Chapter

Introductory Chapter: Customer Satisfaction Alignment with "On the Edge" IT Tools

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1. Introduction

This book is about the new role of IT in managing customer relationships. CRM (or customer relationship management) systems are well-known and widely implemented for a long time. On the edge IT technologies provide an opportunity for a breakthrough in customer relationship management and improve the role of IT in the process. In this book the respected authors represent their experience and provide meta-analysis of the IT technologies implementation in the subject area and the results gained.

In the current chapter, the author, who is the academic editor of the book, presents his vision and approach of the role of IT and especially on the edge technologies for customer relationship management.

The growth of the on the edge technologies such as big data [1], machine learning, and artificial intelligence [2] provides new opportunities for customer relationship management. In this chapter, the author makes a general overview of those new opportunities and tools.

I. Implementing artificial neural networks (ANN)

The ANN tools provide support for the vast area of business tasks in CRM area.

a. Define product groups or bundle offers for sales

b. Define customer groups by behavior

c. Search for customer individual preferences

d. Customer recognition technologies:

e. Face recognition to improve customer service

f. Voice recognition

g. Emotion recognition (voice and chat)

II. Graph models. Predict customer path and lifecycle in a company

a. Define probable customer journey (on the example of buying a ticket)

b. Define customer lifecycle in a company

III.Fuzzy logic models

a. Estimate customer satisfaction

b. Estimate customer demand and develop new products/services/offers

c. Estimate demand

d. Estimate internal capabilities and capacity

e. Estimate external (market/technology) capabilities and capacity

f. Develop a product/service/offer

2. Applied research and analysis methods

a. Author analyses his own projects results.

b. Meta-analysis of existing publications and articles.

c. Analysis of request forms and queries.

3. Implementing of ANN tools

In this section I deliver our team experience of applying emotion recognition of a customer for call (contact) center systems and leisure services (karaoke and similar). Well-known fact is that customer satisfaction is one of the most important indicators for business. Net present score (NPS) is often used as such indicator based on customer satisfaction surveys. But NPS is a kind of the lagging (or postmortem) indicator. An organization can implement also the so-called leading (or proactive) indicators. For example, contact centers and some other services can use speech emotion recognition services and manage customer satisfaction in a real-time mode.

Detecting customer reaction by emotion recognition is a task, which can be solved using both supervised and unsupervised ANN learning [2, 3]. In this chapter, the author represents the example of the emotion recognition based on voice speed and timbre analysis without speech recognition.

In this model we do not recognize speech, but emotions only. The recognition technique is based on the analysis of the so-called static and dynamic parameters. Static parameters are basic voice timbre: gender (if known). Dynamic parameters are the following: voice timbre change, speech speed and loudness, and surrounding noise level.

Static parameters are basic for a certain caller (or user). They help to adjust the dynamic parameters during the contact session. The ANN contains input layer, which consists of:

- Gender (if known)

- Age (if known)

Input audio are separated into eight components. Each component is equivalent to a certain frequency in the voice audio range: starting from 300 Hz and to 16 kHz.

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- The first hidden layer includes artificial neurons for:
- Basic voice timbre
- Gender (can be empty)
- Age (can be empty)
- Starting surrounding noise level

The second hidden layer proceeds the loudness parameter and contains, for example, artificial neurons for the following attributes:

- Level of surrounding noise loudness
- Level of total voice loudness
- Level of high-frequency loudness
- The third layer proceeds the timbre parameters, and contains the following:
- Differences in timbre
- Trend in timbre differences

The fourth layer proceeds speech tempo parameters, such as:

- Faster
- Slower
- The same
- Trend in speech tempo

The output layer contains the artificial neurons, which indicate user's satisfaction:

- Neutral
- Better
- Worse
- Excited
- Dissatisfied

The simplified example of the ANN is shown in **Figure 1**.

The training algorithm is based on backpropagation analysis with elements of convolutional artificial neural network [3, 4].

As the result, a contact center agent can receive an advice about customer emotions in a real-time visual mode. This helps an agent to correct his/her talk with a customer and gain customer satisfaction.

