Wrocław University of Technology

Consensus as a Tool Supporting Customer Behaviour Prediction in Social CRM Systems

Adam Czyszczoń

Research tutor:
dr hab. inż. Aleksander Zgrzywa, prof PWr.

Faculty of Computer Science and Management
Institute of Informatics
Division of Information Systems

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Overview

Introduction

CRM

CRM — Customer Relationship Management

„CRM is first of all a philosophy, or business strategy, whereas the tool supporting the realization of this philosophy/strategy becomes the technology of information processing."

[Grzanka I., CRM a społeczny potencjał przedsiębiorstwa, „Kapitał społeczny w relacjach z klientami", CeDeWu, Warszawa 2009]

- *Ongoing* and *long-term process* aimed at providing *added value* to the customer.
- Information is gathered from the beginning of customer-company contact, often before a person actually becomes a customer.
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CRM Systems

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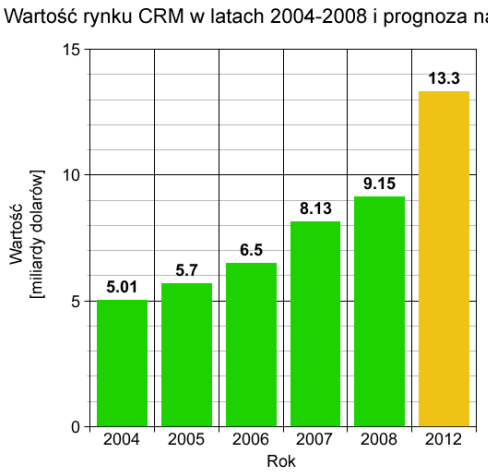

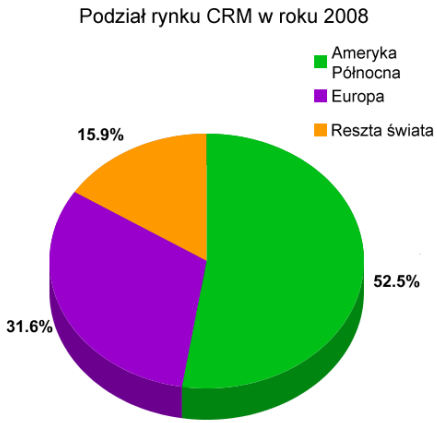

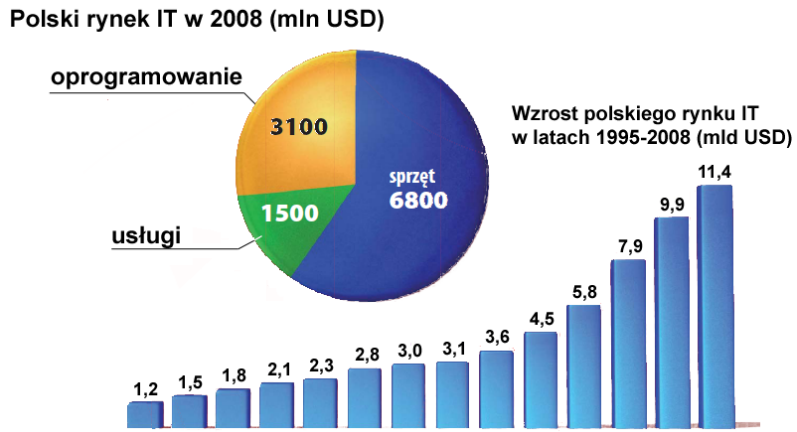

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- No system of among the world leading CRM vendors (SAP, Oracle, Salesforce.com, Microsoft) did not have similar functionality in 2010.
- World's CRM market value is forecasted to reach over $20 billion in contrast to 2011 where revenues were projected to total $16.5 billion.

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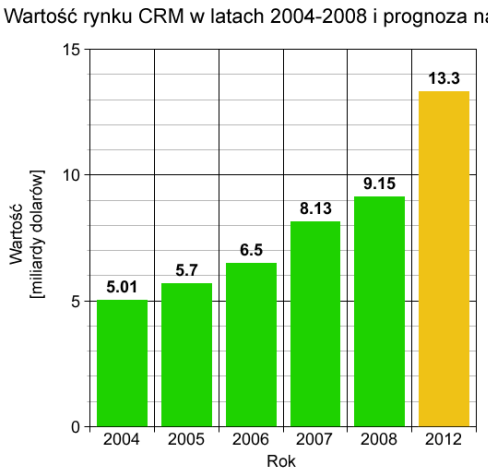

