept of UML package. This meta-class is connected to the meta-class *Classifier*.
- **Classifier:** This is an abstract meta-class representing both the concept of UML class and the concept of data type.
- **Class:** is the concept of UML class.
- **DataType:** represents UML data type.
- **Operation:** is used to express the concept of operations of a UML class.
- **Parameter:** expresses the concept of parameters of an operation. These are of two types, Class or DataType. It explains the link between Parameter meta-class and Classifier meta-class.
- **Property:** expresses the concept of properties of a UML class. These properties are represented by the multiplicity and meta-attributes upper and lower.

## 6.2 Meta-model N-tiers target

Our target meta-model is composed of three essential part. Figure 4 illustrates the first part of the target meta-model. This meta-model represents a simplified version of the DAO pattern. It presents the different meta-classes to express the concept of DAO contained in the DaoPackage:

- **CrudProjectPackage:** represents the project package. This meta-class is connected to the meta-class DaoPackage, BusinessPackage and UIPackage.
- **DaoPackage:** represents package which contains the different meta-classes to express the concept of DAO.
- **HibernateDaoSupport:** expresses the concept of generic class for DAOs, defining template methods for DAO initialization.
- **Interface:** is the concept of UML interface.
- **IDao:** represents the concept of Dao interface containing the methods definition to create, retrieve, update, and delete data in the database.
- **DaoImpl:** expresses the concept of Dao implementation, all methods to create, retrieve, update, and delete data in the database are implemented in this meta-class.
- **Pojo:** represents the concept of pojo. The latter extends the meta-class *Class*. The pojoes represents objects in the area of application. These objects communicate with the tables of relational database, which explains the meta-association with meta-class *Table*.
- **Table:** is the concept of table in the relational databases. It contains a meta-attribute *name* which represents the table name in the database. The meta-class is connected by a meta-association to the meta-class *Column*. Figure 5 illustrates the second part of target meta-model. This meta-model is the business model of the application to be processed. In our case, we opted for components such as DTO and DI pattern. Here, we present the different meta-classes to express the concept of DI contained in the Business Package.



- **ApplicationContext:** represents the concept of Central interface to provide configuration for an application. An ApplicationContext provides a Bean factory methods for accessing application components and Inheritance from a parent context. Definitions in a descendant context will always take priority. This means, for example, that a single parent context can be used by an entire web application, while each servlet has its own child context that is independent of other servlets.
- **ServiceLocator:** expresses the concept of Service lookup and creation involves complex interfaces and network operations.

This meta-model structures the models representing the view application. In this model, the Servlet invokes the execute( ) method on the instance of the action class. This method completes its processing and then calls the mapping.findforward( ) method with a return to a specified Jsp page.

Annexe 1 shows the global view of our meta-model target.

## 7. Transformation process from UML to N-tiers implementation

CRUD operations (Create, Remove, Update, and Display) are most commonly implemented in all systems. That is why we have taken into account in our transformation rules these types of transactions.

We first developed EMOF models corresponding to our source and target meta-models, and then we implemented the algorithm using the transformation language QVT Operational Mappings. To validate our transformation rules, we conducted several tests. For example, we considered the class diagram (see Figure 7). After applying the transformation from the UML model, composed by the classes User and advertisement, we generated the target model (see Figure 9).



Fig. 7 UML instance model

### 7.1 Transformation rules

By source model, we mean model containing the various classes of our business model. The elements of this model are primarily classes.

