

**T.C.
BAHÇEŞEHİR UNIVERSITY**

**HUMAN RESOURCE MANAGEMENT
IN CAMPAIGN MANAGEMENT
BY USING FUZZY C-MEANS**

M.S. Thesis

İlknur KALENDER

İstanbul, 2011

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BAHÇEŞEHİR UNIVERSITY**

**GRADUATE SCHOOL OF NATURAL AND APPLIED SCIENCE
COMPUTER ENGINEERING**

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Supervisor: Assoc. Prof. Dr. Adem KARAHOCA

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Asst. Prof. F. Tunç BOZBURA
Acting Director

This is to certify that we have read this thesis and that we find it fully adequate in scope, quality and content, as a thesis for the degree of Master of Science.

Examining Committee Members:

Assoc. Prof. Dr. Adem KARAHOCA :

Asst. Prof. Dr. Mehmet Alper TUNGA :

Asst. Prof. Dr. Yalçın ÇEKİÇ :

ABSTRACT

HUMAN RESOURCE MANAGEMENT IN CAMPAIGN MANAGEMENT BY USING FUZZY C-MEANS

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Can a company operate without people? Absolutely can't! Every company needs employee to survive. Thence, human resource management and performance management are important for all sphere of business. As in every sector human resource performance management is also important in banking sector. According to the performance management in the banking sector: often a target is identified for employers and employees are evaluated according to the success of this goal. Performance of employees can be evaluated for success in campaigns that the employees follow. In this study customers will be segmented according their product that the employees sell and the employees will be rewarded according to their performance.

Keywords: HRM, Campaign Management, Performance Management.

ÖZET

KAMPANYA YÖNETİMİ İÇİN FUZZY C-MEANS ALGORİTMASI KULLANILARAK İNSAN KAYNAKLARI YÖNETİMİ

Kalender, İlknur

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Bir şirket çalışanı olmadan varlığını sürdüremez. Bu nedenle insan kaynakları yönetimi ve performans yönetimi büyük önem taşır. Her sektörde olduğu gibi, insan kaynakları yönetimi banka sektörü içinde önemlidir. Banka sektöründeki performans yönetimine göre: çoğu zaman çalışanlar için bir hedef belirlenir ve çalışanlar bu hedefe yakınlıklarına göre değerlendirilir. Bu çalışmada, müşteriler, çalışanların kendilerine sattıkları ürünlere göre sınıflara ayrılacak ve çalışanlarda performanslarına göre ödüllendirilecektir

Keywords: HRM, Campaign Management, Performance Management.

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1. INTRODUCTION

1.1 PROBLEM DEFINITION

Businesses can not survive without employees. As it isn't easy to select employees, employees' performance is important for adding value to the job. So that human resource management and performance management are the first order of importance for businesses.

HRM evaluates every stage of work via observation and results. Performance rating gives feedback about employees' success at a work and employees' defects. In light of performance rating, employees can be rewarded.

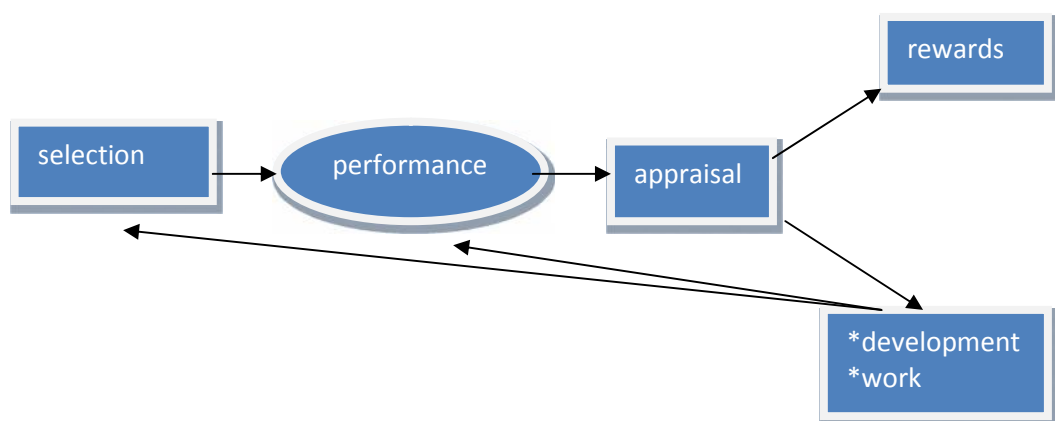


Figure 1.1: Human resource cycle (Chris Hendry 1995)

This situation can cause a competition between employees for every business sector. In banking sector, bank industry always prepare campaigns that considering people needs. Employers who follows the campaign hold key for rising and decreasing conduct of the campaign. These situations are important for rising service quality for the bank which is given to customers.

In this study, main purpose is researching the best data mining model for campaign management in banking sector, according to the measure of the performances of the models. We have used many data sets which are provided from a bank's data warehouse system to analyze the customers' informations and products for developing a data mining model.

The data in Table 1.1 represents part of the information collected by the manager and it illustrates the target for a worker which sold a campaign product. Table 1.2 illustrates the campaign points that the worker will gain. For every customer type: points are given which are gained from sale products according the product group.

First the customers will be segmented then the datas (products and their values) will be segmented into many parts with using Neural Net Models and fuzzy c-means algorithm.

1.1.1 Human Resource Management

Human resource management caught on in the 1970s. Recasting the employment relationship for ensuring employee efforts were focused on achieving organisational performance as a managerial approach purpose. Human Resource Management has more innovative view of workspace than another traditional approaches (Susan Marlow, 2006).

HRM practices and systems that deals with employees' behavior, approach and performance and it is directly related to company performance. Figure 1.2 accents that there are several important HRM practices:

- analyzing work and designing jobs, attracting potential employees (recruiting)
- choosing employees (selection)
- teaching employees how to perform their jobs and repairing them for the future (training and development)
- evaluating their performance (performance management)
- rewarding employees (compensation)
- creating a positive work environment (employee relations)
- supporting the organization's strategy (hr planning and cahange management)

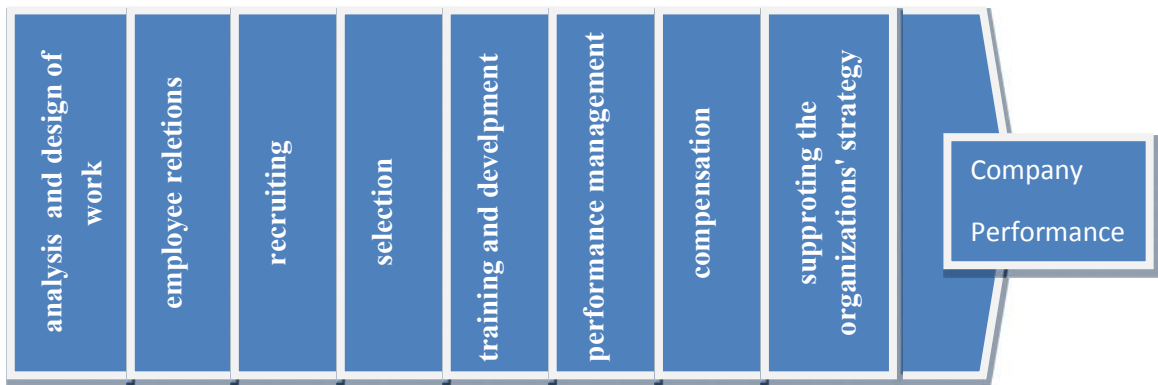


Figure 1.2: Company Performance (Mc Graw-Hill, 2006)

The impact of human resource management on performance has become the dominant research issue in the field. There has been a unguarded of studies demonstrating a positive association between human resource management and performance, providing encouragement to those who have always defended the case for a special approach to the management of human resources.

The concept of “human resource management” represents that employees are resources of the employer. As a type of human resource means the organization’s employees described in parts of their education, experimentation, intelligence, relationships and perception.

It is important that employees who worked for a target(for a campaign) and how the employees work. HRM measures employees' success as quality, profitability and customer pleasure (Dave Mote, 2008).

It has many techniques for the managers to apply their goals and measuring the workforce according to achieve this goal. With these techniques the managers get the resources for completing the tasks that are given to the employees. Human Resource Management techniques, when uniformly applied, are useful and meaningful for the goals and operating practices of the institutes. (Berkeley University of California)

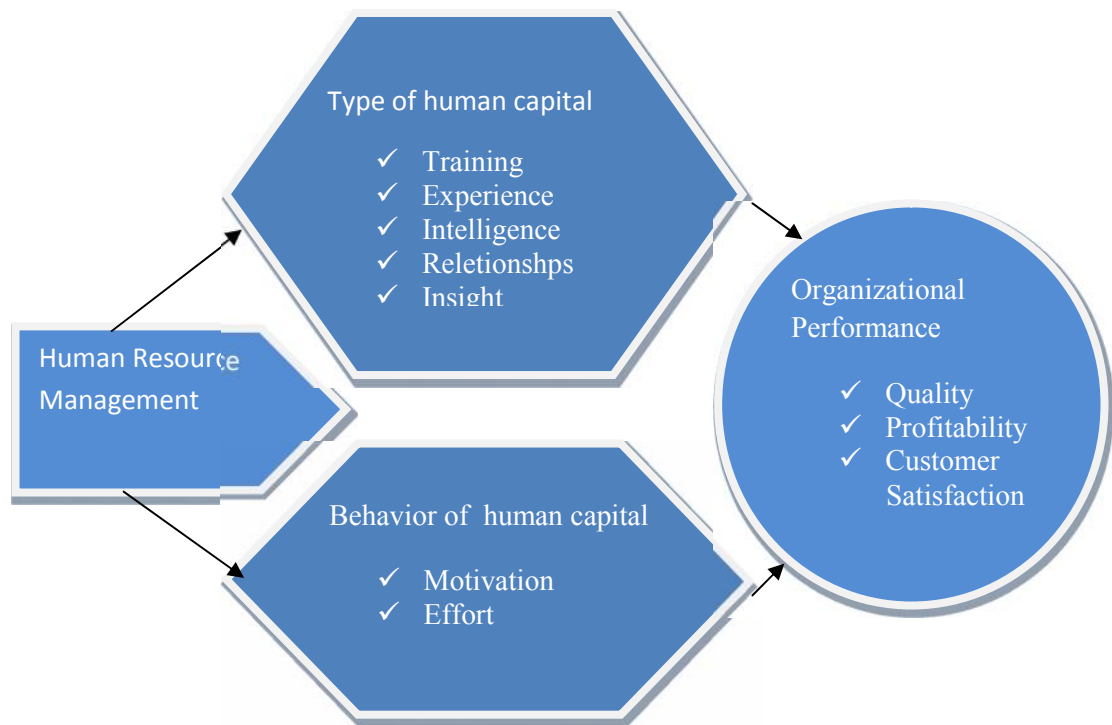


Figure 1.3: Relationship (Mc Graw-Hill, 2006)

If we want to have effective performance management it must be included a plan for saving manager's and the employees' time and energy. More importantly it can motivate to the employees and it can help employees for increasing their performance.

Human resources is a term that used for ascribing to how employers are managed by organizations. As a new term for managing employment, human resource management has get quick and common acceptance. Human resource management has different associations for different people and does not yet organize a combined theory. A lot of people are familiar with this statement as our human resource is the most important asset. In some states acceptance of principles of human resource management goes no further than this.

Human resource management (HRM) is a consistent and sufficient approach to the management for an company's most important entity: the employee that working who singular and collectively assist in the success of its targets.

The main features of HRM are(Michael Armstrong,2003):

- An accent on the strategic management of people (the human capital of the organization) which succeed 'fit' or integration between the business and the HR strategy;
- A wide and consistent approach to the preparation of contain supporting employment practices and attitudes, the development of integrated HR attitudes and practices (configuration or bundling);
- the valuation of employee as entities preferably costs - they are accepted as a source of competitive advantage and as human capital to be invested in through the provision of learning and development opportunities.

HRM purposes to help the organization to get success through employees. HRM is interested with both meeting human capital needs and the development of process capabilities.

Achieving high performance through people:

The aim of HRM is to contribute to the success of ascending the levels of organizational performance. The combination of HR and business strategies will generally focus on this target (Ashraf).

Enhancing motivation, commitment and job engagement:

A considerable aim of the HR function is to help with the enhancement of motivation, commitment and job engagement as a means of improving performance and retaining talented people.

Motivation is the process of encouraging employees to apply their efforts and talents in ways that will further the attainment of the organization's goals as well as the satisfaction of their own needs. (Ashraf)

1.1.2 Campaign Management & Performance Management

There are many performance evaluation techniques like task management, human relations, being result-focused etc. But we will use campaign management.

Employees are required to continue companies' existence. It is important that the employees have to know their duties for showing their performance and adding value to the company that they work. Every company give targets to the employees and evaluate the employees according to their performance at a campaign. In this respect performance management is a key point for companies.

Every employees have to make a contribution to the company. When a target is given to the employees at a campaign, an employee that achieve the target should be rewarded. This situation causes a competitive situation. But ultimate purpose is that working employees and maintain companies continuity.

Campaign management for banks, concerned target position of the bank, between the times that the campaign starts and ends. The employees are evaluated according to target position. For example; A policy for checking rate of increase the number of credit cards: It's important to add new credit card user to the bank. So number of credit card user that the employee have earned to the bank reflects employee's performance.

Marketing decisions, such as promotions, based on traditional segmentation because of customers' choices. So it is hard to group them for developing marketing strategies and making some necessary campaigns. As we realised, each customer wants to be served according to his/her personal and special needs.

Database marketing, defined by marketing strategies based on the great deal of information available from the transaction databases and customer databases. In this way banks can generate many useful campaigns and give targets to the employee for evaluating employees' performance.

Managing human resource contains keeping track of how well employees are performing connected to objectives such as job descriptions and goals for a particular position.

The process of ensuring that employees' activities and outputs match the organization's goals is called performance management. (David A. Aaker; V. Kumar; George Day John Wiley & Sons, Inc. 2001) The activities of performance management include explaining the tasks and consequence of a job that contribute to the corporation's success.

The human resource department may be responsible for developing or obtaining questionnaires and other devices for measuring performance. The performance measures specify conspicuous behaviors (for instance: answering the telephone by the third ring), consequences (number of customers complaints and compliments) or both.

Performance management eliminates the performance conjectural or yearly review as the focus and concentrates on the complete spectrum of performance management and development issues including employee performance development, training, challenging assignments, and regular performance feedback.

Performance and Reward



Figure 1.4: Performance Management (<http://career.huawei.com/career/en/i18n/Performance.do>)

Performance Management is one of the key processes that, when effectively achieved, helps employees know that their accountability are recognized and acknowledged. Performance management is a continuous process of communication between a supervisor and an employee that occurs throughout the year, in support of accomplishing the strategic objectives of the organization. The communication process contains explaining expectations, setting objectives, identifying aims, providing feedback, and evaluating results.

We can't say it is an annual event for Performance management, contrarily it is a continuous process demanding clear performance expectations, feedback periodically, coaching and recognition for improvement. There must be a confidential relationship between manager employee that enables open two-way communication for effective performance management.

Human resource performance management helps achieve strategic goals

- ✓ Businesses find success when they can establish clear strategic goals and compose all resources to achieve those objectives. Manager among those resources is the workforce, and the management of the actions and behavior of employees at every level is critical to achieving results.

After all, few things impact business performance more than human capital. Consequently, human resource performance management is a huge priority for competitive organizations. But often these HR attempts are not provided the kind of tools needed for successful deployment.

By automating much of the human resource performance management process, and adding much-needed knowledge and information access to the equation, such solutions can help to make these HR attempts a source of success.

Methods for Measuring Performance

- ✓ Making comparisons between employees
- ✓ Rating individuals: Instead of focusing on arranging a group of employees from best to worst, performance measurement can look at each employee's performance relative to a uniform set of standards.
- ✓ Rating behaviors
- ✓ Measuring results: for instance according to results of a campaign

HR Performance Management for Campaign Management in Banks

As in every sector human resource performance management is also important in the banking sector. According to performance management in the banking sector: often a target is identified for employees and employees are evaluated according to the success of this goal. Performance of employees can be measured for success in campaigns that the employees follow. The bank industry always prepares campaigns that consider people's needs. Employees who follow the campaign hold the key for rising and decreasing conduct of the campaign.

Target Audience of the Campaign and Scoring

Target audience of the campaign: Sales will be evaluated in customer and product groups terms with all our individual customers. Points will be evaluated according to sales products not over the size of the product.

If there is a multiple sale to a customer in the same product group is not acceptable and the sale shall be calculated as a single sale. For this situation, it is important for sales the products to different customers. In this way, employees endeavour for getting new customers except individual customers.