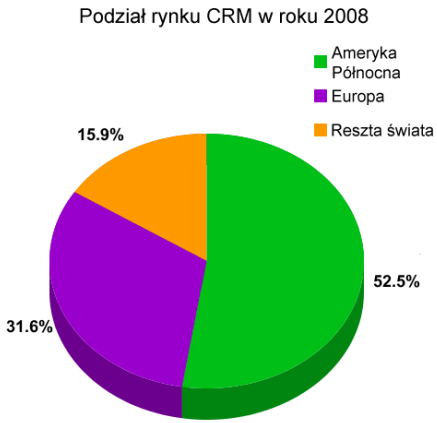

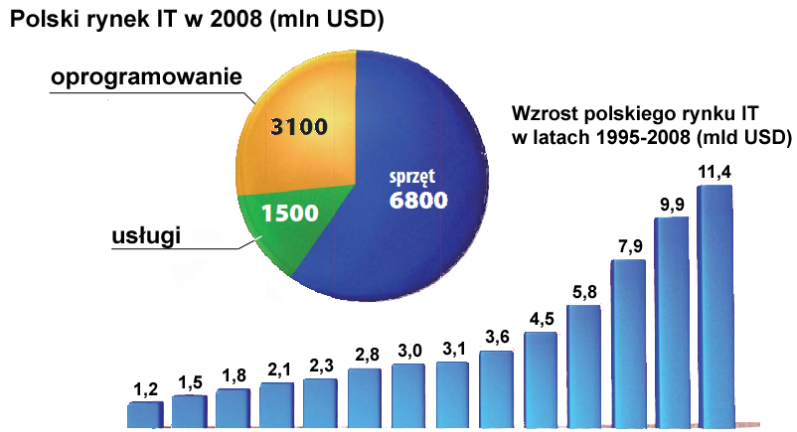

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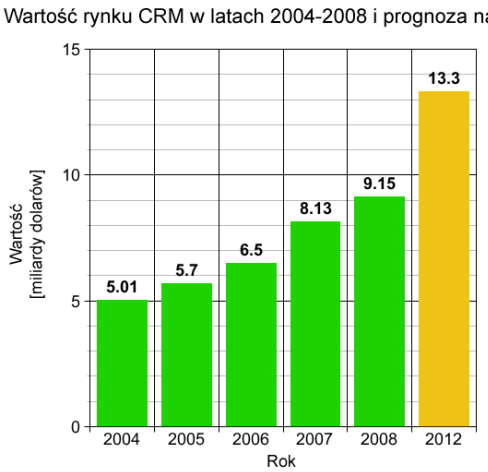

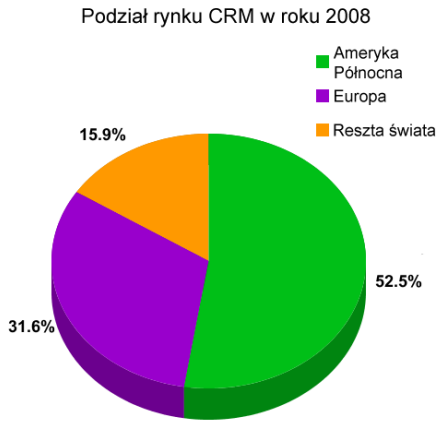

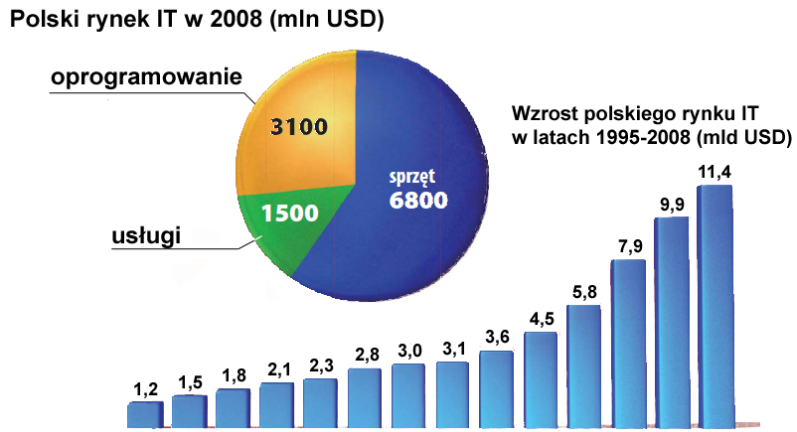

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Social CRM Systems

- Growth of interest in *Social Network* Services (blogs, Facebook, Flickr, Twitter).
- New type of media: *Social Media*.
- **sCRM** (or SCRM) is a CRM oriented on Social Media.