#### Main algorithm:

```

input umlModel:UmlPackage
output crudModel:CrudProjectPackage
begin
create CrudProjectPackage crud
    
```

```

create DaoPackage daoPackage
for each e ∈ source model
x = transformationRuleOnePojo(e)
link x to dp
x = transformationRuleOneIDao(e)
link x to dp
x = transformationRuleOneDaoImpl(e)
link x to dp
end for
create BusinessPackage bp;
for each pojo ∈ target model
x = transformationRuleTwoDto(pojo)
link x to bp
end for
for each e ∈ source model
x = transformationRuleTwoIService(e)
link x to bp
x = transformationRuleTwoSrviceImpl(e)
link x to bp
end for
create UIPackage uip;
create ViewPackage vp
vp = transformationRuleThreeView(e)
create ControllerPackage cp
cp = transformationRuleThreeController(e)
link vp to uip
link cp to uip
link dp to crud
link bp to crud
link uip to crud
return crud
end
    
```

```

function
transformationRuleOnePojo(e:Class):Pojo
begin
create Pojo pj
pj.name = e.name
pj.attributes = e.properties
return pj
end
    
```

```

function
transformationRuleOneIDao(e:Class):IDao
begin
create IDao idao
idao.name = 'I'+e.name+ 'Dao'
idao.methods = declaration of e.methods
return idao
end
    
```

```

function
transformationRuleOneDaoImpl(e:Class):DaoImpl
begin
create DaoImpl daoImpl
daoImpl.name = e.name+ 'DaoImpl'
for each el ∈ DaoPackage
if el.name = 'I'+e.name+ 'Dao'
put el in interfaces
end if
end for
link interfaces to daoImpl
return daoImpl
end
    
```

```

function
transformationRuleTwoDto(p:pojo):Dto
begin
create Dto dto
dto.name = p.name
dto.attributes = p.attributes
return dto
end
    
```

```

function
transformationRuleTwoIService(e:Class):IService
    
```

```

begin
  create IService iservice
  iservice.name = 'I'+e.name+ 'Service'
  iservice.methods = declaration of e.methods
  return iservice
end
function
transformationRuleTwoServiceImpl(e:Class):Service
Impl
begin
  create ServiceImpl serviceImpl
  serviceImpl.name = e.name+ 'ServiceImpl'
  for each e1 ∈ BusinessPackage
  if e1.name = 'I'+e.name+ 'Service'
  put e1 in interfaces
  end if
  end for
  link interfaces to ServiceImpl
  return ServiceImpl
end
function
transformationRuleThreeView(e:Class):ViewPackage
begin
  create ViewPackage vp
  for each e ∈ source model
  if e.methods.name ≠ 'remove'
  create JspPage page
  link page to vp
  end if
  end for
  return vp
end
function
transformationRuleThreeController(e:Class):Contro
llerPackage
begin
  create ControllerPackage cp
  create ActionMapping am
  for each page viewPackage
  link page to actionForward
  create ActionForm
  create Action action
  create ActionForward actionForward
  actionForm.input=page
  actionForm.attribute=action
  link page to actionForward
  link actionForward to action
  put action in am
  end for
  link am to cp
  return cp
end

```

Figure 8 represents the first part of the code of the transformation of UML model source to N-tiers target model.

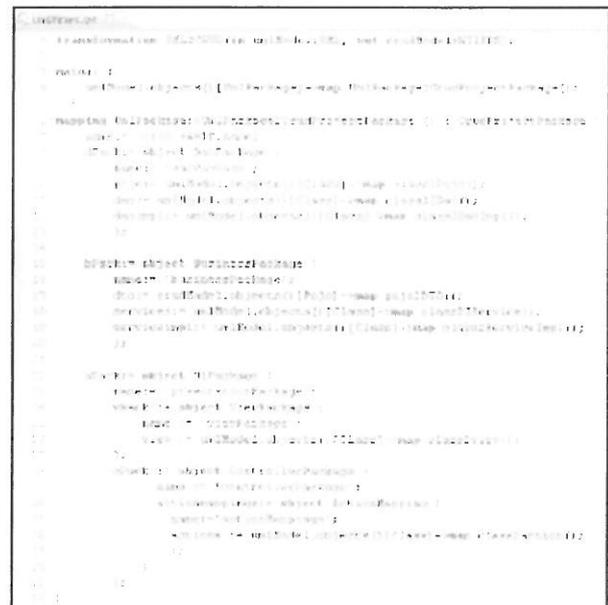


Fig. 8 A transformation code UML2CRUD

The transformation uses, in entry, a model of the UML type named umlModel, and in output a model of the N-tiers named crudModel.