In table 1.1 we can see the employees' target. For instance, an employee can raise the credit card limit from 19.269.281.300 to 19.880.106.600 the employee will be successful.

Table 1.1: Target of the Campaign

Alan Adı	Portföyün 2. Ay Durumu	Portföyün 5. Ay Durumu
KUMULE NET KAZANC	40.119.651	50.639.441
TP URUN ADET	106.543	110.936
TP CALIS TUT	2.353.018.559	2.396.623.244
KK LIMIT	19.269.281.300	19.880.106.600
TAKSIT TUT	8.732.281	9.449.706
TP VARLIK	2.210.487.409	2.215.707.184
GCKM TAKSIT ADET	1.734	1.487
TP VDL TUT	2.061.556.495	2.067.364.459
VDSZ ORT TUT	26.490.961	30.270.916
KMH ORT TUT	2.924.190	3.392.509
VDL ORT TUT	1.523.843.065	1.533.202.716
DTH ORT TUT	573.517.545	568.389.675
MENKUL ORT TUT	130.049.599	127.963.743
BK ORT TUT	193.243.761	227.069.228
ALTIN BKY TUT	7.269.645	11.326.771
NAR BKY TUT	1.884.589	2.707.763
SGRT KOM TUT	575.115	687.068
INTRNT ISL TUT	76.572.861	98.405.011
DIALOG ISL TUT	2.995.565	2.452.722
BORDRO24 MAAS TUT	7.851.214	10.013.881
SGK MAAS TUT	12.145.833	10.025.927
ABONE24 TUT	1.729.883	2.221.398
KKB BNK LMT	2.011.701.745	2.122.502.058
KKB BNK RISK	928.337.328	967.646.469
VDSZ TL ADEDİ	37.038	39.447
VDL TL ADEDİ	12.268	12.348
DTH ADEDİ	13.965	14.973
BK ADEDİ	9.671	10.449
MNKL ADEDİ	12.049	13.110
KMH ADEDİ	13.269	15.031
OTMTK_TLMT ADEDİ	18.802	19.794
KK ADEDİ	28.367	29.712
SIGORTA ADEDİ	10.444	11.481
BORDRO24 ADEDİ	3.598	4.699
SGK ADEDİ	7.067	7.707
TAKIP ADEDİ	648	687
DBT KART ADEDİ	26.480	28.563
ALTIN ADEDİ	1.250	2.123
NAR ADEDİ	510	761

Campaign Measurement

Rating employees' performance is a central section of performance management. Performance management is the process whereby which managers ensure those employees' activities and outputs contribute to the organization's goals.

This process requires knowing what activities and outputs are desired and providing feedbacks to help employees' expectations. For feedback, managers and employees may identify performance problems and establish ways to resolve the problems

Campaign measurement: The measurements will be weekly, monthly and at the end of the competition (campaign). The measurements weekly, monthly and at the end of the competition: are based on coordination branch and BMIY / MI. Region of the coordinator points will be calculated over CRM(customer relationship manager) and each department measurement average, departments will be put in order between each other. Branches and CRMs will be ordered based on league.

Branch points will be estimated to get over all sales per CRM. In other words, marketers and employees' performance of all branches determine the campaign's ordering in the league. CRM item measurement is total of the BMIY / MIA that at the end of the month.

- Weekly measurements are made for seeing the sales status, ordering and performance in competition
- Collective sales that made by center of the bank will not include in the campaign.
- For necessary states, sale factor point can be added when measuring the sale performance that the branch have less customer according to other branches and the branch that haven't payroll 24, retirement customers.

In addition, the branches that have over three and more BMIY/MIYA, if necessary to know number of sales, total point can edit but it will not exceed 50% for the BMIY/MIYA of the branch.

Target audience of the campaign: Sales will be evaluated in customer and product groups terms with all our individual customers. Points will be evaluated according to products which sold and which have big value.

The data in table represents part of the information collected by the manager and it illustrates the number of times per month that a worker sold campaign product.

For every customer type: points are given which are gained from sale products according the product group.

First the customers will be segmented into three parts then the datas (products and their values) will be segmented into fourteen parts with using fuzzy c-means algorithm.

Table 1.2: Campaign Points

Products	Bordro 24 & Retirement fund customers	Other individual customers	Retired customers
Abone 24	5	4	3
Debit Card	9	7	5
Credit Card	9	7	5
Diyalog	1	1	1
Internet Branch Office	1	1	1
Gold Deposit Account	4	4	3
Foreign Currency Account	4	4	3
Investment Account	9	9	5

Tablo 1.2: Campaign Points (continued)

Credit-Deposit Account	8	6	4
Deposit Account	8	6	4
Sight Deposit Account	9	9	6
Insurance	3	2	2
Number of Products that the customer have	6	5	5
CumulativeNet Earnings	9	8	7

As it seen in the table there are different points to earn for each customer group and each products. If necessary to explain, the customers are segmented into three parts as bordro24 customers that get the salary using bank account, another personal customers and retired customers. The products segmented into fourteen parts as Abone 24, Debit Card, Credit Card, Diyalog, Internet Branch Office, Gold Deposit Account, Foreign Currency Account, Investment Account, Number of Products that the customer have, Credit-Deposit Account, Deposit Account, Sight Deposit Account, Insurance and Cumulative Net Earnings.

If a customer instructs to the bank for direct debit mandate(Abone 24) and if s/he is a bordro 24 customer(gets the salary using bank account), the employee, that the customer is related, gets 5 points. If s/he is a personal customer then the employee gets 4 points. If s/he is retired then the employee gets 3 points.

If a customer which is retired have many products from the bank, the employee, that the customer is related, will have 5 points. If the customer is a retirement fund customer and have many products from the bank, the employee gets 6 points.

Dialog and internet branch have the lowest points. Debit Card, Credit Card Investment Account, Credit-Deposit Account, Deposit Account and Sight Deposit Account have the

biggest points. This is because banks give more values to products that related to customer needs.

In this study our target is based on Cumulative Net Earnings. So employee will get the biggest point according to closeness to Cumulative Net Earnings.

1.2 BACKGROUND

Data mining techniques have been applying for HR performance management. Data mining is a method for analyzing data and summarizing the useful information which can be use to make appraisal for future experiments. In this study data mining technologies used for human resource management.

Many managers are forced for having datas that deal with employees' performance. Data mining technologies and techniques help for fixing unrelated data for meaningful relationships.

The aim of this study is about getting information respecting employees' work performance and giving incentive payment according to employees' performance.

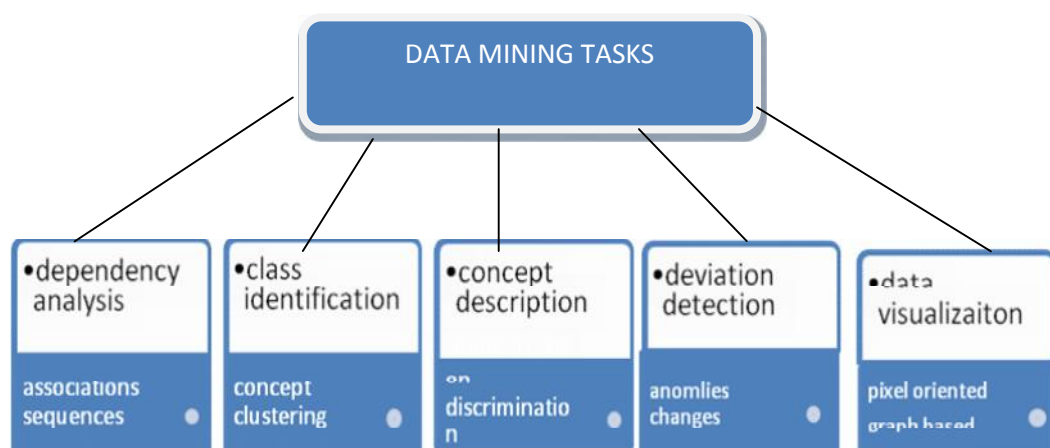


Figure 1.5: Data Maning Tasks (Shaw, Subramaniam, Gek Tan, E. Welge,2001)

- ✓ **Dependency analysis**

The first type is the relation between sets of items stated with some minimum specified confidence. This gives us the relationship between different products purchased by a customer. This type of knowledge can be useful in developing marketing strategies for promoting products that have dependency relationships in the minds of the customers. Consequently the worker can commercialize the campaign according to customers' dependence.
- ✓ **Class identification**

Class identification segments customers into classes. These classes are mathematical taxonomy and concept clustering.
- ✓ **Concept description**

Concept description is a method for segmenting customers according to domain knowledge and the database, without forced descriptions of the groups. Concept description is used for abridgement, selection or comparing marketing and customer knowledge. Consequently the marketer can commercialize the campaign according to customers' need.
- ✓ **Deviation detection**

Deviations are useful for the discovery of anomaly and changes. Anomalies are things that are different from the normal.
- ✓ **Data Visualization**

Data visualization software permits marketers to view complex patterns in their customer data as visual objects complete in three dimensions and colors. They also provide advanced manipulation capabilities to slice, rotate or zoom the objects to provide varying levels of details of the patterns observed. It is useful for grouping the customers according to their needs.

Different levels of analysis are available:

- ✓ Regression
- ✓ Classification
- ✓ Artificial neural networks
- ✓ Genetic algorithms
- ✓ Decision trees

- ✓ Nearest neighbor method
- ✓ Rule induction
- ✓ Data visualization

By way of addition conventional human resource management approaches, there is an imperative requirement to develop effective personnel selection mechanism to find the capabilities who are the most compatible to their own organizations.

This study aims to fill the gap by developing a data mining framework based on decision tree and association rules to generate useful rules for personnel selection. The results can provide decision rules relating personel information with work performance and retention. Moreover, based on discussions among domain experts and data miner, specific recruitment and human resource management strategies were created from the results. The outputs(results) of data mining solutions will be used as inputs for campaign management and human resource management.

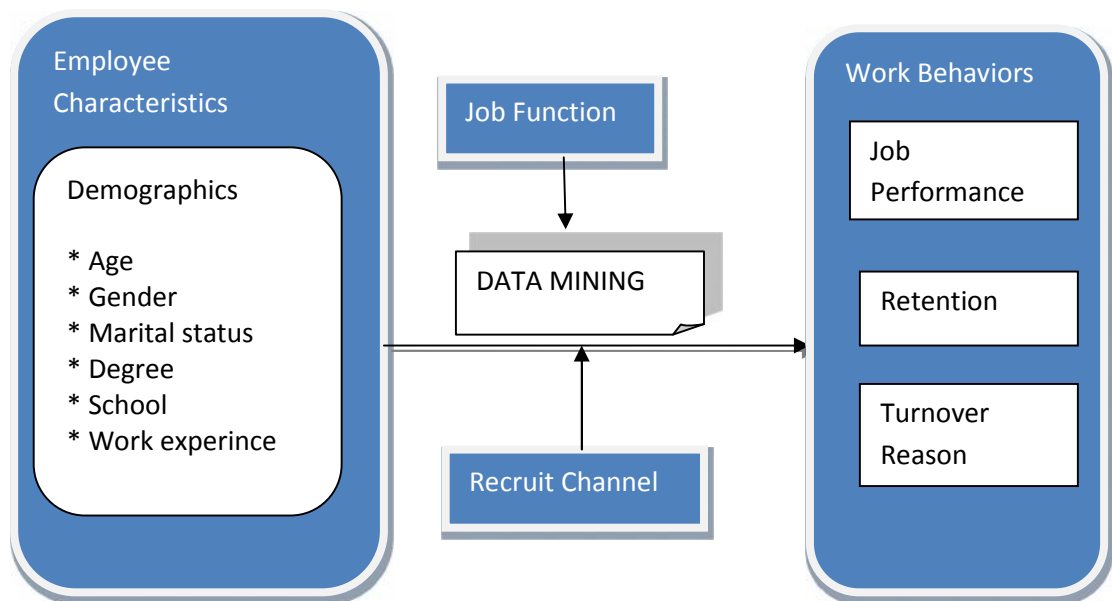


Figure 1.6: Data Mining inputs & outputs (Chen-Fu Chien, 2006)

The data mining method must be safe and repeatable by people with little data mining skills. Crisp Dm: Cross-Industry Standard Process For Data Mining. (Laura Squier 2001)

CRISP-DM is flexible to account for differences

- Different business/agency problems
- Different data

Crisp dm has 6 Phases:

- **Business Understanding**

- Focused on understanding the project objectives and needs from a business perspective
- Transforms this knowledge to a data mining problem description and an initial plan designed for succeeding the objectives.

According to our study, employees' performance is important for adding value to the job. So that human resource management and performance management mean thread of life for businesses. For this reason employee segmentation is necessary for measuring performance according to their success that they get from a campaign.

- **Data Understanding**

- Start with an initial data collection
- Proceed with activities in order to get familiar with the data, to set data quality problems, to find first perception into the data, or to detect interesting sub groups to form hypotheses for confidential information.

For this study, 50.000 customers were used. Then we get two data sets : Demographic informations and Operational informations . Operational information is hold monthly and 5 monthly datas are used in this application.

- **Data Preparation**

- Contain all activities to design the final dataset to be fed into the modeling tool(s).
- Preparation tasks are likely to be performed multiple times, and not in any prescribed order. Tasks include table, record, and attribute selection as well as transformation and cleaning of data for modeling tools.

We have many tables, datas and flag lines. So employees can release products that customers have and employees can sell different products that employees haven't. There aren't wrong datas and missing datas were completed. We can use table 3 for this step.

- **Modeling**

- Various modeling techniques are selected and applied, with optimal parameter values.
- There are many methods for the same data mining problem type. Some have specific needs on the form of data.

Purpose of modeling is clustering and pointing the employees. During the modeling phase of the project, specific modeling algorithms are selected and run on the data. Selection of the specific algorithms employed in the data mining process is based on the output. For example, decision tree models used to create decision rules based on known categories or relationships

- **Evaluation**

- Overview the steps executed to contrive the model, to be certain it properly achieves the business objectives.
- Control if there is some important business issue not being sufficiently considered.

- **Deployment**

- Organize and present the result in a way that customers can use it.
- Generating a report is simple and the deployment can be like it or implementing a data mining process is complex so the deployment can be like it.
- If the employee can't accomplish the deployment steps that it is important to customers for understanding which actions need to be accomplished to make use of the created models.

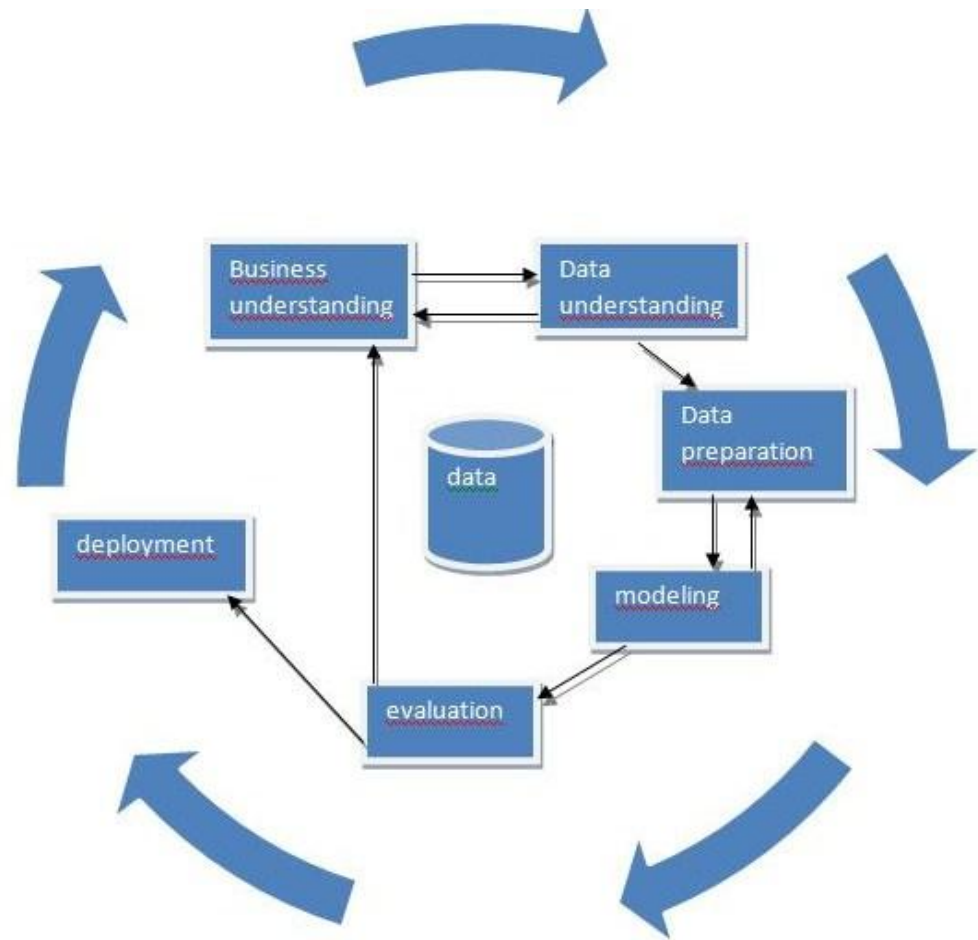


Figure 1.7: Phases of the CRISP-DM Reference Model (Laura Squier, 2001)

In this study, employee segmentation will be done by using CRISP-DM according a campaign. Every phases of the CRISP-DM methodology will be applied step for step.