„Social CRM is a philosophy and a business strategy, supported by a technology platform, business rules, processes, and social characteristics, designed to engage the customer in a collaborative conversation in order to provide mutually beneficial value in a trusted and transparent business environment. [...]"

[P. Greenberg. CRM at the Speed of Light: Social CRM Strategies, Tools, and Techniques for Engaging Your Customers. McGraw-Hill, fourth edition, 2010]

- CRM and sCRM are very close with a difference in technology use, process conception and ways of interaction with the customer.

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Consensus System

Task and Definition

- The use of consensus approach is aimed at resolving contradictory forecasts of customer behaviour.
- Forecasts are provided by different agents working as independent Artificial Neural Network (ANN) systems.
- The goal of presented tool is to improve prediction functionality of customer behaviour.
- The task of consensus method is to determine version of knowledge which best reflects given versions.

Consensus System:

$$CS = \langle A, X, P, Z \rangle \tag{1}$$

where

A – a finite set of attributes, each attribute $a \in A$ has a domain V_a (a finite set of elementary values).
X – a finite set of consensus carriers, $X = \{\prod(V_a) : a \in A\}$.
P – a finite set of relations on carriers from X, each relation is of some type T (for $T \subseteq A$).
Z – a finite set of propositional calculus, for which the model is relation system (X,P)

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Knowledge Scope

In sCRM key structural elements of knowledge about customer concern:

- basic information about client (age, gender, city etc.),
- extended information (favourite categories of products, complaints, opportunities),
- properties related to Social Media (interests on Facebook, followers on Twitter),

Consensus System

Knowledge Scope

- customer loyalty:

Recency Frequency Money:

$$RFM = (R \cdot \alpha) + (F \cdot \beta) + (M \cdot \gamma) \tag{2}$$

where

R – number of days since last purchase, α – weight of last purchase,
F – total number of purchases, β – weight of number of purchases,
M – total value of purchases, γ – weight of the value of purchases.

Next Purchase Probability:

$$NPP = (\frac{\alpha}{\beta})^n \tag{3}$$

where

α – number of days between first and last purchase,
β – number of days taken into account in historical client analysis,
n – number of purchases in the entice historical period.

Customer LifeTime Value:

$$LTV = \alpha + \beta \tag{4}$$

where

α – annual profit from sales of products to the customer,
β – number of years of customer-company relation.

Consensus System

Knowledge Carriers

- Agents represent knowledge carriers about customer behaviour.
- Their knowledge is is stored in synaptic weights of ANN, based on a set of *profile* characteristics associated with some *activities*.
- *Profile* allows to differentiate clients on the basis of their individual set of attributes (age, gender, . . . , RFM, . . . , Facebook, Twitter).
- *Activities* concern elements which define his behaviour (categories, complaints, opportunities, leads).
- ANN is trained for each customer separately.

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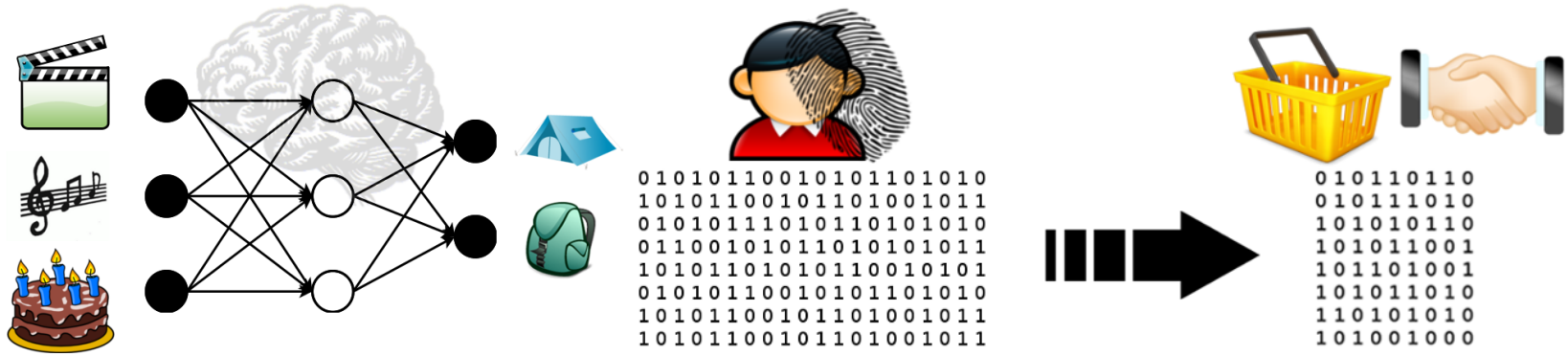

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Consensus System

Knowledge Structure

- Knowledge about each client is composed of:
  - **attributes** and their **values**,
  - **relations and conditions** on those attributes.