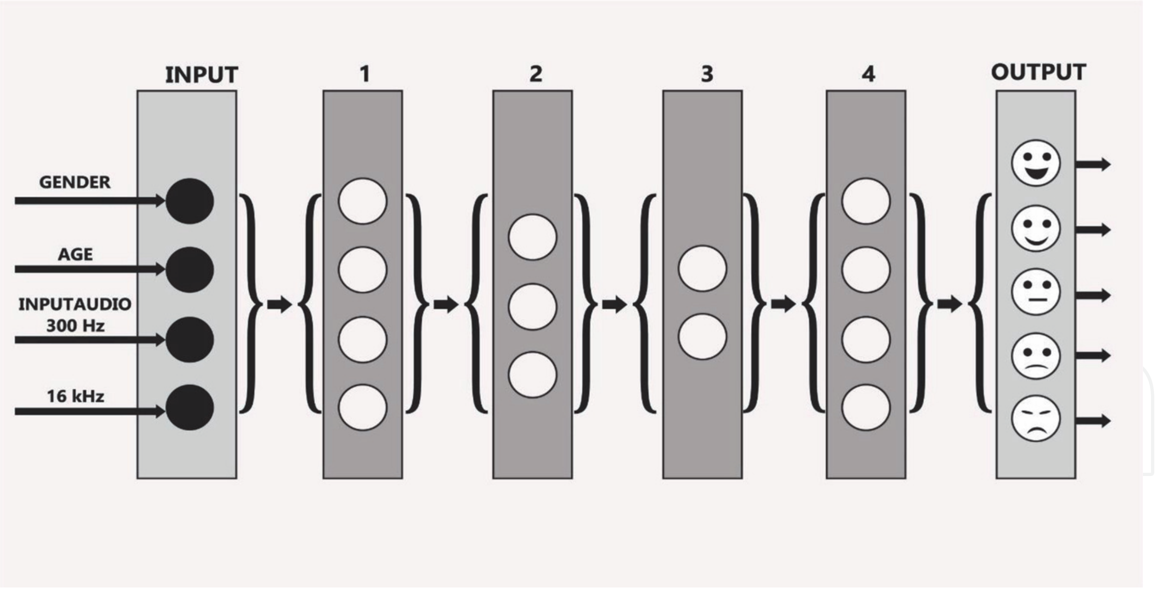

Figure 1.
ANN Schema.

4. Stochastic graph models for customer lifecycle and behavior prediction

In this section I deliver the stochastic graph model [5], which controls a user—ticket buyer—behavior at the ticket-selling Website. The goal of the ticket selling organization is to maximize revenues with minimal expenditures and simultaneously serve as many clients as possible. The ticket system should be able to predict customer behavior at the Website, offer special prices in a dynamic mode, and change number of offered places (e.g., additional carriers in a train or additional flights).

The stochastic graph tools [6] are worth to solve this class of tasks, because user's behavior at a Website is probabilistic at each step. Below we discuss step by step the model of a ticket-buying process.

The stochastic graph nodes indicate current state of a system, and edge reflects an action which leads to a new state. Each edge is weighted with a probability of a certain action—p(ij)—where i is a starting node and j is a target node (**Figure 2**).

Usually a node will have a loop, which indicates that a user stays at a current state or leaves the system with a certain probability p(i,i) (**Figure 3**).

1. The first node is "Start page open" V(1).

   There are at least three probable next steps by a user (**Figure 4**):

   a. Authorize in the ticket system (V2).

   b. Select a route destination (V3).

   c. Leave the ticket system (loop) (V1).

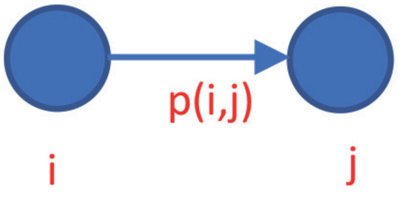

Figure 2.
Simple stochastic graph.

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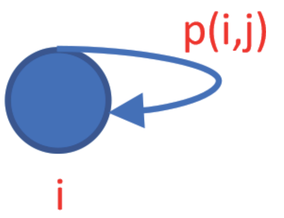

Figure 3.
Stochastic loop.

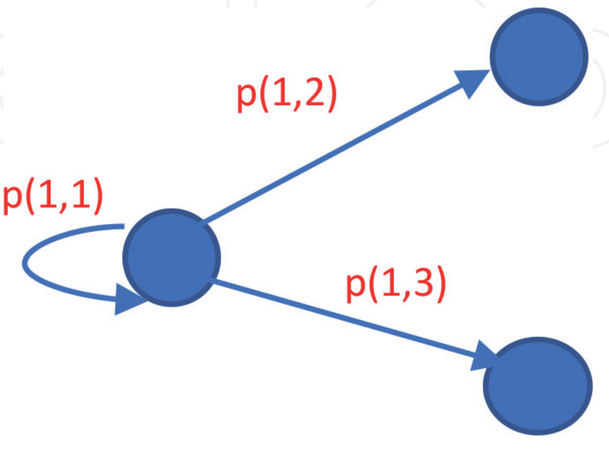

Figure 4.
Stochastic routes at step 1.

2. If V2 path is selected, the system makes estimate of the demand based on statistical data. Certain dynamically based tariff is generated for a user

3. If the user authorizes (V3 node), preferred routes and destinations can be offered. Let us examine the probabilities at the next step

4. From V2 node the user can:

    a. Select the route, time, and carrier (move to V4 node). Note: each of the mentioned parameters implies on ticket cost. The ticket seller can make changes dynamically, for example:

        i. Add or remove carriers.

        ii. Increase/decrease costs for certain routes/carrier types/time slots.

    b. Move to a new selection page (V5 node).

    c. Authorize (move to V3 node).

    d. Leave the page (move to V1 node).