2. LITERATURE SURVEY

There are many studies about using data mining techniques for performance management. One of them is data mining for the human resource management (employee segmentation) by using demographic and operational datas. In this study employees will be segmented according their performance at a campaign. Data mining approaches, that deal with Classification & Regression Tree, Neurol Networks, Regression, K-means and rough-set, are used to estimate segments. The same approaches are used for rewarding the employees according to outputs of data mining datas.

“Management By Objectives” (MBO) is a method which observing employee performance according to reach a specific target that given by the manager. It is applied fixed time interval like every month or every week, but according to our project it will be applied every week.

Another way is the “Performance Ranking Method” which set in order the employees from best to worst according to their responsibility about a campaign. This way isn’t acceptable for our study.

Another one is 360 Degree appraisal. In 360 Degree appraisal, the employees will have confidential and nameless feedback about their performance from the another employees that work around them. This way isn’t acceptable for our study. 360 degree :

- ✓ measures behaviors and competencies.
- ✓ shows skills such as listening, planning, and goal-setting.
- ✓ focuses on subjective areas such as teamwork, character, and leadership effectiveness.
- ✓ provides feedback on how others perceive an employee.

Another different technique is “assessment center”. This technique is used to evaluate employees’ abilities and skills. It is a helpful technique for promotion and placement of existing employees. This way isn’t acceptable for our study.

Assessment center methodology is important because of promotion and selection according to another traditional methods and there are many reasons for this situation:

Assessment center tasks are improved depends on job analysis and it is supported that these tasks are beter than other tools because it is a better indicator and inherently valid.

This is used for promotions to identify employees' proficiency and check the convenience of the employees for new roles.

Besides all this, another technique is "Behaviorally Anchored rating scales" (BARS) that aggregation of critical incident and rating scale methods. This tecnique is improving reliability of personnel assessment and the evaluation of performance management. This way isn't acceptable for our study.

Literature survey of this subject is done with using Web Of Sicence (ISI Web of Knowledge). HRM and Data Mining are reviewed in two points: document type and subject area.

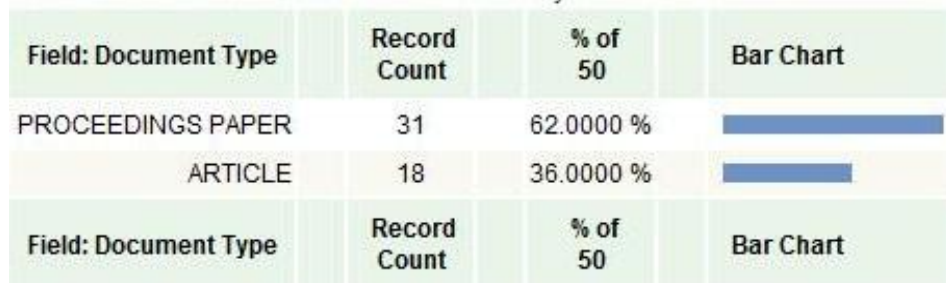


Figure 2.1: Document Tpes of Investigation "HRM" and "Data Mining"

There are 50 topics for "HRM" and Data Mning and there are 464 topics for "Performance Management" and "Data Mining" in figure 2.1.




Field: Document Type	Record Count	% of 464	Bar Chart
PROCEEDINGS PAPER	290	62.5000 %	
ARTICLE	168	36.2069 %	
REVIEW	6	1.2931 %	
Field: Document Type	Record Count	% of 464	Bar Chart

Figure 2.2: Document types of investigation “performance management” and “Data Mining”











Field: Subject Area	Record Count	% of 50	Bar Chart
COMPUTER SCIENCE, ARTIFICIAL INTELLIGENCE	11	22.0000 %	
ENVIRONMENTAL SCIENCES	8	16.0000 %	
COMPUTER SCIENCE, THEORY & METHODS	7	14.0000 %	
COMPUTER SCIENCE, INFORMATION SYSTEMS	6	12.0000 %	
COMPUTER SCIENCE, INTERDISCIPLINARY APPLICATIONS	5	10.0000 %	
ENGINEERING, ELECTRICAL & ELECTRONIC	5	10.0000 %	
MANAGEMENT	5	10.0000 %	
OPERATIONS RESEARCH & MANAGEMENT SCIENCE	5	10.0000 %	
ECONOMICS	4	8.0000 %	
BUSINESS	3	6.0000 %	
Field: Subject Area	Record Count	% of 50	Bar Chart

Figure 2.3: The subject areas of investigation “HRM” and “Data Mining”

Field: Subject Area	Record Count	% of 17	Bar Chart
ENGINEERING, ELECTRICAL & ELECTRONIC	5	29.4118 %	
COMPUTER SCIENCE, ARTIFICIAL INTELLIGENCE	4	23.5294 %	
COMPUTER SCIENCE, THEORY & METHODS	4	23.5294 %	
MANAGEMENT	4	23.5294 %	
COMPUTER SCIENCE, INTERDISCIPLINARY APPLICATIONS	3	17.6471 %	
ECONOMICS	3	17.6471 %	
OPERATIONS RESEARCH & MANAGEMENT SCIENCE	3	17.6471 %	
BUSINESS	2	11.7647 %	
COMPUTER SCIENCE, INFORMATION SYSTEMS	2	11.7647 %	
ENGINEERING, INDUSTRIAL	2	11.7647 %	
Field: Subject Area	Record Count	% of 17	Bar Chart

Figure 2.4: The subject areas of investigation “HRM” and “Data Mining” and “Performance Management”

Field: Subject Area	Record Count	% of 19	Bar Chart
COMPUTER SCIENCE, THEORY & METHODS	6	31.5789 %	
COMPUTER SCIENCE, INFORMATION SYSTEMS	3	15.7895 %	
COMPUTER SCIENCE, INTERDISCIPLINARY APPLICATIONS	3	15.7895 %	
ENGINEERING, ELECTRICAL & ELECTRONIC	3	15.7895 %	
AGRICULTURE, MULTIDISCIPLINARY	2	10.5263 %	
AGRONOMY	2	10.5263 %	
COMPUTER SCIENCE, ARTIFICIAL INTELLIGENCE	2	10.5263 %	
GEOSCIENCES, MULTIDISCIPLINARY	2	10.5263 %	
Field: Subject Area	Record Count	% of 19	Bar Chart

Figure 2.5: The subject areas of investigation “Performance Management” and “Fuzzy c- means”

3. MATERIALS & METHODS

In this study, the information about employees' performance is collected as data. After the collecting data, information extracting is realized by using SPSS. The collected data are arranged for use in data mining techniques.

Researchers for data mining are creating new automated methods for discovering knowledge to meet the needs. This need for analysis will keep growing, driven by the business trends of one-to-one marketing, crm management, human resource management, risk management and intrusion detection.

3.1 MATERIALS

3.1.1 Program

For this study, the following programs were used:

- SPSS Clementine Version 12: SPSS Clementine, data mining techniques. Also it is name of the leading in the Gartner Magic Quadrant report of 2008 for data mining solution.
- KNIME (Konstanz Information Miner) Version 2.3.0: KNIME is a user-friendly and comprehensive open-source data integration, processing, analysis, and exploration platform.

3.1.2 Preparing Data Set

As in every sector human resource performance management is also important in banking sector. According to the performance management in the banking sector: often a target is identified for employers and employees are evaluated according to the success of this goal. Performance of employees can be evaluated for success in campaigns that the employees follow.

For this study we used two data sets for 50.000 customers :

- Operational data set. 5-month operational informations,
- Demographic data sets. ,

All important areas will be shown in the Table 3 in appendix section. In Table 3 (customer info & info about bank account) there are many informations that are related to customers. According to these informations, employee will get points for performance evaluation. For example if a customer have a flag that deals with BORDRO24_FLAG_1 (The Flag of Customer who take salary through bank) ,the employee that s/he responsible for the customer, the employee gets positive points. Another example, if a customer have big values about GCKM_TAKSIT_ADET_1 area (The Number of Loan Delay),the employee that s/he responsible for the customer, the employee gets negative points.

Table 3 (customer info & info about bank account) was used for employee performance evaluation. Some lines which have flag are important like “ALTIN_FLAG_1” line which deals with the flag of gold account. Employees can see information about customers which have credit card, personel loan, debit card, credit deposit account etc.

These areas are:

- ✓ **Must_No:** Identity of customer. Every customer have must_no.
- ✓ **Müşteri Tipi:** Type of customer. These types are retired customer,bordro24 customer,abone24 customer etc.
- ✓ **Muta sube:** Branch Office of the customer.
- ✓ **İlk tanımlama tar:** Initial day of the customer. The first day that the bank product is used by the customer.
- ✓ **MİY_SICIL_NO:** Customer relations officer id. We can see the customers that are related to the customer relations officer according to these id.
- ✓ **ABONE24_TUT_1:** The Amount of Direct Debit Account for a customer according to first month.
- ✓ **ALTIN_BKY_TUT_1:** The amount of the Gold Account according to first month.

- ✓ **ALTIN_FLAG_1:** The flag of Gold account according to first month. If the flag is 1 the customer has gold account but if it is 0 the customer does not have gold account.
- ✓ **BK_FLAG_1:** The The Falg of Personal Loan according to first month. If the flag is 1 the customer has Personal Loan but if it is 0 the customer does not have Personal Loan.
- ✓ **BK_ORT_TUT_1:** The Average Amount of Personal Loans according to first month. If the bk_flag is 1 then it is measured monthly.
- ✓ **BORDRO24_FLAG_1:** The Flag of Customer who take salary through bank according to first month. If the flag is 1 the customer takes salary through bank but if it is 0 the customer does not take salary through bank.
- ✓ **BORDRO24_MAAS_TUT_1:** The Amount of Salary Paid Through Bank according to first month.
- ✓ **DBT_KART_FLAG_1:** The Flag of Debit Card according to first month. If the flag is 1 the customer has debit card but if it is 0 the customer does not have debit card.
- ✓ **DIALOG_ISL_TUT_1:** The Amount of Transactions via The Call Center according to first month.
- ✓ **DTH_FLAG_1:** The Flag of Foreign Exchange Deposit Account according to first month. If the flag is 1 the customer has Foreign Exchange Deposit Account but if it is 0 the customer does not have Foreign Exchange Deposit Account.
- ✓ **DTH_ORT_TUT_1:** The Avarage Amount of Foreign Exchange Deposit Account according to first month. If the dth_flag_1 is 1 then it is measured monthly.
- ✓ **GCKM_TAKSIT_ADET_1:** The Number of Loan that is delayed according to first month.
- ✓ **INTRNT_ISL_TUT_1:** The Amount of Transactions on The Internet according to first month.
- ✓ **KK_FLAG_1:** The Flag of Credit Card according to first month. If the flag is 1 the customer has Credit card from the bank but if it is 0 the customer does not have Credit card from the bank.
- ✓ **KK_LIMIT_1:** The Limit of Credit Card according to first month.

- ✓ **KKB_BNK_LMT_1:** The Limit of Customer in All Banks for first month, according to the personal loan, credit card limits etc.
- ✓ **KKB_BNK_RISK_1:** The Total Risk of Customer in All Banks for first month, according to loans that is not paid.
- ✓ **KKB_KRD_NOT_1:** The Credit Score of Customer according to first month. It shows the customers' amount of the all credit.
- ✓ **KMH_FLAG_1:** The Flag of Credit Deposit Account according to first month: If the flag is 1 the customer has Credit Deposit Account but if it is 0 the customer does not have Credit Deposit Account.
- ✓ **KMH_ORT_TUT_1:** The Average Amount of Credit Deposit Account according to first month. It is measured monthly.
- ✓ **KUMULE_NET_KAZANC_1:** Customers' Cumulated Net Profit according to first month.
- ✓ **MENKUL_ORT_TUT_1:** The Average Amount of Investment Account according to first month. It is measured monthly.
- ✓ **MNKL_FLAG_1:** The Flag of Investment Account according to first month. If the flag is 1 the customer has Investment Account but if it is 0 the customer does not have Investment Account.
- ✓ **OTMTK_TLMT_FLAG_1:** The Flag of Direct Debit Instruction according to first month. If the flag is 1 the customer has Direct Debit Instruction but if it is 0 the customer does not have Direct Debit Instruction.
- ✓ **SGK_FLAG_1:** The Flag of the customer who is retired according to first month. If the flag is 1 the customer is retired Direct Debit Instruction but if it is 0 the customer is not retired.
- ✓ **SGK_MAAS_TUT_1:** The Amount of Salary that is Paid Through Bank for retired customers according to first month.
- ✓ **SGRT_KOM_TUT_1:** The Amount of Insurance Commission according to first month.
- ✓ **SIGORTA_FLAG_1:** The Flag of Insurance according to first month. the flag is 1 the customer has Insurance from bank but if it is 0 the customer does not have Insurance from bank.

- ✓ **TAKIP_FLAG_1:** The Flag of Customer who is insolvent because of the credit that is not paid according to first month.
- ✓ **TAKSIT_TUT_1:** The Amount of Loan Installment according to first month. Payment of the customers' Installment.
- ✓ **TP_URUN_ADET_1:** The Number of Total Product that the customer uses from the bank according to first month.
- ✓ **VDL_TL_FLAG_1:** The Flag of Term Deposit Account according to first month. If the flag is 1 the customer has Term Deposit Account but if it is 0 the customer does not have Term Deposit Account.
- ✓ **TP_VDL_TUT_1:** Total amount of Term Deposits according to first month.
- ✓ **VDSZ_TL_FLAG_1:** The Flag of Demand Deposit Account according to first month. If the flag is 1 the customer has Demand Deposit Account but if it is 0 the customer does not have Demand Deposit Account.

Some datas that are written like "_1", "_2", "_3", "_4" and "_5" are shown in Table 2. The parameter names have the numbers "_1", "_2", "_3", "_4" and "_5" at the end of the data and they refer the month of data.

We can see a product which is taken or not taken by the customer according to the flag rows. Generally the other rows gives information value of the products of the bank that the customer have.

3.1.3 Data Understanding

Minimum values, maximum values, mean values and standard deviation of these parameters is shown in Table 4(the analysis of data).

Data Sources: For this study, 50.000 customers were used. Then we get two data sets: Demographic informations and Operational informations. Operational information is hold monthly and 5 monthly datas are used in this application.

Demographic Input Datas

- Customer Type,
- Birth Date,

- Branch Office,
- Profession,
- Work Place Information,
- Marital Status,
- Educational Background,
- Gender,
- Getting Customer Date,
- City.

Operational Input Datas

- Sight Deposit Account
- Deposit Account
- Gold Deposit Account
- Foreign Currency Account
- Credit-Deposit Account
- Order Account
- Credit Card
- Investment Account
- Insurance
- Personal Loan
- Salary
- Internet Branch Office
- Call Center
- Cumulative Net Earnings

There are 224 fields as input datas in this application. All datas can be analysed easily by Data Audit Module of SPSS.

SPSS (Originally, the Statistical Package for Social Sciences) SPSS Clementine, data mining techniques, with remarkable achievements in many areas has been signed. Also it is leader in the Gartner Magic Quadrant report of 2008 for data mining solution.