Attributes and Values

$$A = \{Agent, RFM, NPP, LTV, Facebook, Twitter, Category, Value\} \tag{5}$$

$$X = \{\prod(V_{Agent}), \prod(V_{RFM}), \prod(V_{NPP}), \ldots, \prod(V_{Value})\} \tag{6}$$

where

$V_{Agent} = \{a_1, a_2, a_3, \ldots, a_n\}$
$V_{RFM} = [1, +\infty]$
$V_{NPP} = [0, 1]$
$V_{LTV} = [1, +\infty]$
$V_{Facebook} = [0, +\infty]$
$V_{Twitter} = [0, +\infty]$
$V_{Category} = \{c_1, c_2, c_3, \ldots, c_n\}$
$V_{Value} = [1, +\infty]$

Consensus System

Knowledge Structure

Relations and Conditions

$$P = \{Purchase, Opportunity, Lead\} \tag{7}$$

where *Purchase*, *Opportunity*, *Lead* are following types of relations:
$Purchase : \{Agent, RFM, NPP, LTV, Facebook, Twitter, Category, Value\}$
$Opportunity : \{Agent, Facebook, Twitter, Category, Value\}$
$Lead : \{Agent, Facebook, Twitter, Category\}$

Above relations have to satisfy following conditions:

$$\begin{aligned} Z = \{ & \\ & (Purchase(a,r,n,l,f,t,c,v)) \Rightarrow (\neg Lead(a,f,t,c)), \\ & (Lead(a,f,t,c)) \Rightarrow (Opportunity(a,f,t,c,v)), \\ & (Purchase(a,r,n,l,f,t,c,v) \wedge r > 300) \Rightarrow (Opportunity(a,f,t,c,v)), \\ & (Purchase(a,r,n,l,f,t,c,v) \wedge n > 0.7) \Rightarrow (Opportunity(a,f,t,c,v)), \\ & (Purchase(a,r,n,l,f,t,c,v) \wedge l > 1000) \Rightarrow (Opportunity(a,f,t,c,v)), \\ & (Purchase(a,r,n,l,f,t,c,v) \wedge t > 10) \Rightarrow (Opportunity(a,f,t,c,v)) \\ \} & \end{aligned} \tag{8}$$

Consensus System

Conflict Situations

$$s = \langle P, A \rightarrow B \rangle \tag{9}$$

where

A represents conflict subject and B the content of the conflict.

$$s_1 = \langle Purchase, Category \rightarrow \{RFM, NPP, LTV, Facebook, Twitter, Value\} \rangle \tag{10}$$

$$s_2 = \langle Opportunity, Category \rightarrow \{Facebook, Twitter, Value\} \rangle \tag{11}$$

$$s_3 = \langle Lead, Category \rightarrow \{Facebook, Twitter, Category\} \rangle \tag{12}$$

Consensus System

Conflict Situations

Example of conflict situation s_1.

Agent	Category	RFM	NPP	LTV	Facebook	Twitter	Value
a_1	c_3	300	0.7	600	$\{2,5\}$	1	80
a_2	$\{c_1, c_2\}$	320	0.7	710	$\{1,5\}$	3	100
a_3	c_1	250	0.5	600	$\emptyset$	$\emptyset$	50
a_4	$\{c_1, c_2\}$	280	0.8	650	$\{2,5\}$	1	100
a_5	c_1	310	0.6	600	$\{2,5,7\}$	11	50

Example of conflict situation s_2.

Agent	Category	Facebook	Twitter	Value
a_1	c_3	5	$\emptyset$	50
a_2	$\{c_1, c_2\}$	$\{1,5\}$	3	100
a_4	$\{c_1, c_2\}$	$\{2,5\}$	1	100
a_5	c_1	$\{2,5,7\}$	11	50
a_6	$\{c_1, c_3\}$	$\{2,3\}$	5	100

Example of conflict situation s_3.

Agent	Category	Facebook	Twitter
a_6	c_3	5	$\emptyset$
a_7	$\{c_1, c_3\}$	$\{1,2,3\}$	30

Consensus System

Conflict Profiles

For each conflict subject $e \in Category$ we determine conflict profiles $profile(e)$ which contain opinions of agents on given subject.

$$profile(e) = \left\{ r_{B \cup \{Agent\}} : r \in P \right\} \tag{13}$$

Example of conflict profiles for *Purchase* event.