5. From the V3 node the user can:

    a. Select a route and destination from a preferred list (V6 node).

    b. Move to a new selection page (V5 node).

    c. Leave to the start page (V1 node).

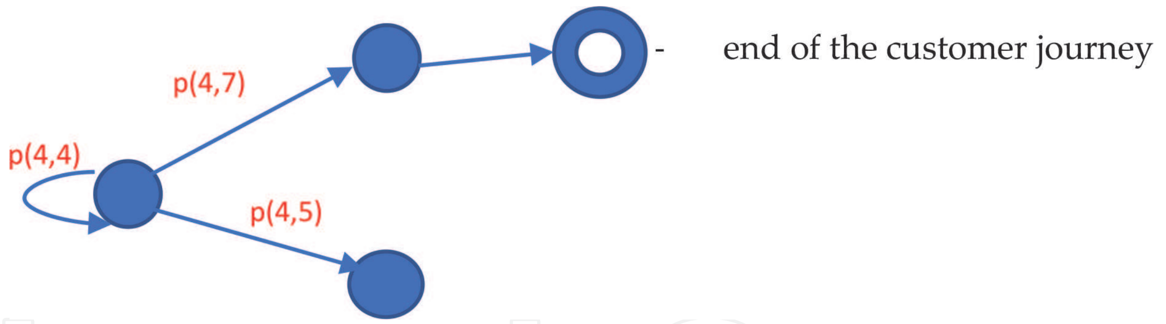

Figure 5.
Stochastic routes at the end of customer journey.

Next, I show the main path on this graph, at which a user moves to buy a ticket procedure.

6. From V4 node a user can select a place (**Figure 5**). Note: each place has attribute of cost (e.g., more convenient according to general statistical information and more preferred by this certain user). The ticket system can have varying costs in order to gain more revenue from this certain order or by filling the carrier. In the first case the price increases and in the second decreases. See stochastic paths from V4 node in **Figure 5**.

    a. Buy ticket—move to V(7) node.

    b. Return to the selection page (V5 node).

As a result, the stochastic graph model can adjust the ticket system behavior according to the user's behavior based not only on previous statistical data but on the probability of his/her behavior in the current session. Those algorithms can improve both customer satisfaction and operator's value.

5. Role of fuzzy logic in defining and balancing customer demand while creating a new product or a service

Fuzzy (or linguistic) models usually implement subject matter (or common) terms, for example, "good," "cheap," "far," etc. Fuzzy models, as described by Lotfi Zade and other researchers [7–9], provide formal models based on linguistic terms by simultaneous inclusion of an element into several sets. The author of the article provided a research [10], in which he shows the extended definition area of fuzzy element weight from interval $[0; 1]$ to$[-\infty; \infty]$. The extended definition area provides the opportunity to apply fuzzy logic together with scoring models.

Let us consider a task of developing a new customer offer (either product, goods, or service) based on customer feedback analysis, company capabilities, technological opportunities, and other factors. The author previously published his experience in applying fuzzy logic to develop new service offers for lifelong learning business [10].

Learning organization efficiency on the other hand depends on student's satisfaction and their willingness for continuous learning and capabilities to deliver learning services cheap and adapt them to changes in customer demand.

Based on customers' surveys, and their analysis, the author defined students' professional improvement and satisfaction as one of the critical success factors. The main satisfaction attributes are:

- Price (mark this attribute with parameter named P)
- Personalized approach (PA)
- Mobility (MB)
- Actual content (AC)

All attributes are represented as fuzzy linguistic variables in L. Zade terms [0;1] with step 0.2, which is like a common 5 grade model (1–5 grades). Based on those weights (and a lot of others as well), the learning organization developed a series of learning methods combining class-based, online, blended, synchronous, and asynchronous learning. **Table 1** is the excerpt from the decision matrix.

In this chapter, the general overview of this approach is given, including new data from the latest projects. The "big data" tools such as ANN, graph models, fuzzy sets, and others can help organizations in building strong customer relationship, based on real-time knowledge about customer demand, happiness, and trends.

In this book, the respected reader learns about concrete implementations of IT tools in CRM systems in different countries and businesses.

Learning method/attributes	Class traditional	Webinar	Blended	Self-paced	Micro-learning
Price	0.2	0.4	0.2	0.6	1
Mobility	0.2	0.8	0.6	0.6	0.8
Personal approach	0.6	0.2	0.8	0.4	0
Actual content	0.8	0.6	0.4	0.4	0.6

Table 1.
Awareness level of fuzzy model attributes.

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