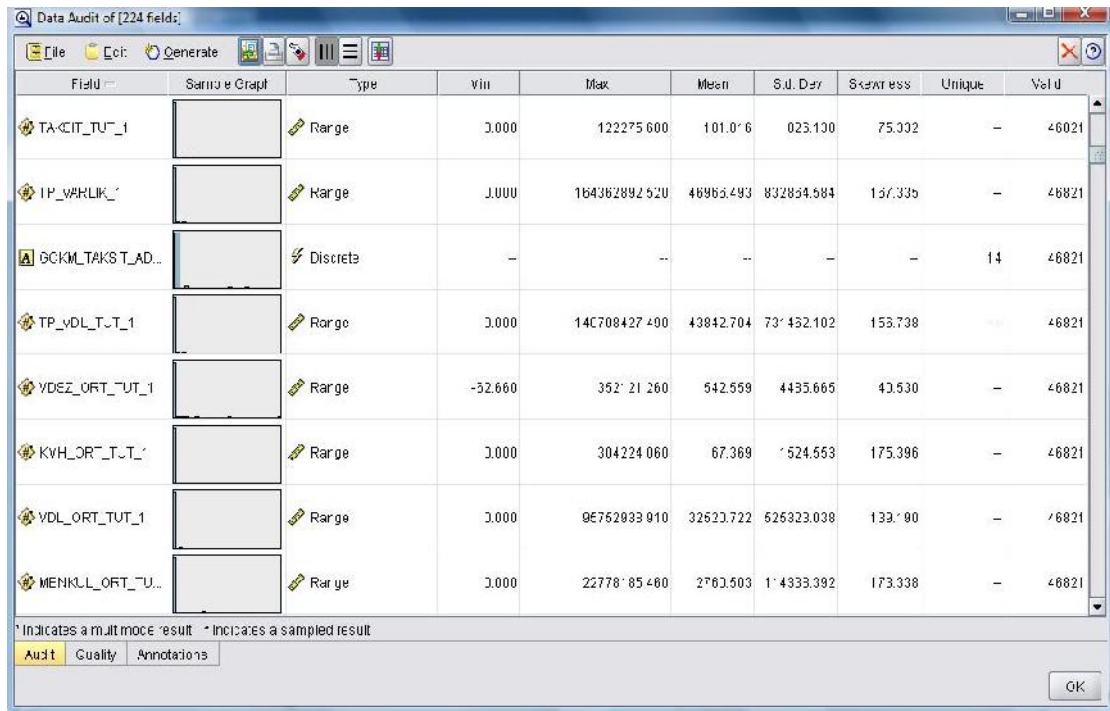


Figure 3.1: Data Audit

3.2 METHOD

3.2.1 Fuzzy C-Means

Cluster analysis is a technique in for grouping datas. The technique is used for dividing a given data set many pieces according to likeness of datas. There are many theories for modeling vagueness and fuzziness like fuzzy sets and rough sets (Mingrui Zhang, Terry Therneau, A Fuzzy C-Means Algorithm Using a Correlation Metrics).

C-means is a clustering technique for classification of a data set. It has the advantage of giving good modeling results in many classes.

This paper will mark an algorithm to produce fuzzy preference relations from data and integrate the fuzzy relations with general fuzzy rough sets.

Fuzzy C-means Algorithm is based on minimization of the following objective function.
(P.Vasuda, S.Satheesh)

$$J(U, c_1, c_2, \dots, c_c) = \sum_{i=1}^c J_i = \sum_{i=1}^c \sum_{j=1}^n u_{ij}^m d_{ij}^2 \quad (3.1)$$

U_{ij} is between 0 and 1; C_i is the centroids of cluster I ; d_{ij} is the Euclidean distance between i th centroids and j th data point; $m \in [1, \infty]$ is a weighting function.

Fuzzy partitioning of known data sample is carried out through an iterative optimization of the objective function.

$$u_{ij} = \frac{1}{\sum_{k=1}^c \left(\frac{d_{ij}}{d_{kj}} \right)^{2/(m-1)}} \quad (3.2)$$

$$c_{ij} = \frac{\sum_{j=1}^n u_{ij}^m x_j}{\sum_{j=1}^n u_{ij}^m} \quad (3.3)$$

This iteration will stop when $\max_{ij} \left\{ \left| u_{ij}^{(k+1)} - u_{ij}^{(k)} \right| \right\} < \varepsilon$ where ε is a termination criterion between 0 and 1, whereas k is the iteration steps. This procedure converges to a local minimum or a saddle point of J_m .

The algorithm is composed of the following steps:

1. Initialize $U=[u_{ij}]$ matrix, $U(0)$
2. At k-step: calculate the centers vectors $C(k)=[c_j]$ with $U(k)$

$$c_j = \frac{\sum_{i=1}^N u_{ij}^m x_i}{\sum_{i=1}^N u_{ij}^m} \quad (3.4)$$

1. Update $U(k)$, $U(k+1)$

$$u_{ij} = \frac{1}{\sum_{k=1}^c \left(\frac{\|x_i - c_j\|}{\|x_i - c_k\|} \right)^{\frac{2}{m-1}}} \quad (3.4)$$

2. If $\|U(k+1) - U(k)\| < \epsilon$ then STOP; otherwise return to step 2.

Here we will construct algorithms for analyzing the dependency and significance of criteria. The lower and upper approximations in fuzzy preference analysis can be interpreted as the pessimistic and optimistic decisions, respectively.

There are many approaches for the problem of how to understand and commit imperfect knowledge. The most important one is fuzzy set theory suggested by Zadeh (Zadeh, 1965).

Our data will be segmented into clusters with using fuzzy c-means algorithm.

4. FINDINGS

In this study products of bank and employee segmentation are formed by using CRISP-DM methodology. All steps of the CRISP-DM methodology were applied step-by-step. After that there are some segmentation procedures for bank products flags (who have the products) and amount of the bank products.

During the modeling phase of the project, specific modeling algorithms are selected and run on the data. Selection of the specific algorithms employed in the data mining process is based on the output. For example, for creating decision rules based on sections, decision tree models are used.(Colleen McCue, 2007)

4.1 CLUSTERING PHASE

We have applied two models (fuzzy c-means & k-means) for seeing product flag dependence according to other products and based on customer. We used Knime Data Mining Program.

Mean and standard deviation values for all clusters are as summarized in Table 4.1.

Table 4.1: Clusters

Cluster	Mean	Standard Deviation
0	0.332	0.005
1	0.333	0.004
2	0.335	0.008

Distribution of clusters is shown in figure 4.1.

Row ID	FL..	BK_FLA..	MWK_...	OH_F..	OTMK..	KK_FLA..	SIGOR..	EORDR..	SGK_P_...	TAKP_...	DBF_S...	A.TIN_...	D cluster_0	D cluster_1	D cluster_2	S Winner...
Row534	0	0	1	1	1	0	0	0	0	0	0	0	1	0	0	cluster_0
Row535	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	cluster_2
Row536	0	1	1	1	1	0	0	0	0	0	0	0	0	0	0	cluster_0
Row537	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	cluster_0
Row538	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	cluster_0
Row539	1	0	0	1	0	1	0	0	0	0	0	0	0	0	0	cluster_0
Row540	1	0	0	0	1	1	0	0	0	0	0	0	0	0	0	cluster_0
Row541	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	cluster_2
Row542	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	cluster_2
Row543	0	1	1	1	0	0	0	0	0	0	0	0	0	0	0	cluster_0
Row544	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	cluster_0
Row545	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	cluster_0
Row546	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	cluster_0
Row547	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	cluster_0
Row548	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	cluster_0
Row549	0	1	1	1	1	0	0	0	0	0	0	0	0	0	0	cluster_0
Row550	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	cluster_0
Row551	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	cluster_2
Row552	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	cluster_1
Row553	0	0	1	1	1	0	0	0	0	0	0	0	0	0	0	cluster_0
Row554	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	cluster_2
Row555	1	0	0	1	0	1	0	0	0	0	0	0	0	0	0	cluster_0
Row556	0	1	1	1	1	0	0	0	0	0	0	0	0	0	0	cluster_0
Row557	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	cluster_2
Row558	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	cluster_2
Row559	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	cluster_2
Row560	0	1	1	1	1	0	0	0	0	0	0	0	0	0	0	cluster_0
Row561	0	0	1	1	1	0	0	0	0	0	0	0	0	0	0	cluster_0
Row562	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	cluster_2
Row563	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	cluster_2
Row564	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	cluster_2
Row565	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	cluster_0
Row566	1	1	0	1	1	1	0	0	0	0	0	0	0	0	0	cluster_0
Row567	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	cluster_2
Row568	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	cluster_2
Row569	1	0	1	1	1	1	0	0	0	0	0	0	0	0	0	cluster_0
Row570	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	cluster_2
Row571	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	cluster_2
Row572	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	cluster_2
Row573	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	cluster_2

Figure 4.1: Clusters in fuzzy c-means

In figure 4.1 we can see the the cluster of flags as “cluster 0”, “cluster 1” and “cluster 2”. Also we can see the rows that are related to clusters as winner cluster.

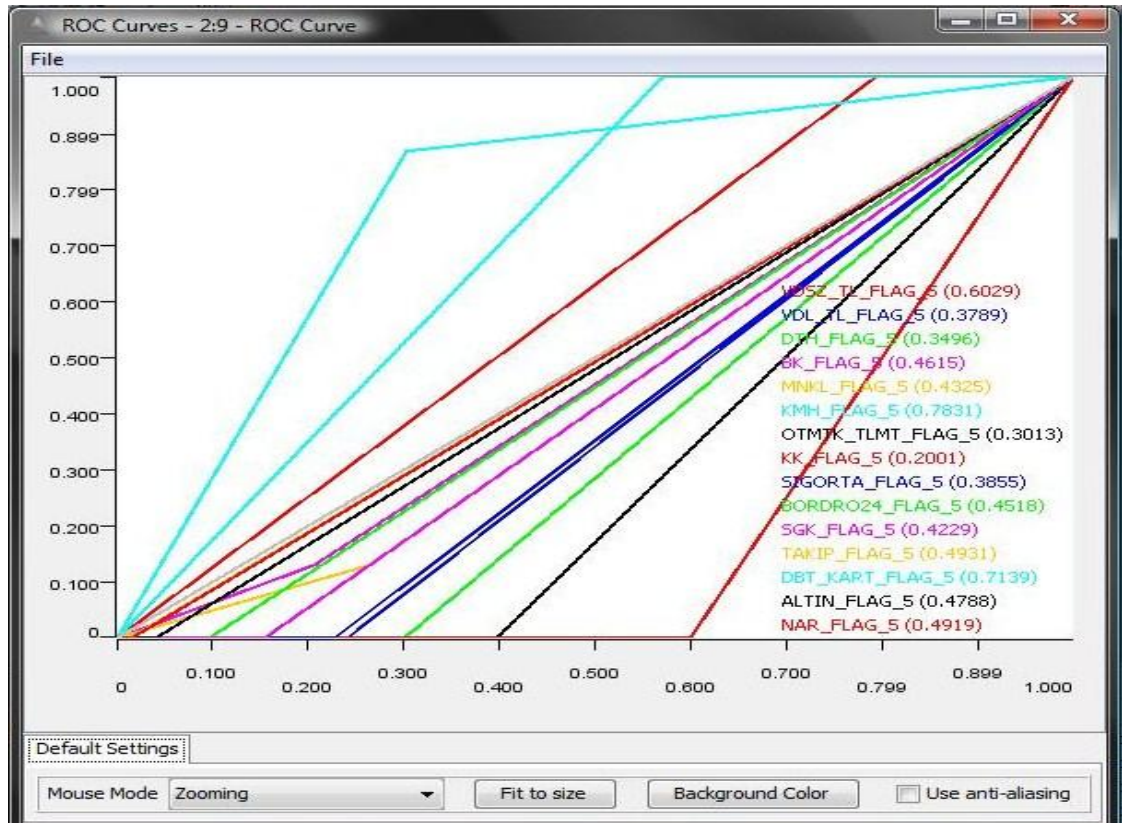


Figure 4.2: Roc curves fuzzy c-means

In figure 4.2 we can see roc curves. Each point on the ROC curve represents a sensitivity/specificity pair corresponding to a particular decision threshold. Perfect discrimination has a ROC curve that passes through the upper left corner.

As we have seen in figure 4.2, deposit account (vdl_tl flag), credit card (kk_flag), personel loan (bk_flag) and credit deposit account (kmh_flag) are important values. Nar campaign (nar_flag) and deposit account (vdsz_tl_flag) have low importance.

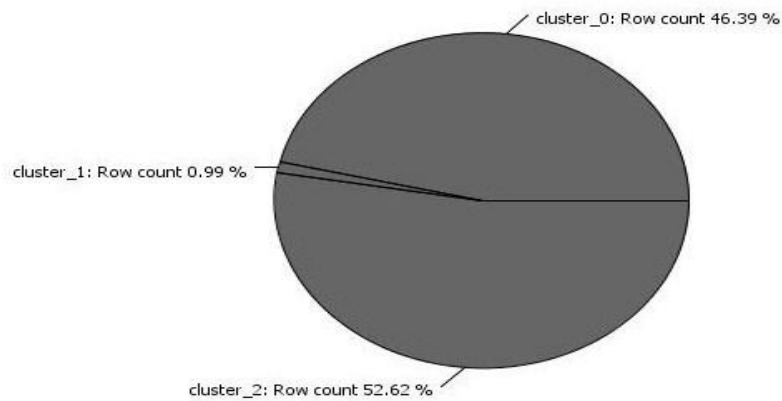


Figure 4.3: Distrubition of fuzzy c-means clusters

In figure 4.3 we can see the clusters in fuzzy c-means. “Cluster 1“has the lowest percent.”Cluster 0” and “cluster 2” nearly have the same percent.

After clustering we put the clusters in the knime. First we used two models fuzzy c-means and k-means models. Then we joined together and we made a comparison between these two models.

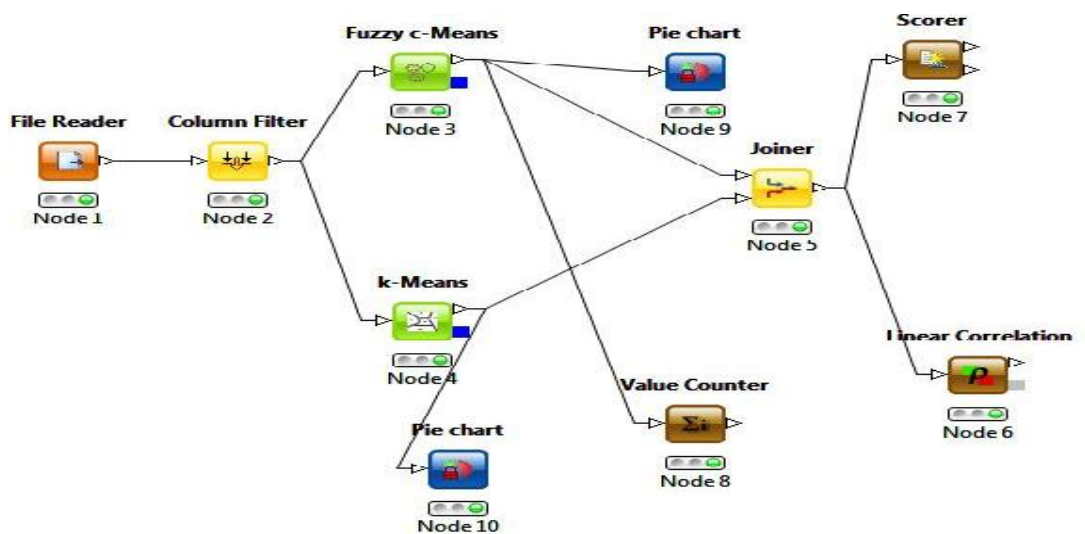


Figure 4.4: Fuzzy c- Means and k-Means in The Knime

Row ID	count	Row ID	count
cluster_0	23196	cluster_0	15782
cluster_1	494	cluster_1	16620
cluster_2	26310	cluster_2	17598

Figure 4.5: Accuracy statistics of c-means & k-means

After comparing algorithms, clusters are as follows in figure 4.5. Right column refers the results of k-means algorithm. Left column refers the results of fuzzy c-means algorithm. We can see a balanced distribution in k-means every clusters. In fuzzy c-means we can see a balanced distribution only between two clusters.

The accuracy statistics of the results of two algorithms are shown in figure 4.6.

Row ID	TruePo...	FalsePo...	TrueNe...	FalseN...	D Recall	D Precision	D Sensitivity
cluster_2	14609	2989	20701	11701	0.555	0.83	0.555
cluster_0	15780	2	26802	7416	0.68	1	0.68
cluster_1	316	16304	33202	178	0.64	0.019	0.64

Figure 4.6: The confusion matrix of the results of c-means and k-means.