The entry point of the transformation is the method 'main'. This method makes the correspondence between all the elements of the UMLPackage type of the input model and the element of the CrudProjectPackage type of the output model. The objective of the second part of this code is to transform a UML package into N-tiers package, by creating the elements of type package 'Dao', 'Business' and 'Presentation. It is a question of transforming each class of package UML to Jsp page and Action in the View package, to DTO, IService and ServiceImpl in the Business package, and to Pojo, IDao and DaoImpl in the Dao package, without forgetting to give names to the different packages.

### 7.2 Result:



Fig. 9 Sample of the generated Web site

## 8. Conclusion

In this paper, we applied the MDA approach to generate the N-tiers web application based on UML class diagram to generate a skeleton of a application to manage the expenses of urban districts in Morocco.

This involves developing all meta-classes needed to be able to generate an N-tiers application respecting a MVC2, DI and DAO patterns, then we applied the approach by modeling and used the MOF 2.0 QVT standard as a transformation language. The transformation rules defined allow browsing the source model instance class diagram, and generating, through these rules, an XML file containing layers of N-tiers architecture according to our target model. This file can be used to produce the necessary code of the target application. The algorithm of transformation manages all CRUD operations. Moreover, it can be re-used with any kind of methods represented in the UML class diagram. In the future, this work should be extended to allow the generation of other components of Web application besides the configuration files. For instance, we will be able to provide part of user interface. Afterward we can consider integrating other execution platforms like PHP and DotNET.

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# Plasmonic Analogue of Electromagnetically Induced Transparency in Detuned Nano-cavities Coupled to a Waveguide

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**Abstract.** We theoretically investigate the classical analogue of electromagnetically induced transparency (EIT) in a plasmonic structure constituted by double side cavities connected symmetrically to a waveguide. The EIT is demonstrated by simply detuning the sizes of the two cavities (i.e., the length difference  $\Delta L$ , keeping their width  $w$  similar). The physical mechanism behind the EIT resonance lies in the destructive and constructive interference between the confined modes in the two cavities. The former play the role of two coupled radiative oscillators. The proposed structure may have important applications for designing integrated devices such as: narrow-frequency optical filters, novel sensors and high-speed switches.

**Keywords:** Electromagnetic induced Transparency, Surface plasmon-polariton, cavity resonator

## 1 Introduction

Electromagnetically induced transparency (EIT) is a quantum interference phenomenon that renders an opaque medium transparent in a narrow spectral region with low absorption and steep dispersion [1], [2]. These properties have been exploited to show different applications in these systems such as: slow light, sensing

and data storage [2], [3]. However, it was realized that EIT-like behaviors are not uniquely associated to quantum systems and can be extended to classical systems [2], [3]. In this context, several classical systems have been designed to demonstrate the classical analogue of EIT. Among these systems one can cite: plasmonic nanostructures [4], [5], [6], [7], planar metamaterials [8], [9], photonic crystal waveguides coupled to cavities [10], [11], [12], coupled microresonators [13], [14], [15], [16], micro and radiowave circuits [17], [18], [19] and acoustic slender tube waveguides [20], [21].

As concerns plasmonic systems [4], [5], [6], [7], [8], [9], metamaterials made of split-rings and cut-wires as well as plasmonic waveguides with coupled cavities have shown EIT and Fano [22] resonances with high quality factors. Due to their deep subwavelength confinement of light at the metal-dielectric interface, plasmonic materials have been suggested as an alternative to overcome the classical diffraction limit and manipulation of light in nanoscale domain [23]. The EIT resonance can be obtained using two coupled resonators (or oscillators) with closely spaced frequencies. The resonators with high (dark resonator) and low (radiative resonator) Q factors give rise to the so-called  $\Lambda$ -type configuration [1] in three atomic levels, whereas the resonators with low Q factors (radiative resonators) give rise to the so-called V-type configuration [4], [6], [18], [19], [20], [21]. The latter mechanism has been demonstrated in little works in comparison with the first one.

