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

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1. Introduction
2. Consensus System
3. Conclusion
**Introduction**

**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.
- **Lead** — identified, potential customer.
- **Opportunity** — estimated monetary value associated with a business event, for example acquiring a client or sending an offer.
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- The market of CRM systems is rapidly growing.

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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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. [...]”


- 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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[Greenberg 2010]

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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:

\[ CS = \langle A, X, P, Z \rangle \]  

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 \( T \subseteq A \)).
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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),
customer loyalty:

**Recency Frequency Money:**

\[
RFM = (R \cdot \alpha) + (F \cdot \beta) + (M \cdot \gamma)
\]

where
- \( R \) – number of days since last purchase,
- \( \alpha \) – weight of last purchase,
- \( F \) – total number of purchases,
- \( \beta \) – weight of number of purchases,
- \( M \) – total value of purchases,
- \( \gamma \) – weight of the value of purchases.

**Next Purchase Probability:**

\[
NPP = \left( \frac{\alpha}{\beta} \right)^n
\]

where
- \( \alpha \) – number of days between first and last purchase,
- \( \beta \) – number of days taken into account in historical client analysis,
- \( n \) – number of purchases in the entire historical period.

**Customer LifeTime Value:**

\[
LTV = \alpha + \beta
\]

where
- \( \alpha \) – annual profit from sales of products to the customer,
- \( \beta \) – number of years of customer-company relation.
Agents represent knowledge carriers about customer behaviour. Their knowledge 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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Knowledge Carriers

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Knowledge Structure

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

Attributes and Values

\[ A = \{ \text{Agent}, \text{RFM}, \text{NPP}, \text{LTV}, \text{Facebook}, \text{Twitter}, \text{Category}, \text{Value} \} \]  

\[ X = \{ \prod(V_{\text{Agent}}), \prod(V_{\text{RFM}}), \prod(V_{\text{NPP}}), \ldots, \prod(V_{\text{Value}}) \} \]

where

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

\[ Z = \{
\begin{align*}
(Purchase(a, r, n, l, f, t, c, v)) & \Rightarrow (\neg Lead(a, f, t, c)), \\
(Lead(a, f, t, c)) & \Rightarrow (Opportunity(a, f, t, c, v)), \\
(Purchase(a, r, n, l, f, t, c, v) \land r > 300) & \Rightarrow (Opportunity(a, f, t, c, v)), \\
(Purchase(a, r, n, l, f, t, c, v) \land n > 0.7) & \Rightarrow (Opportunity(a, f, t, c, v)), \\
(Purchase(a, r, n, l, f, t, c, v) \land l > 1000) & \Rightarrow (Opportunity(a, f, t, c, v)), \\
(Purchase(a, r, n, l, f, t, c, v) \land t > 10) & \Rightarrow (Opportunity(a, f, t, c, v))
\end{align*}
\} \tag{8} \]
Consensus System

Conflict Situations

\[ s = \langle P, A \rightarrow B \rangle \]  
(9)

where

\( A \) represents conflict subject and \( B \) the content of the conflict.

\[ s_1 = \langle \text{Purchase}, \text{Category} \rightarrow \{ \text{RFM, NPP, LTV, Facebook, Twitter, Value} \} \rangle \]  
(10)

\[ s_2 = \langle \text{Opportunity}, \text{Category} \rightarrow \{ \text{Facebook, Twitter, Value} \} \rangle \]  
(11)

\[ s_3 = \langle \text{Lead}, \text{Category} \rightarrow \{ \text{Facebook, Twitter, Category} \} \rangle \]  
(12)
### Example of conflict situation $s_1$

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

### Example of conflict situation $s_2$

<table>
<thead>
<tr>
<th>Agent</th>
<th>Category</th>
<th>Facebook</th>
<th>Twitter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>$a_1$</td>
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<table>
<thead>
<tr>
<th>Agent</th>
<th>Category</th>
<th>Facebook</th>
<th>Twitter</th>
</tr>
</thead>
<tbody>
<tr>
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Consensus System

Conflict Profiles

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

\[ \text{profile}(e) = \left\{ r_{B \cup \{\text{Agent}\}} : r \in P \right\} \]  

(13)

Example of conflict profiles for \textit{Purchase} event.

<table>
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<tr>
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### Conflict Profiles

**Example of conflict profiles for *Opportunity* event.**

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<th>Value</th>
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</thead>
<tbody>
<tr>
<td>$c_1$</td>
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<th>Twitter</th>
<th>Category</th>
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Consensus System

Consensus and Distance Function

Consensus of profile(e) on subject e ∈ Category for situation
s = ⟨P, A → B⟩ is represented by tuple C(s, e) of type A ∪ B, which
satisfies the logical formulas from set Z. Based on the above the
consensus definition of situation s is following:

\[
C(s) = \{ C(s, e) : e \in \text{Category} \} \tag{14}
\]

Distance function (reflecting element shares in the distance):

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

where
\[
Part(X, Y, z) = 1 \text{ for every } z \in X \cap Y \\
Part(X, Y, z) = 0 \text{ for every } z \in X \setminus Y \\
Part(X, Y, z) = 0 \text{ for every } z \in V_a \setminus (X \cup Y)
\]
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 \( C = \{ \langle C(s_{11}), C(s_{21}), C(s_{31}) \rangle, \ldots, \langle C(s_{1n}), C(s_{2n}), C(s_{3n}) \rangle \} \).

1: \( C \leftarrow \emptyset \)
2: \( \text{for } sTuple \in S \text{ do} \)
3: \( \quad C(s) \leftarrow \{ \} \)
4: \( \quad \text{for } s \in sTuple \text{ do} \)
5: \( \quad \quad C(s, e) \leftarrow \emptyset \)
6: \( \quad \text{for } e \in \text{Category and Category} \in s \text{ do} \)
7: \( \quad \quad \text{for } \text{prediction} \in \text{Agent}(e) \text{ do} \)
8: \( \quad \quad \quad \text{profile}(e) \leftarrow \text{profile}(e) \cup \text{prediction} \)
9: \( \quad \quad \text{end} \)
10: \( \quad \text{for } \text{subjectSet} \in \text{profile}(e) \text{ do} \)
11: \( \quad \quad \text{for } V_b \in B \text{ do} \)
12: \( \quad \quad \quad \rho_{V_b} \leftarrow \rho_{V_b} \cup \rho(V_b, \text{profile}(e)\text{subjectSet}+1, V_b) \)
13: \( \quad \quad \text{end} \)
14: \( \quad \text{end} \)
15: \( \quad C(s, e) \leftarrow C(s, e) \cup \text{max}(\rho_e) \)
16: \( \text{end} \)
17: \( C(s) \leftarrow C(s) \cup C(s, e) \)
18: \( \text{end} \)
19: \( C_{sTuple} \leftarrow C_{sTuple} \cup C(s) \)
20: \( \text{end} \)
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.
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Thank you for attention.
References