The correlation matrix of Fuzzy C-means Model:

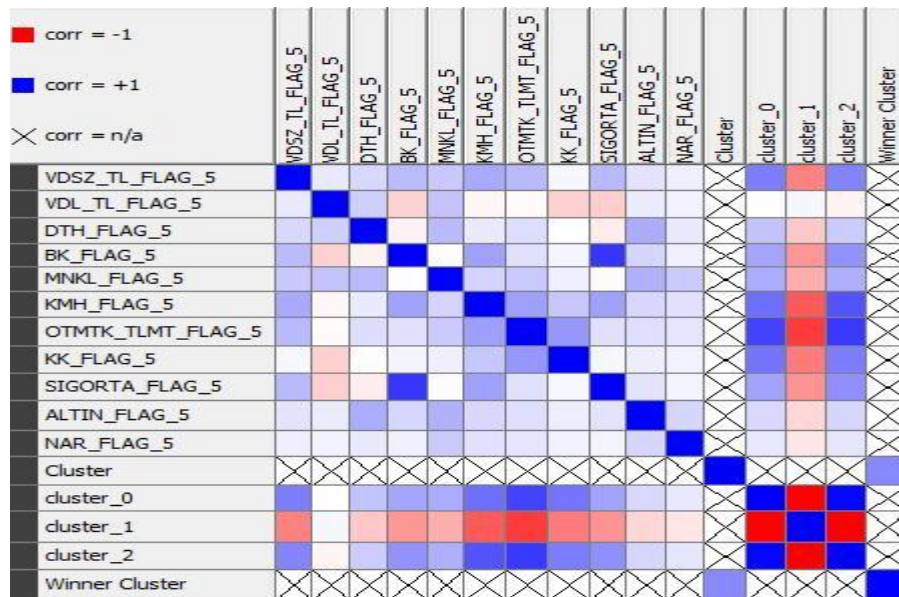


Figure 4.7: The Correlation matrix of K-Means & Fuzzy C-Means Models in The Knime

4.2 PREDICTION PHASE

The C&R Tree, Neural Net, GenLin and CHAID models are applied to data and target is cumulative net earning. A new database is constituted which contains the scores of C&R Tree, Neural Net, GenLin and CHAID models. These models are compared in findings section and according to the comparison CHAID model is seen the best model.

Bank products flags variables show the number of products that sold from the beginning of the year to that month and this variables are our target. All operational data flag inputs are put in the C&R tree model which designs a decision tree using the clustering and regression algorithm, Neural net model which designs a neural net model to examine the impacts of operational variables on cumulative net earning, GenLin and CHAID which is used to study the relationship between a dependent variable and constructs a predictive decision tree.

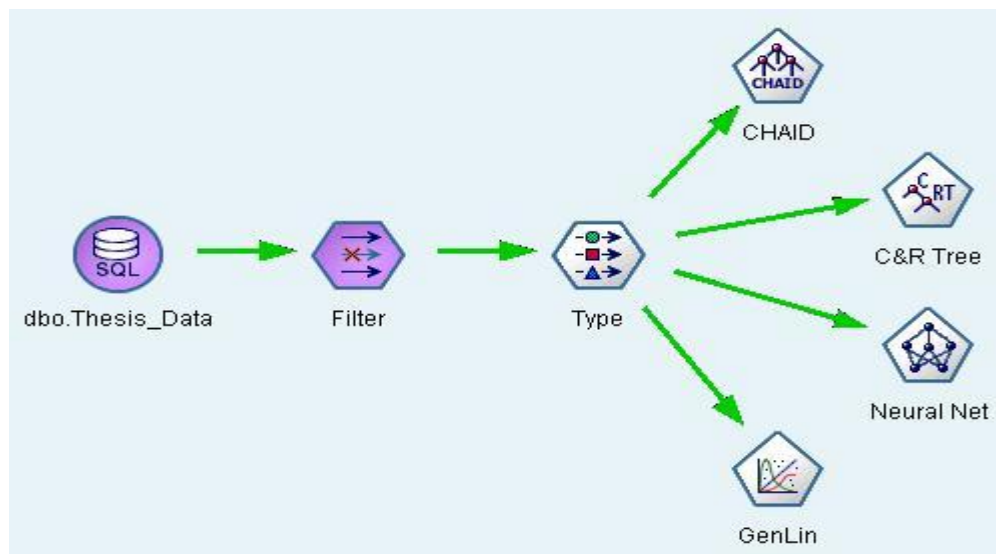


Figure 4.8: C&R Tree, Neural Net, GenLin and CHAID Models

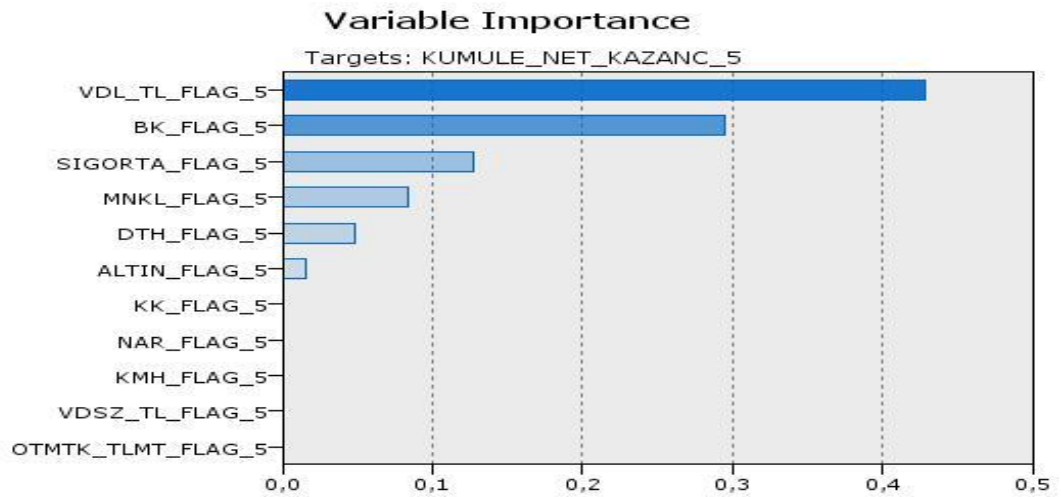


Figure 4.9: C&R Tree Model Variable Importance (Flags) for Demographic Variables

The result of this model is importance of input variables on target (cumulative net earning). In variable importance table of C&R Tree model, vdl_tl_flag (deposit account) is the most valuable variable on target.

The following important variables are bk_flag(personel loan), sigorta_flag(insurance) and mnkl_flag(investment account) as we have seen in the figure 4.9.

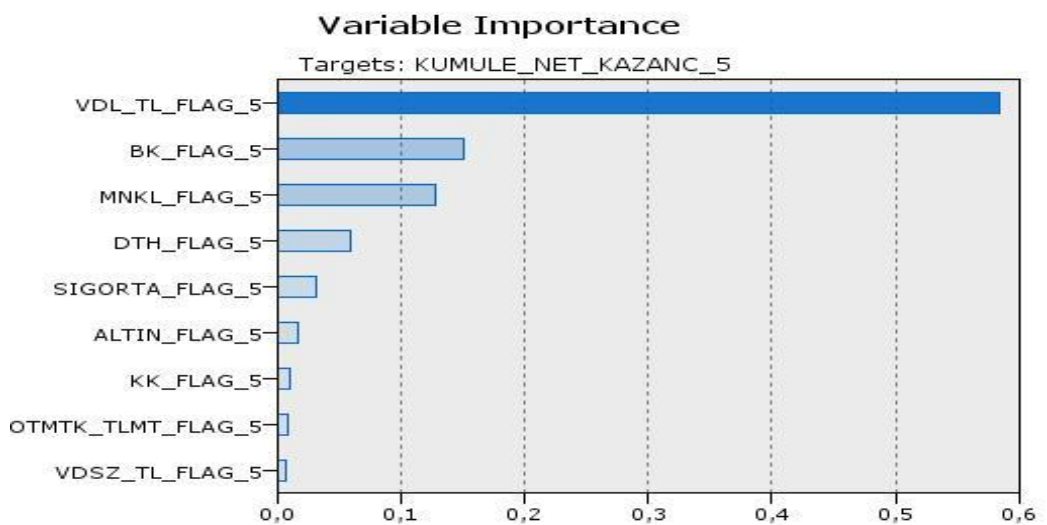


Figure 4.10: CHAID Model Variable Importance for Demographic Variable

The result of this model is importance of input variables on target (cumulative net earning). In variable importance table of CHAID model, vdl_tl_flag (deposit account) is the most valuable variable on target. The following important variables are bk_flag (personel loan),mnkl_flag (investment account), dth_flag (foreign currency account) and sigorta_flag (insurance) as we have seen in the figure 4.10.

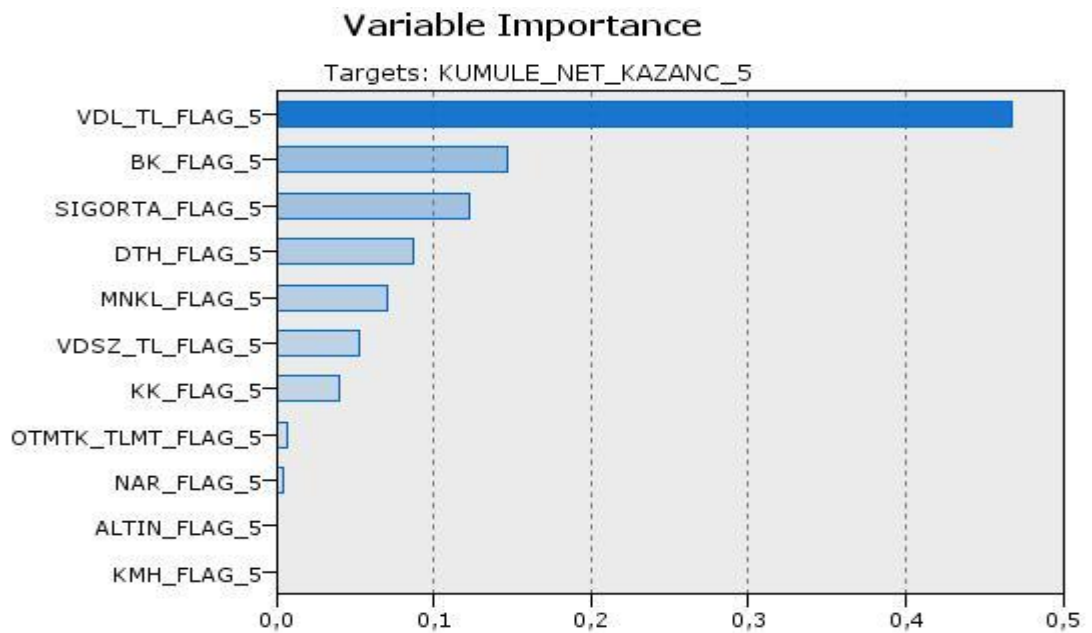


Figure 4.11: GenLin Model Variable Importance for Demographic Variables

The result of this model is importance of input variables on target (cumulative net earning). In variable importance table of GenLin model, vdl_tl_flag (deposit account) is the most important variable on target. The following important variables are bk_flag (personel loan), sigorta_flag (insurance), dth_flag (foreign currency account) and mnkl_flag (investment account) as we have seen in the figure 4.11.

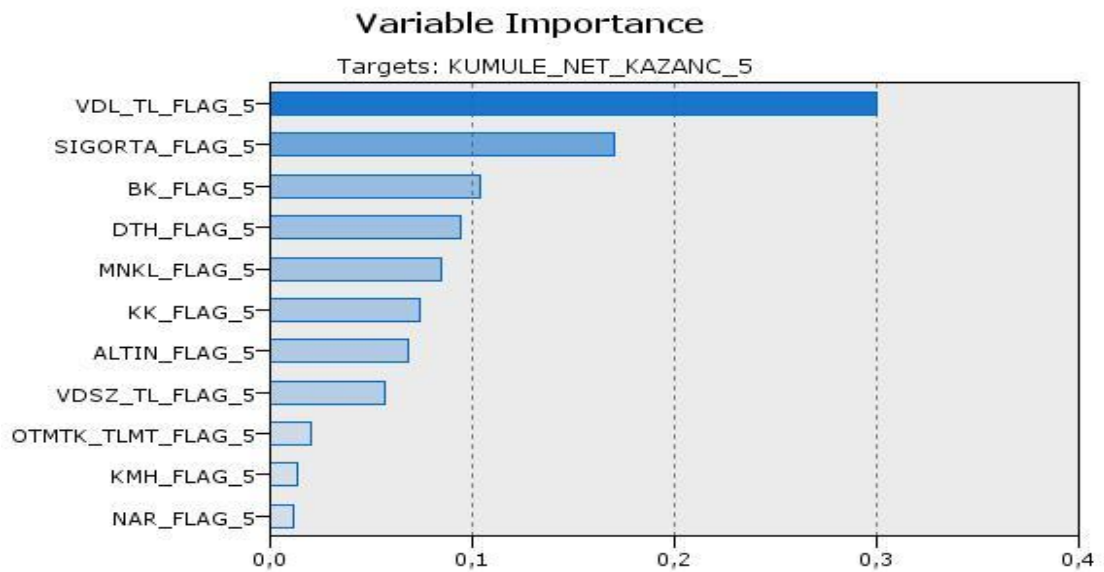


Figure 4.12: Neural Net Model Variable Importance for demographic variables

The result of this model is importance of input variables on target – cumulative net earning. In variable importance table of Neural Net model, vdl_tl_flag (deposit account) is the most important variable on target. The following important variables are sigorta_flag (insurance), bk_flag (personel loan), dth_flag (foreign currency account) and mnkl_flag (investment account) as we have seen in the figure 4.12.

According to all of these models we can see that the most valuable product is vdl_tl_flag (deposit account). It is always first-order. It is possible that the employee can make cross-sell to customers because this product has interest sensitivity.

The models are compared. The C&R Tree, Neural Net, GenLin and CHAID models are applied to data and Target is cumulative net earning. A new database is constituted which contains the scores of C&R Tree, Neural Net, GenLin and CHAID models.

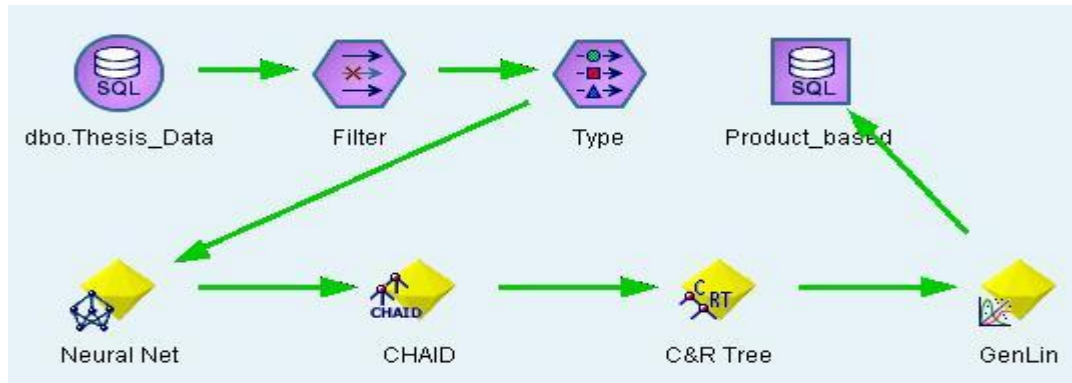


Figure 4.13: New Database which Contains Scores of Models

The analysis makes a comparison between the models for showing the correctness. The evaluation prepares charts comparing the accuracy of predictive models.