In few recent works, the V-type resonances in double stub resonators connected at the same site along a waveguide have been shown in plasmonic [4], [6], photonic [18], [19] and acoustic [20], [21] materials. The case of two plasmonic cavities interacting with a waveguide by means of evanescent waves (near field mechanism) through a metal gap, has been shown by Zhang et al [24]. They have studied numerically light propagation in a metal-air-metal waveguide and two side-coupled cavities located at a symmetric position around the waveguide. The two cavities are characterized by the same size but with different dielectric permittivities. They have shown the possibility of the existence of plasmonic EIT resonance that can be detuned by varying the dielectric permittivities in the two cavities. This study has been implemented by calculating the transmission amplitude through the system using the finite difference time domain (FDTD) method. In this work, we studied numerically the plasmonic analogue of EIT in a two side-coupled cavities to a waveguide. The optical properties of the modeled structure such as transmission, reflection and absorption are obtained using finite-element method (Comsol Multiphysics Package) [28]. The waveguide and the cavities are embedded in a metal and filled with air. Also, we consider that both cavities have the same width ( $w=100\text{nm}$ ), whereas their lengths  $L_1$  and  $L_2$  can be detuned. We show the possibility of existence of EIT resonance by detuning the size of the two cavities (Fig. 1). Their separation from the waveguide is referred to as  $g$  (metallic gap that enables evanescent coupling).

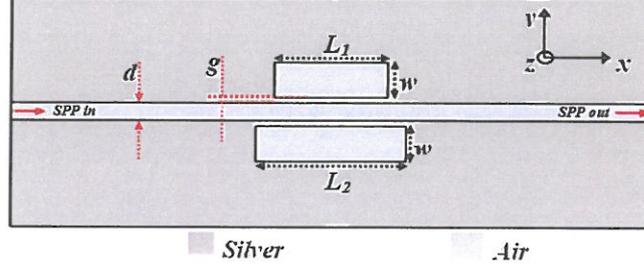


Fig. 1. Structure of the plasmonic nanoscale resonator system.

### 3 Numerical results

In our model the dielectric function of the metal (silver) is described by the lossy Drude model whose parameters are:  $\epsilon_{\infty} = 12.5$ ,  $\omega_p = 2.05 \times 10^{16}$  rad/s and  $\Gamma = 10^{14}$  rad/s [25]. The waveguide width,  $d$ , is equal to 50nm, and the incident plane wave is a TM polarized one. In order to show the possibility of existence of EIT-resonance, i.e. a resonance squeezed between two transmission zeros, we have to take  $L_1$  and  $L_2$  slightly different. An example corresponding to this situation is given in figure 2(a) (pink curves) for  $L_1=240$ nm and  $L_2=258$ nm (i.e.,  $\Delta L = L_2 - L_1 = 18$ nm). One can notice the existence of deep dips in the transmission spectra around  $\lambda_1 = 654$ nm and  $\lambda_2 = 693$ nm and a resonance peak (transmission window) is induced at  $\lambda_r = 672$ nm between the dips. The resonance does not reach unity because of the absorption in the system (see Fig. 2(c)), the reflection being very weak (Fig. 2(b)). As a matter of comparison, we have also plotted the transmission, reflection and absorption for each resonator alone (black and red curves).