Category	Agent	RFM	NPP	LTV	Facebook	Twitter	Value
c_1	a_2	320	0.7	710	$\{1,5\}$	3	100
c_1	a_3	250	0.5	600	$\emptyset$	$\emptyset$	50
c_1	a_4	280	0.8	650	$\{2,5\}$	1	100
c_1	a_5	310	0.6	600	$\{2,5,7\}$	11	50
c_2	a_2	320	0.7	710	$\{1,5\}$	3	100
c_2	a_4	280	0.8	650	$\{2,5\}$	1	100
c_3	a_1	300	0.7	600	$\{2,5\}$	1	80

Consensus System

Conflict Profiles

Example of conflict profiles for *Opportunity* event.

Category	Agent	Facebook	Twitter	Value
c_1	a_2	$\{1,5\}$	1	100
c_1	a_4	$\{2,5\}$	1	100
c_1	a_5	$\{2,5,7\}$	11	50
c_1	a_6	$\{2,3\}$	5	100
c_2	a_2	$\{1,5\}$	1	100
c_2	a_4	$\{2,5\}$	1	100
c_3	a_1	5	$\emptyset$	50
c_3	a_6	$\{2,3\}$	5	100

Example of conflict profiles for *Lead* event.

Category	Agent	Facebook	Twitter	Category
c_1	a_7	$\{1,2,3\}$	30	$\{c_1, c_3\}$
c_3	a_6	5	$\emptyset$	c_3
c_3	a_7	$\{1,2,3\}$	30	$\{c_1, c_3\}$

Consensus System

Consensus and Distance Function

Consensus of $profile(e)$ on subject $e \in Category$ for situation $s = \langle P, A \rightarrow B \rangle$ is represented by tuple $C(s,e)$ of type $A \cup B$, which satisfies the logical formulas from set Z. Based on the above the consensus definition of situation s is following:

$$C(s) = \{C(s,e) : e \in Category\} \tag{14}$$

Distance function (reflecting element shares in the distance):

$$\rho(X,Y) = \frac{1}{2card(V_a) - 1} \sum_{z \in V_a} Part(X,Y,z) \tag{15}$$

where
$Part(X,Y,z) = 1$ for every $z \in X \cap Y$
$Part(X,Y,z) = 0$ for every $z \in X \setminus Y$
$Part(X,Y,z) = 0$ for every $z \in V_a \setminus (X \cup Y)$

Consensus System

Consensus Determination Algorithm

Input: Set of conflict situation tuples $S = \{\langle s_{11}, s_{21}, s_{31}\rangle, \langle s_{12}, s_{22}, s_{32}\rangle, \ldots, \langle s_{1n}, s_{2n}, s_{3n}\rangle\}$.
Output: Set of consensus tuples $C = \{\langle C(s_{11}), C(s_{21}), C(s_{31})\rangle, \ldots, \langle C(s_{1n}), C(s_{2n}), C(s_{3n})\rangle\}$.

$C \leftarrow \emptyset$
for $sTuple \in S$ **do**
  $C(s) \leftarrow \langle\rangle$
  for $s \in sTuple$ **do**
    $C(s,e) \leftarrow \emptyset$
    for $e \in Category$ **and** $Category \in s$ **do**
      for $prediction \in Agent(e)$ **do**
        $profile(e) \leftarrow profile(e) \cup prediction$
      end
      for $subjectSet \in profile(e)$ **do**
        for $V_b \in B$ **do**
          $\rho_{V_b} \leftarrow \rho_{V_b} \cup \rho(V_b, profile(e)_{subjectSet+1,V_b})$
        end
      end
      $C(s,e) \leftarrow C(s,e) \cup max(\rho_e)$
    end
    $C(s) \leftarrow C(s) \cup C(s,e)$
  end
  $C_{sTuple} \leftarrow C_{sTuple} \cup C(s)$
end

Conclusion

- Agents are considered as knowledge carriers which store knowledge about customer behaviour in synaptic weights of ANN.
- In sCRM systems we distinguished three events: *Purchase*, *Opportunity* and *Lead*.
- Those events represent the actual targets of behaviour forecasts.
- Every event is described by *attributes*, *values*, *relations* and *conditions* which allows to give their definitions.
- In order to establish consensus $C(s)$ distance function and consensus determination algorithm were used.

Conclusion

- Agents are considered as knowledge carriers which store knowledge about customer behaviour in synaptic weights of ANN.
- In sCRM systems we distinguished three events: *Purchase*, *Opportunity* and *Lead*.
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Thank you for attention.

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