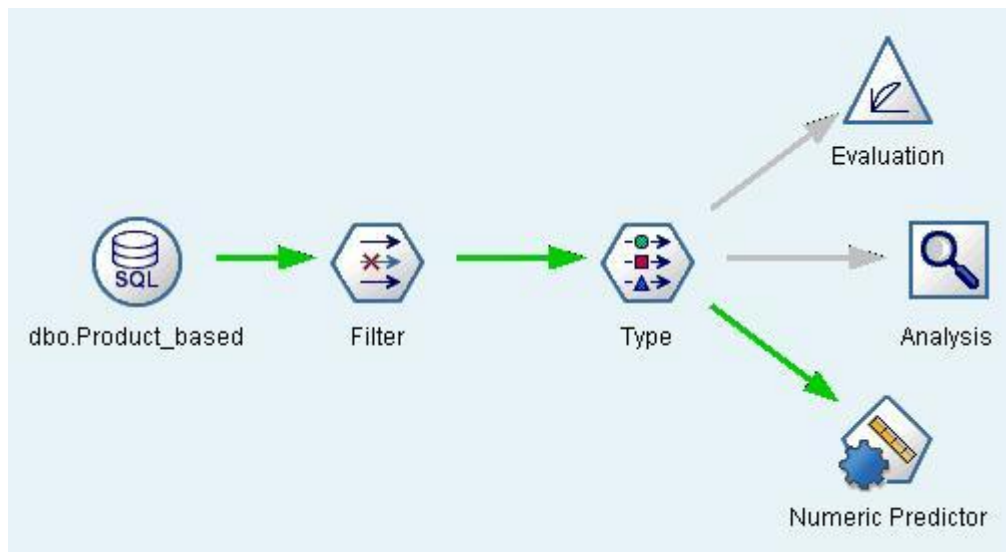


Figure 4.14: The Evaluation and Analysis of Demographic Models

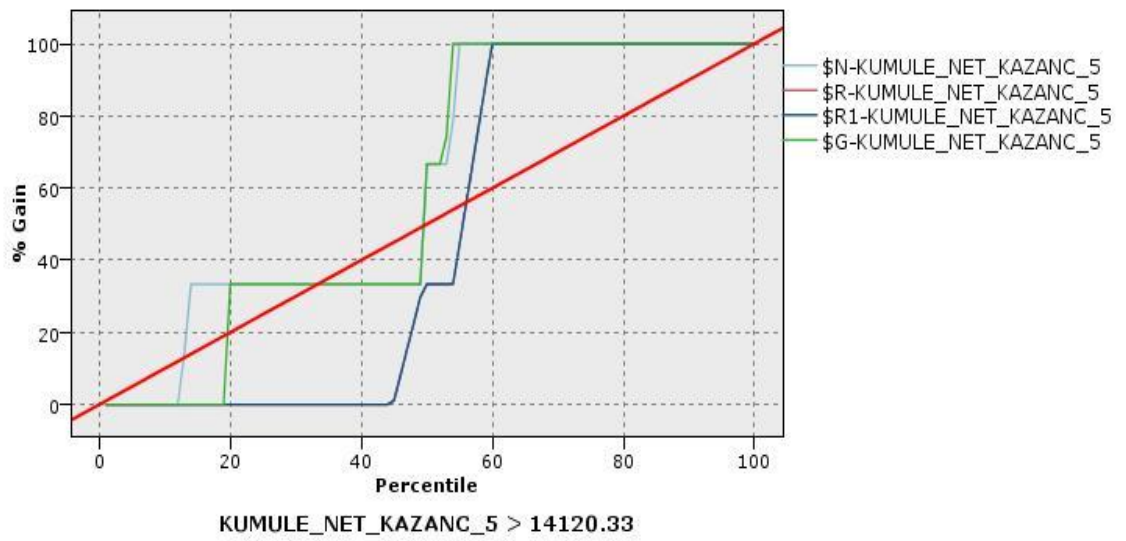


Figure 4.15: The Evaluation of the Models

The results of the evaluation on our models that we used are shown in figure 4.15. \$R refers C&R Tree model. \$N refers Neural Net model. \$G refers GenLin model. \$R1 refers CHAID model. The red line refers the real cumulative-earning in figure 4.15. The C&R Tree model is seen better than the others however it is hard to say which one is the best according to this figure. GenLin and Neural Network models have coincident lines. Therefore, we will examine the analysis and the numeric predictor to find out which one is better than the others.

Results for output field KUMULE_NET_KAZANC_5

Individual Models

- Comparing \$N-KUMULE_NET_KAZANC_5 with KUMULE_NET_KAZANC_5

Minimum Error	-683,768
Maximum Error	28747,598
Mean Error	0,049
Mean Absolute Error	65,831
Standard Deviation	278,477
Linear Correlation	0,195
Occurrences	50.000
- Comparing \$R-KUMULE_NET_KAZANC_5 with KUMULE_NET_KAZANC_5

Minimum Error	-669,386
Maximum Error	28770,837
Mean Error	-0,0
Mean Absolute Error	63,268
Standard Deviation	277,931
Linear Correlation	0,204
Occurrences	50.000
- Comparing \$R1-KUMULE_NET_KAZANC_5 with KUMULE_NET_KAZANC_5

Minimum Error	-673,286
Maximum Error	28770,837
Mean Error	-0,0
Mean Absolute Error	63,422
Standard Deviation	278,014
Linear Correlation	0,203
Occurrences	50.000
- Comparing \$G-KUMULE_NET_KAZANC_5 with KUMULE_NET_KAZANC_5

Minimum Error	-686,149
Maximum Error	28748,813
Mean Error	0,0
Mean Absolute Error	65,676
Standard Deviation	278,378
Linear Correlation	0,197
Occurrences	50.000

Figure 4.16: The comparison of C&R Tree, Neural Net, GenLin and CHAID Models with Cumulative Net Eraning in Analysis Module

The results of the analysis on four models are shown in figure 4.16. We can see that CHAID model is better than other models because its minimum error is better than others.

Graph	Model	Build Time (mins)	Correlation τ	No. Fields Used	Relative Error
	CHAID 1	< 1	0,206	4	0,958
	Generalized Line...	< 1	0,205	4	0,958
	Neural net 1	< 1	0,205	4	0,958
	C&R Tree 1	< 1	0,199	4	0,961

Figure 4.17: The comparison of C&R Tree, Neural Net, GenLin and CHAID with Cumulative Net Eraning in Numeric Predictor Module

Finally we analysed correlation of these models for releasing best model. CHAID model is the best model because its linear correlation is the best as it is shown in figure 4.17.

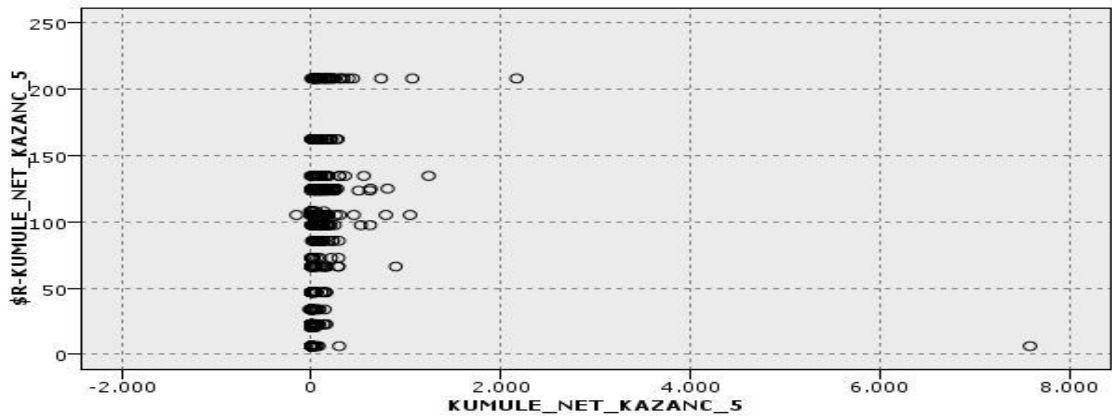


Figure 4.18: The correlation of C&R Tree, Neural Net, GenLin and CHAID with Cumulative Net Earning in Numeric Predictor Module

The correlation of all models are clearly shown in Figure 4.18. \$R1 – KUMULE_NET_KAZANC_5 is instead of CHAID model. CHAID model is the best model because its correlation is the best as it is shown in figure 4.18.

The segmentation will be made with CHAID model. CHAID model based on decision tree models. After applying the model to our data, seventeen subgroups are appeared.

CHAID model and Neural Net Models(with using SPSS) are applied to data which include only operational data flags and target is cumulative net earning. The analysis which creates a report comparing the accuracy of predictive models is applied to new database which includes the results of CHAID model and Neural Net models.

The subgroups are Node 9, Node 12, Node 18, Node 19, Node 20, Node 21, Node 22, Node 23, Node 24, Node 25, Node 26, Node 27, Node 28, Node 29, Node 30, Node 31, Node 32.

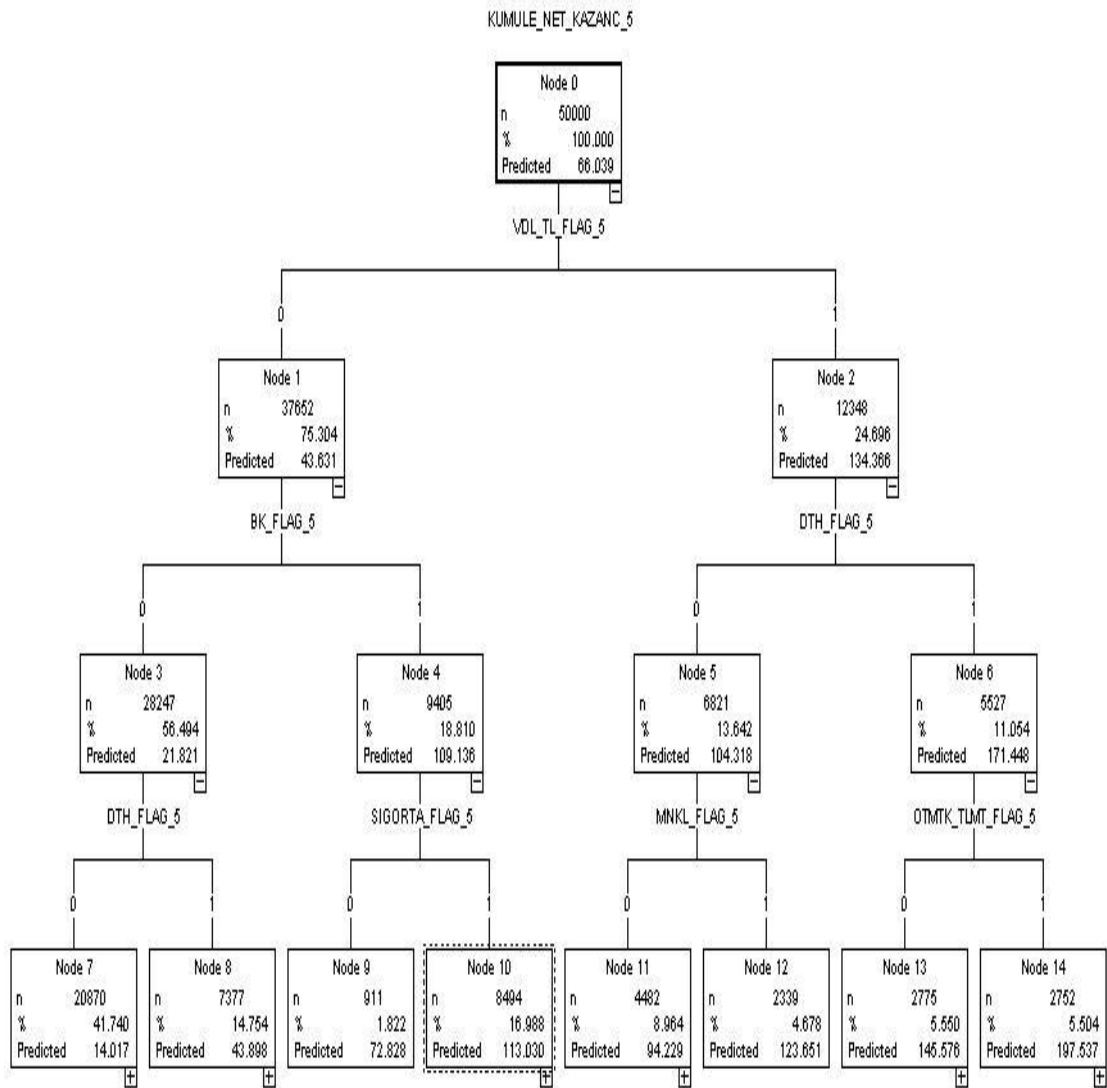


Figure 4.19: CHAID Model Part 1

Node 9 and Node 12 are shown in Figure 4.19.

- ✓ Node 9 is composed of customers who haven't deposit account (vdl_tl_flag), who have insurance (sigorta_flag) and who haven't personel loan (bk_flag).
- ✓ Node 12 is composed of customers who have deposit account (vdl_tl_flag), who haven't foreign currency account (dth_flag) and who have investment account (mnkl_flag).

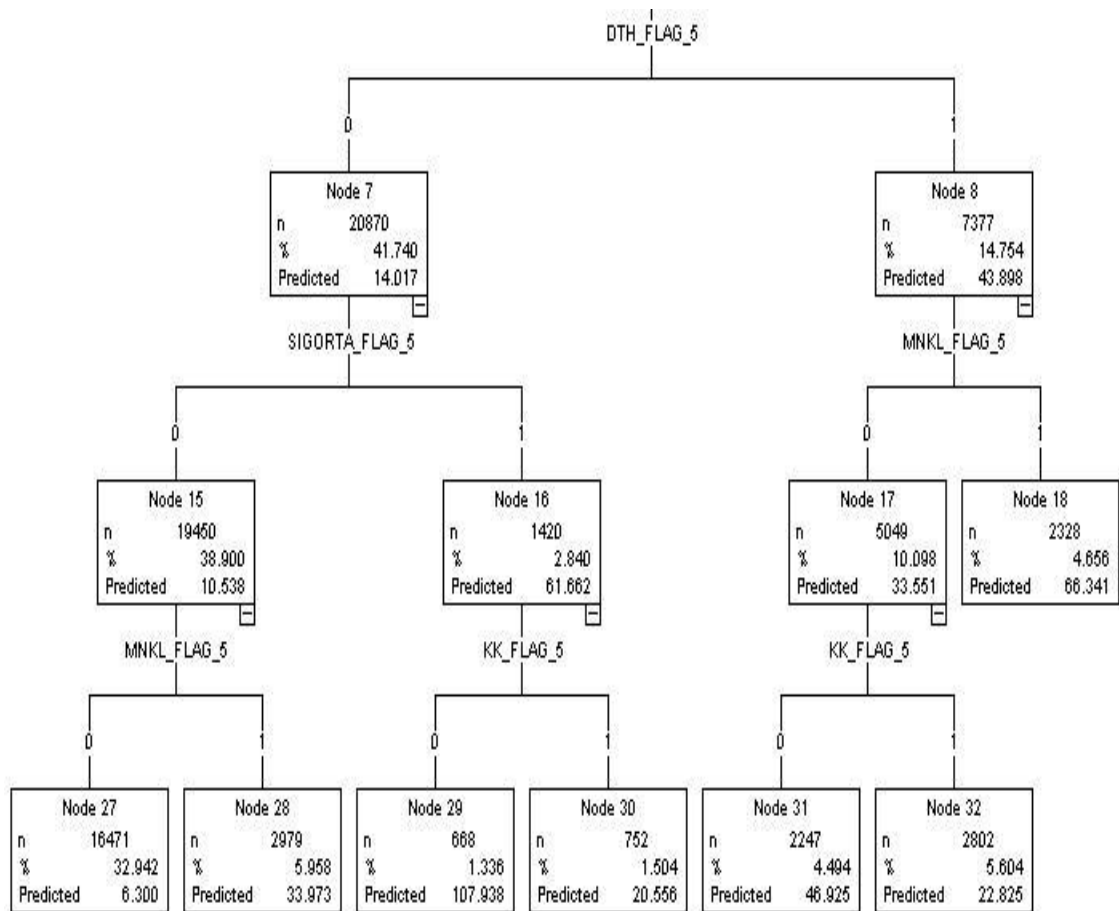


Figure 4.20: CHAID Model Part 2

Node 18, Node 27, Node 28, Node 29, Node 30, Node 31 and Node 32 are shown in figure 4.20.

- ✓ Node 18 is composed of customers who have deposit account (vdl_tl_flag), foreign currency account (dth_flag) and investment account (mnkl_flag).
- ✓ Node 27 is composed of customer who have not deposit account (vdl_tl_flag), foreign currency account (dth_flag), insurance (sigorta_flag) and investment account (mnkl_flag).

- ✓ Node 28 is composed of customer who have not deposit account (vdl_tl_flag), foreign currency account (dth_flag), insurance (sigorta_flag) and who have investment account (mnkl_flag).
- ✓ Node 29 is composed of customer who have not deposit account (vdl_tl_flag) and foreign currency account (dth_flag),who have insurance (sigorta_flag) and who have not credit card (kk_flag).
- ✓ Node 30 is composed of customer who have not deposit account (vdl_tl_flag) and foreign currency account (dth_flag),who have insurance (sigorta_flag) and who have credit card (kk_flag).
- ✓ Node 31 is composed of customer who have not deposit account (vdl_tl_flag), who have foreign currency account (dth_flag),who have not investment account (mnkl_flag) and who have not credit card (kk_flag).
- ✓ Node 32 is composed of customer who have not deposit account (vdl_tl_flag), who have foreign currency account (dth_flag),who have not investment account (mnkl_flag) and who have credit card (kk_flag).

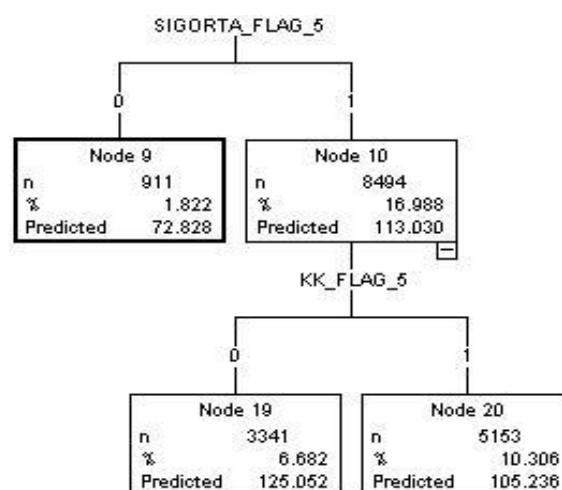


Figure 4.21: CHAID Model Part 3

Node 19 and Node 20 are shown Figure 4.21.