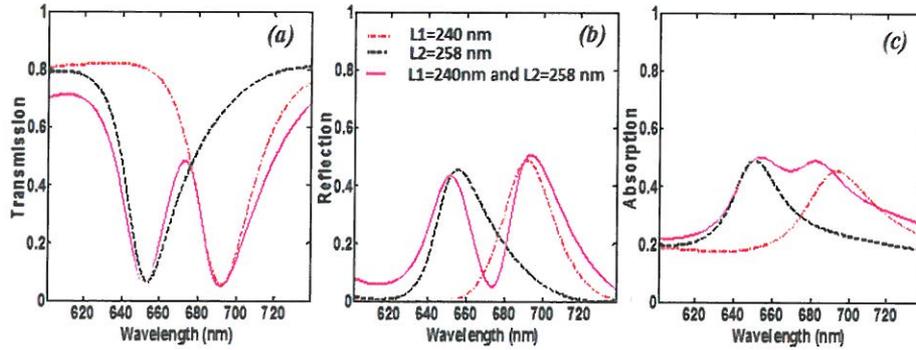
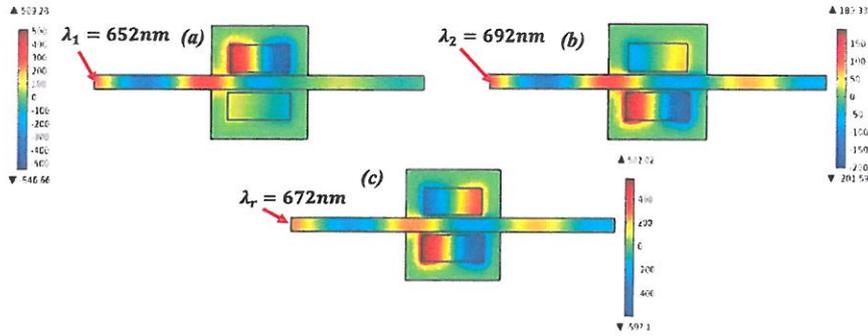


Fig. 2. (a) Transmission spectra when a single cavity is coupled to the waveguide with  $L_1=240$ nm (red curve) and  $L_2=258$ nm (black curve). The pink curve corresponds to the case when both cavities are present in the system ( $L_1=240$ nm and  $L_2=258$ nm). (b) The same as in (a) but for the reflection. (c) The same as in (a) but for the absorption.

One can notice that the transmission zeros are induced by each cavity [27], whereas the resonance is a consequence of the constructive interference between cavities. In order to show the spatial localization of the different modes in Fig.2, we have plotted in Fig. 3 the amplitude of the magnetic field map at the two dips around  $\lambda_1 = 654nm$  (Fig. 3(a)) and  $\lambda_2 = 693nm$  (Fig. 3(b)). As predicted, the magnetic fields are mainly confined in each cavity and do not propagate in the system. These results are in accordance with those in Fig.2 (a) where the trapping and the rejection of the incident light wave is induced by the two cavities [27]. Around the resonance at  $\lambda_r = 672nm$  (Fig.3(c)), one can notice that both cavities are excited and the wave is transmitted along the waveguide as mentioned above. Therefore, the EIT resonance is a consequence of the constructive interference between the waves in the two cavities. However, the field is more localized in the lower cavity compared with upper one, which indicates that the latter is a bit less excited than the former. This is actually related to the asymmetry of the transmission spectra in Fig. 2(a) (pink curve) where the resonance peak wavelength is closer to the lower cavity eigenmode resonance wavelength than to the upper cavity. On the other hand, the field map shows that the excited cavities modes oscillate out of phase; this effect has been also observed in microwave photonic circuits [17], [18], [19].



**Fig. 3.**(a), (b) Magnetic field map at transmission dips around  $\lambda_1 = 652nm$  and  $\lambda_2 = 692nm$  respectively.(c) The same as in (a) and (b) but for the resonance peak around  $\lambda_r = 672nm$ .

## 4 Conclusion

In this paper, we have demonstrated numerically the possibility of existence of plasmonic analogue of EIT in metal-air-metal waveguide coupled to two nano-cavities filled with air but with different sizes. The waveguide and the cavities are embedded in a metal and the interaction between the incident light wave and the cavities occurs by means of evanescent waves through a small metal gap. The proposed structure may have important applications for designing integrated devices such as: narrow-frequency optical filters, novel sensors and high-speed switches.

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