- ✓ Node 19 is composed of who have not deposit account (vdl_tl_flag),who have personel loan (bk_flag),who have insurance (sigorta_flag) and who have not credit card (kk_flag).
- ✓ Node 20 is composed of who have not deposit account (vdl_tl_flag),who have personel loan (bk_flag),who have insurance (sigorta_flag) and who have credit card (kk_flag).

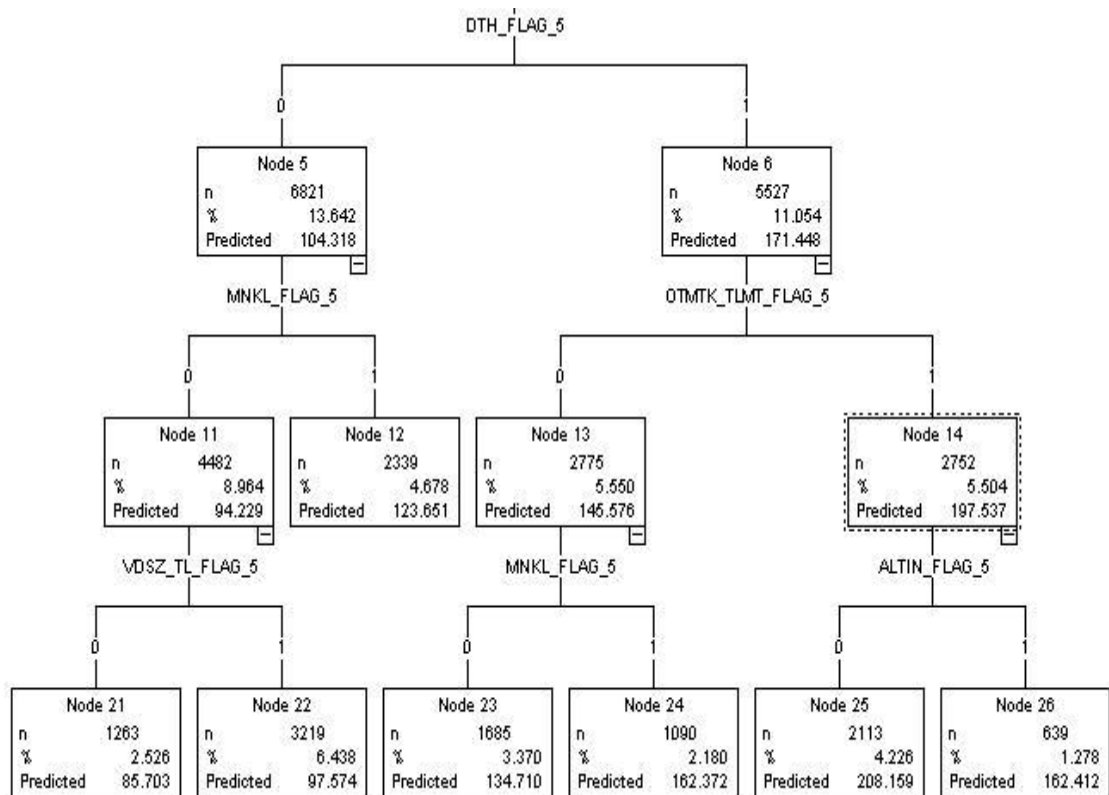


Figure 4.22: CHAID Model Part 4

Node 21, Node 22, Node 23, Node 24, Node 25 and Node 26 are shown in figure 4.22.

- ✓ Node 21 is composed of customers who have deposit account (vdl_tl_flag), who haven't foreign currency account (dth_flag) , investment account (mnkl_flag) and sight deposit account (vdsz_tl_flag).
- ✓ Node 22 is composed of customers who have deposit account (vdl_tl_flag), who haven't foreign currency account (dth_flag) and investment account (mnkl_flag), who have sight deposit account (vdsz_tl_flag).
- ✓ Node 23 is composed of customers who have deposit account (vdl_tl_flag) and foreign currency account (dth_flag) , who have not abone (24otomatk_talmt_flag) and investment account (mnkl_flag).
- ✓ Node 24 is composed of customers who have deposit account (vdl_tl_flag) and foreign currency account (dth_flag) , who have not abone 24 (otomatk_talmt_flag) and who have investment account (mnkl_flag).
- ✓ Node 25 is composed of customers who have deposit account (vdl_tl_flag), foreign currency account (dth_flag) and abone 24 (otomatk_talmt_flag) and who have not gold deposit account (altin_flag).
- ✓ Node 26 is composed of customers who have deposit account (vdl_tl_flag), foreign currency account (dth_flag) and abone 24 (otomatk_talmt_flag) and who gold deposit account (have altin_flag).

Finally we can see the customers who have many products from the bank and this situation effects performance management positively. For example if an employee's customer who have deposit account (vdl_tl_flag), foreign currency account (dth_flag), Abone 24 (otmtk_talmt_flag) and gold deposit account (altin_flag) the employee will get positive points.

Personel loan is dragged a product group and these products are: insurance and credit card. Insurance generally is selled with personel loan so it is hard to sell alone. For these reasons 9, 19 and 20 clusters are combined for insurance. This is first cluster.

These products can be combined: deposit account (vdl_tl_flag), foreign currency account (dth_flag) and gold deposit account (altin_flag) because they have likeness in terms of using. For these reasons 25 and 26 clusters are combined for insurance.

This is second cluster. Then 29 and 30 clusters are combined for credit card. This is final cluster.

Deposit account customers is the most valuable type of customer according to profitability, so the employees have to make cross-sell to these customers.

Credit card product is the most profitable product when the customers use it. But there are many alternatives for customers, so it is hard to manage as campaign management.

According to all of these models we have seen that vdl_tl_flag (deposit account) and bk_flag (personal loan) are the most important products. Also we have seen other products that are sold few like altin_flag(gold deposit account), kmh_flag(credit deposit account) etc. So the employees have to find a strategy for selling these products.

Two more different models will be compared our best model (C&R Tree model) for realize which model is beter. Fuzzy c-means and K-means will be used as an input.

First of all we used clusters that was created by fuzzy c-means algorithm as an input for modeling phase. The target is cumulative net earning.

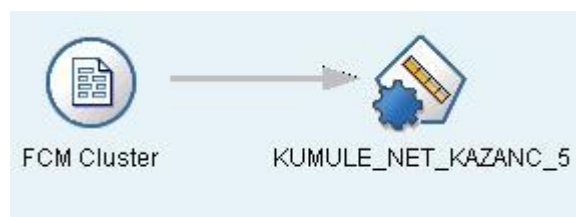


Figure 4.23: The Selection of Best Model with Numeric Predictor for Fuzzy c-means






Graph	Model	Build Time (mins)	Correlation ∇	No. Fields Used	Relative Error
	CHAID 1	< 1	0,205	10	0,958
	C&R Tree 1	< 1	0,205	11	0,958
	Generalized Line...	< 1	0,197	11	0,961
	Regression 1	< 1	0,197	10	0,961
	Neural net 1	< 1	0,196	11	0,962

Figure 4.24: The comparison of C&R Tree, CHAID, GenLin and Neural Net with Cumulative Net Earning in Numeric Predictor Module for fuzzy c-means

C&R Tree is the best model because its correlation is the best as it is shown in figure 4.24. After that, we used clusters that was created by k-means algorithm as an input for modeling phase. The target is cumulative net earning.

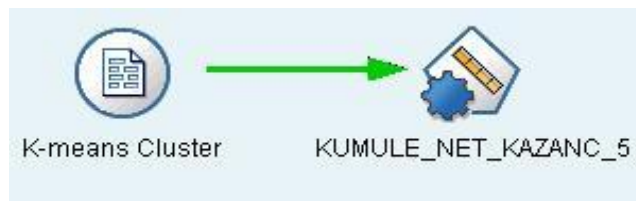


Figure 4.25: The Selection of Best Model with Numeric Predictor for k-means

Graph	Model	Build Time (mins)	Correlation ∇	No. Fields Used	Relative Error
	C&R Tree 1	< 1	0,203	11	0,959
	CHAID 1	< 1	0,203	10	0,959
	Generalized Line...	< 1	0,197	11	0,961
	Regression 1	< 1	0,197	10	0,961
	Neural net 1	< 1	0,196	11	0,962

Figure 4.26: The comparison of C&R Tree, CHAID, GenLin and Neural Net with Cumulative Net Earning in Numeric Predictor Module for k-means

C&R Tree is the best model because its correlation is the best as it is shown in figure 4.26.

Lastly, we will compare fuzzy c-means and k-means for deciding which one is better.

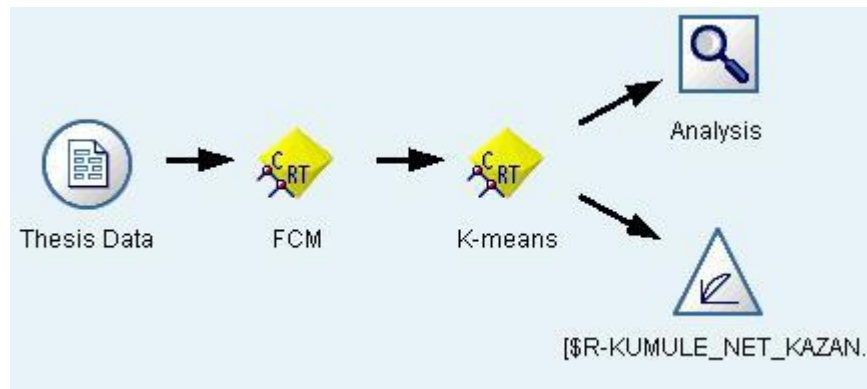


Figure 4.27: The Evaluation and Analysis of Models

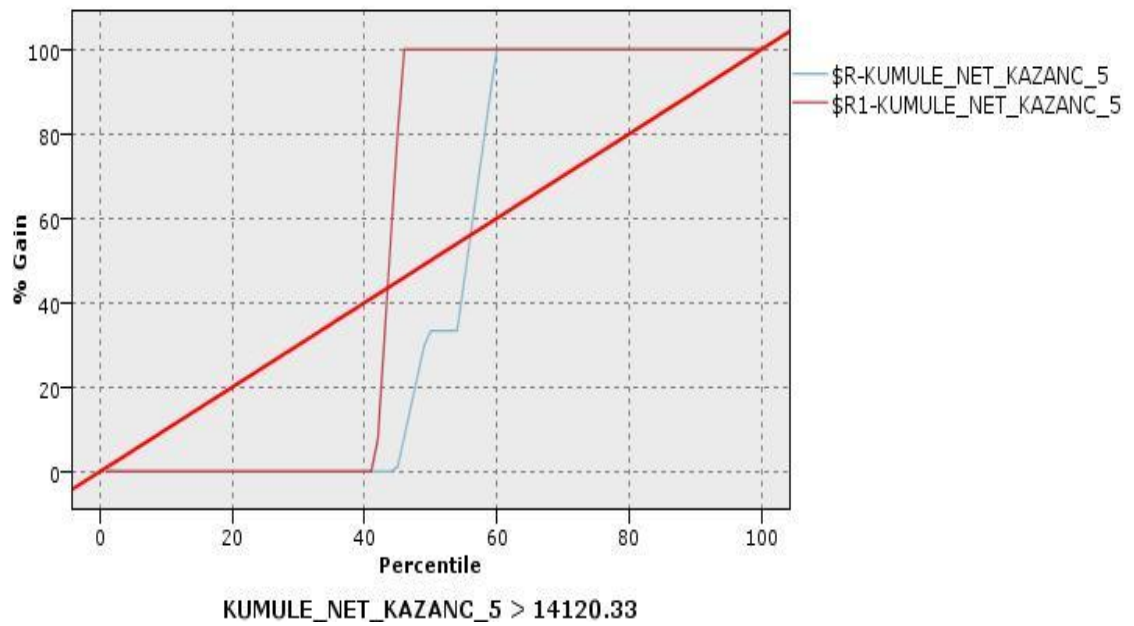


Figure 4.28: The Evaluation of Models

The comparison of fuzzy c-means & k-means models are shown in figure 4.28. \$R refers C&R tree model which is generated by using K-means clusters. \$R1 refers C&R tree model which is created by using FCM clusters. According to the red line, (refers real cumulative-earning) \$R1 seems better than the \$R however it is hard to say which one is the best. In this way, we will examine the analysis and the numeric predictor to find out which one is better than the others.

Results for output field KUMULE_NET_KAZANC_5

- [-] Individual Models
 - [-] Comparing \$R-KUMULE_NET_KAZANC_5 with KUMULE_NET_KAZANC_5

Minimum Error	-669,386
Maximum Error	28770,837
Mean Error	-0,0
Mean Absolute Error	63,31
Standard Deviation	277,922
Linear Correlation	0,205
Occurrences	50.000
 - [-] Comparing \$R1-KUMULE_NET_KAZANC_5 with KUMULE_NET_KAZANC_5

Minimum Error	-669,386
Maximum Error	28731,681
Mean Error	-0,0
Mean Absolute Error	63,809
Standard Deviation	278,013
Linear Correlation	0,203
Occurrences	50.000
- [-] Agreement between \$R-KUMULE_NET_KAZANC_5 \$R1-KUMULE_NET_KAZANC_5
 - [-] Comparing Agreement with KUMULE_NET_KAZANC_5

Minimum Error	-669,386
Maximum Error	28751,259
Mean Error	-0,0
Mean Absolute Error	63,413
Standard Deviation	277,877
Linear Correlation	0,205
Occurrences	50.000

Figure 4.29: The Analysis of Models

The final analysis of the models (fuzzy c-means & k-means) is shown in figure 4.29. We can see the models' many important datas like linear correlation. So we can see that \$R1 linear correlation is beter than other. Finally we decided to use fuzzy c-means.

The C&R Tree model and fuzzy c-means are applied to data which include only operational data flags and target is cumulative net earning. The analysis which creates a report comparing the accuracy of predictive models is applied to new database which includes the results of C&R Tree model and Neural Net models.

The subgroups are Node 9, Node 11, Node 12, Node 13, Node 18, Node 20, Node 23, Node 24, Node 25, Node 26, Node 27, Node 28, Node 29, Node 30, Node 31, Node 32.

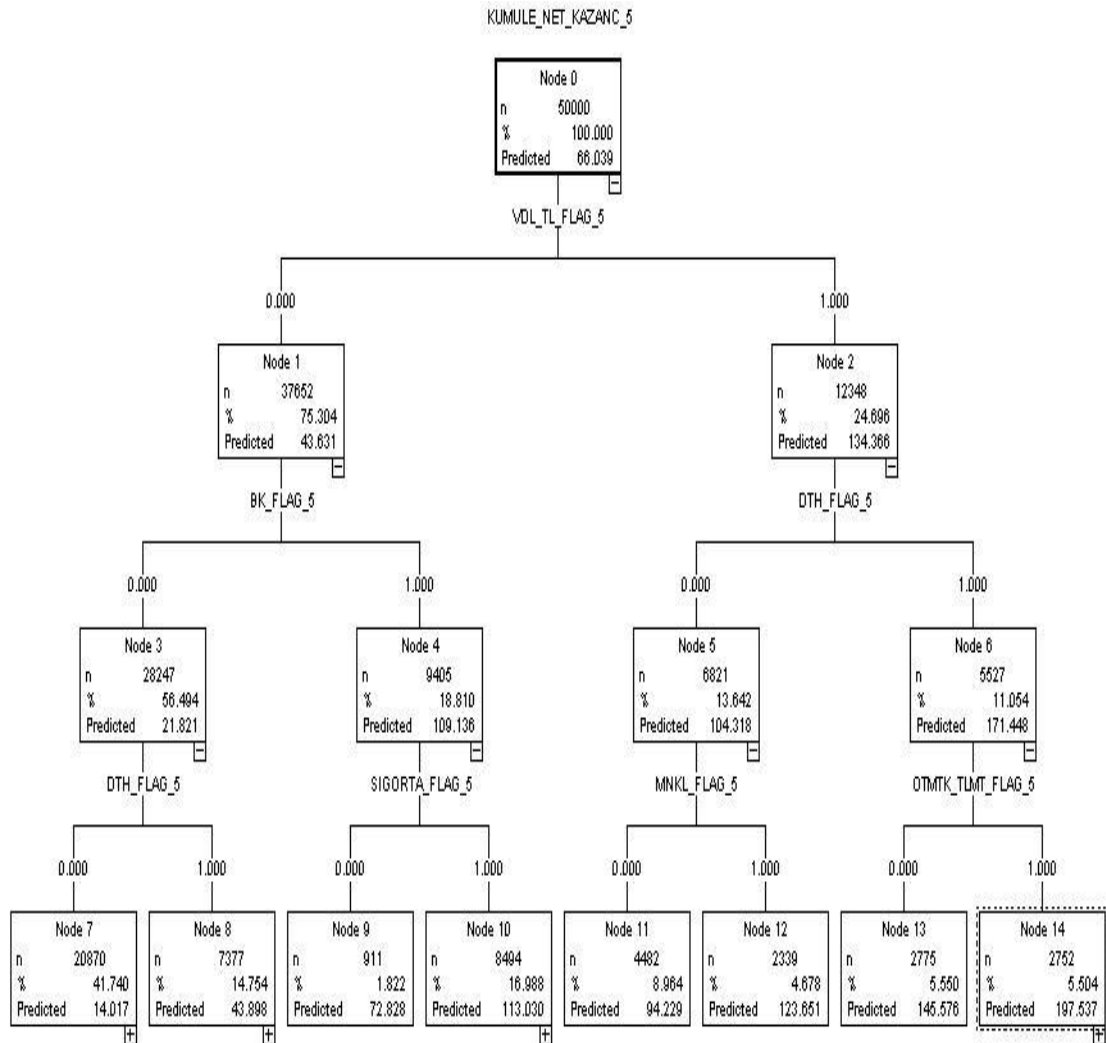


Figure 4.30: The FCM - C&R Tree Model – Part 1

We used flags and values of flags can be one or zero. According to figure 4.30, figure 4.31 and figure 4.32 we can see only two clusters at the end of the figure 44 as “cluster 0” and “cluster 2”.

In figure 43, we can see the nodes that related to “cluster 0” and “cluster 2”. These nodes are Node 1, Node 4 and Node 10.

Node 10 is composed of customers who have not deposit account, who have personal loan and insurance.

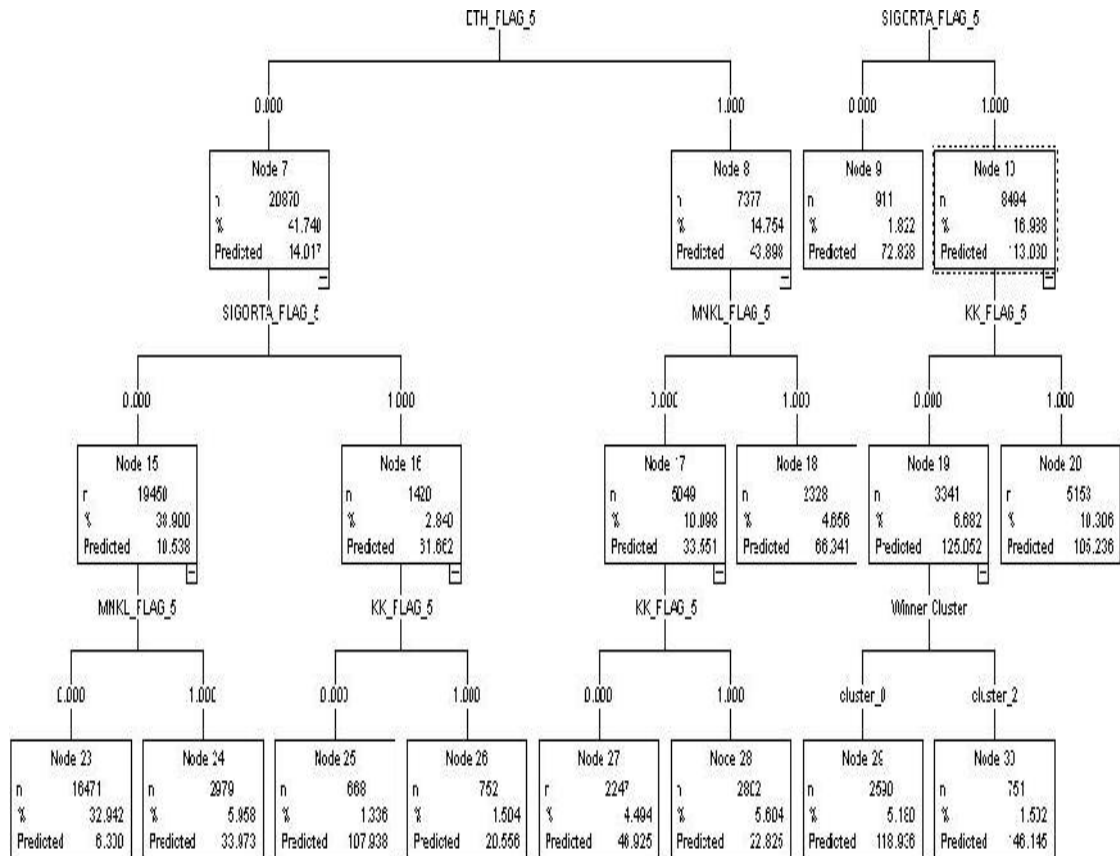


Figure 4.31: The FCM - C&R Tree Model – Part 2

In figure 44, we can see Node 19 that is composed of customers who are in “cluster 0” or “cluster 2”. Node 19 is composed of customers who have insurance, who have not credit card. Finally we can say that the customers who have personal loan and insurance, who have not deposit account and credit card are in “cluster 0” or “cluster 2”.

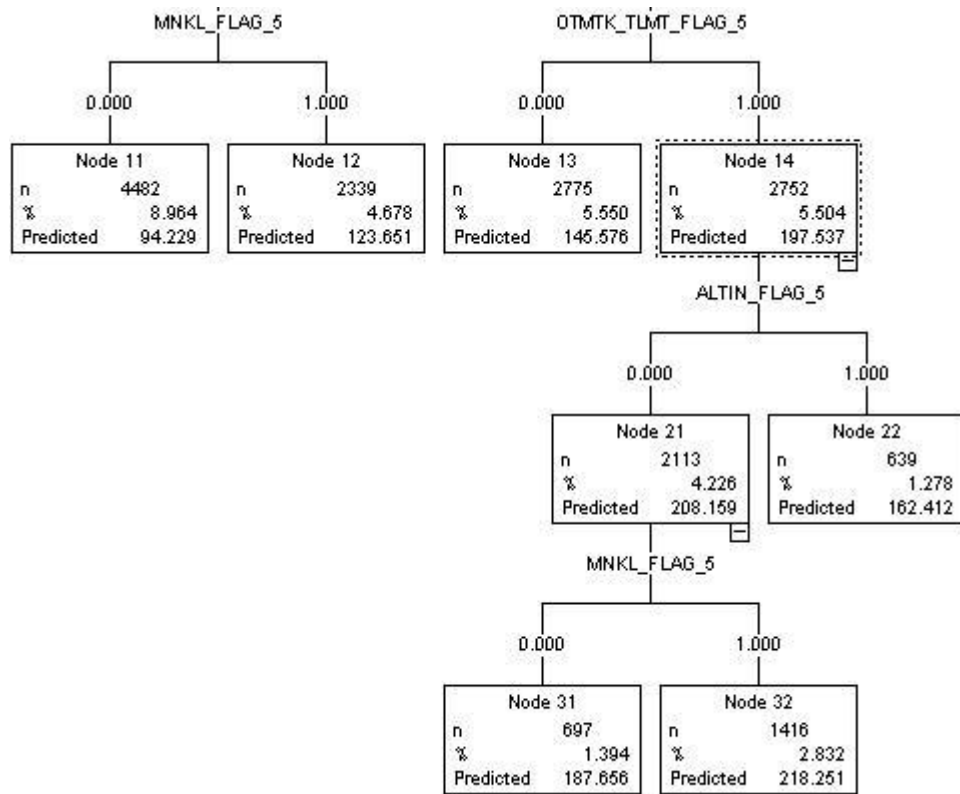


Figure 4.32: The FCM - C&R Tree Model – Part 3

The products are:

- VDL_TL_FLAG_5 refers deposit account,
- BK_FLAG_5 refers personel loan,
- SIGORTA_FLAG_5 refers insurance,
- DTH_FLAG_5 refers foreign currency account,
- MNKL_FLAG_5 refers investment account,
- KK_FLAG_5 refers credit card
- ALTIN_FLAG_5 refers gold deposit account.

If value of the product is 1 then the customer have the product. If value of the product is 0 then the customer doesn't have the product. \$Score refers score of the rule. If score of the rule is big then the number of customers that related to the rule is big.

The rules of C&R Tree model are shown below.

Rule 1: If $VDL_TL_FLAG_5 = 0$, $BK_FLAG_5 = 1$ and $SIGORTA_FLAG_5=0$ then $\$Score = 72,828$ (Node 8)

Rule 2: $VDL_TL_FLAG_5 = 1$, $DTH_FLAG_5 = 0$ and $MNKL_FLAG_5=0$ then $\$Score = 94,229$ (Node 11)

Rule 3: $VDL_TL_FLAG_5 = 1$, $DTH_FLAG_5 = 0$ and $MNKL_FLAG_5=1$ then $\$Score = 123,651$ (Node 12)

Rule 4: $VDL_TL_FLAG_5 = 1$, $DTH_FLAG_5 = 1$ and $OTMTK_TLMT_FLAG_5=1$ then $\$Score = 145,576$ (Node 13)

Rule 5: If $VDL_TL_FLAG_5=0$, $BK_FLAG_5=0$, $DTH_FLAG_5=0$ $SIGORTA_FLAG_5=0$ and $MNKL_FLAG_5=0$ then $\$Score = 6,3$ (Node 23)

Rule 6: If $VDL_TL_FLAG_5=0$, $BK_FLAG_5=0$, $DTH_FLAG_5=0$ $SIGORTA_FLAG_5=0$, and $MNKL_FLAG_5=1$ then $\$Score = 33,973$ (Node 24)

Rule 7: If $VDL_TL_FLAG_5=0$, $BK_FLAG_5=0$, $DTH_FLAG_5=0$ $SIGORTA_FLAG_5=1$, and $KK_FLAG_5=0$ then $\$Score = 107,938$ (Node 25)

Rule 8: If $VDL_TL_FLAG_5=0$, $BK_FLAG_5=0$, $DTH_FLAG_5=0$ $SIGORTA_FLAG_5=1$ and $KK_FLAG_5=1$ then $\$Score = 20,556$ (Node 26)

Rule 9: If $VDL_TL_FLAG_5=0$, $BK_FLAG_5=0$, $DTH_FLAG_5=1$ and $MNKL_FLAG_5=1$ then $\$Score = 66,341$ (Node 18)

Rule 10: If $VDL_TL_FLAG_5=0$, $BK_FLAG_5=0$, $DTH_FLAG_5=1$ $MNKL_FLAG_5=0$ and $KK_FLAG_5=0$ then $\$Score = 46,925$ (Node 27)

Rule 11: $VDL_TL_FLAG_5=0$, $BK_FLAG_5=0$, $DTH_FLAG_5=1$ $MNKL_FLAG_5=0$ and $KK_FLAG_5=1$ then $\$Score = 22,825$ (Node 28)

Rule 12: $VDL_TL_FLAG_5=0$, $BK_FLAG_5=1$, $SIGORTA_FLAG_5=1$, and $KK_FLAG= 0$ then winner cluster “cluster 0” or “cluster 2” $\$Score = 118,938$ or $146,145$ (Node 19)

Rule 13: $VDL_TL_FLAG_5=0$, $BK_FLAG_5=1$, $SIGORTA_FLAG_5=1$, and $KK_FLAG= 1$ then $\$Score = 105,206$ (Node 20)

Rule 14: VDL_TL_FLAG_5 = 1, DTH_FLAG_5 = 1, OTMTK_TLMT_FLAG_5=1
ALTIN_FLAG_5=1 then \$Score = 162,412 (Node 22)

Rule 15: VDL_TL_FLAG_5 = 1, DTH_FLAG_5 = 1, OTMTK_TLMT_FLAG_5=1
ALTIN_FLAG_5=0 and MNKL_FLAG=0 then \$Score = 187,656 (Node 31)

Rule 16: VDL_TL_FLAG_5 = 1, DTH_FLAG_5 = 1, OTMTK_TLMT_FLAG_5=1
ALTIN_FLAG_5=0 and MNKL_FLAG=1 then \$Score = 218,251 (Node 32)

5. DISCUSSION AND CONCLUSIONS

Consequently, the human resource management process provides an opportunity for the employee and performance manager to discuss development goals and jointly create a plan for achieving those goals. For this study, after preparing the data set, data mining techniques and six algorithms, which are compared, were used then the customers were segmented according to flag of products. Beside this segmentation, we have seen the customers who have the products so the employees can sell different products to the customers for reaching the target.

Lastly, in this study we made the segmentation with using many algorithms: Neural Net, C&r Tree, CHAID and GenLin, k-means and fuzzy c-means. Conclusion of these algorithms we can see the importance of employee segmentation and its effect on human resource management. The results show that fuzzy c-means method gathers the datas that deals with each other. Performance management has a developmental purpose, it serves as a basis for developing employees' knowledge and skills. Even employees who meet expectations can become more valuable when they hear and discuss performance feedback. Effective performance feedback makes employees aware of their strengths and of the areas in which they can improve. Final point is the campaign management. The employee get the feedback according to the campaign points and closeness of the target.

CHAID model uses clustering to assess relations between dependent and independent datas. Because of this reason it gives us the best result for segmentation of cutomers. CHAID model results clearly show the target audience to the employee. The results shows that CHAID model is a useful method of summarizing data, and can show major natural divisions of the clients by various defining variables. So this system can be easily used many sector which have many products to sell to customers.

After creating the model, the fuzzy c-means and C&R Tree approach give seventeen rules. Each rule describe a segment or a sub segment. Now this rules will be explained as follows.

Firstly, the segment composed of customers who have deposit account, foreign currency account, above 24 and investment account, who do not have gold deposit account. This segment consist of the products that are low importance. However the segment has the highest profitability. Secondly, the segment has the lowest profitability composed of customers who have not deposit account, personal loan, foreign currency account, insurance and investment account. Lastly the segment composed of customers who have deposit account and investment accounts, who, do not have foreign currency account. The segment has mean profitability however the segment has only two products.

As a result of this study, we have clustered the employees by using c-means method. This study covers all of our needs for human resource management for campaign management. So this approach can be applied to many other campaigns because it has useful information and algorithms.

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APPENDIX A.1

We have 5 monthly data. _1,_2,_3,_4 and _5 refer the months.

Table A1.1: Customer Information

	Value Type	Comment
Must_No	Int	Customer ID
Müşteri Tipi	Nvarchar(1)	Customer Type
Muta Şb	Varchar(4)	Branch Offiec of Bank Customer
İlk tanımlama tar	DateTime	Initial Date (for customer)
MİY_SICIL_NO	Varchar(5)	Customer Relations Officer ID
ABONE24_TUT_1	Float	The Amount of Direct Debit Account
ALTIN_BKY_TUT_1	Float	The Amount of Gold Account
ALTIN_FLAG_1	Bit	The Flag of Gold Account
BK_FLAG_1	Bit	The Falg of Personal Loan
BK_ORT_TUT_1	Float	The Average Monthly Amount of Personal Loans
BORDRO24_FLAG_1	Bit	The Flag of Customer who take salary through bank
BORDRO24_MAAS_TUT_1	Float	The Amount of Salary Paid Through Bank
DBT_KART_FLAG_1	Bit	The Flag of Debit Card
DIALOG_ISL_TUT_1	Float	The Amount of Transactions on The Call Center
DTH_FLAG_1	Bit	The Flag of Foreign Exchange Deposit Account
DTH_ORT_TUT_1	Float	The Avarage Amount of Monthly Foreign Exchange Deposit Account
GCKM_TAKSIT_ADET_1	Int	The Number of Loan Delay
INTRNT_ISL_TUT_1	Float	The Amount of Transactions on The Internet
KK_FLAG_1	Bit	The Flag of Credit Card
KK_LIMIT_1	Float	The Limit of Credit Card
KKB_BNK_LMT_1	Float	The Limit of Customer in All Banks
KKB_BNK_RISK_1	Float	The Total Risk of Customer in All Banks

Table A1.1: Customer Information (continued)

KKB_KRD_NOT_1	Int	The Credit Score of Customer
KMH_FLAG_1	Bit	The Flag of Credit Deposit Account
KMH_ORT_TUT_1	Float	The Average Amount of Monthly Credit Deposit Account
KUMULE_NET_KAZANC_1	Float	Cumulated Net Profit
MENKUL_ORT_TUT_1	Float	The Average Amount of Monthly Investment Account
MNKL_FLAG_1	Bit	The Flag of Investment Account
OTMTK_TLMT_FLAG_1	Bit	The Flag of Direct Debit
SGK_FLAG_1	Bit	The Flag Customer who is retired
SGK_MAAS_TUT_1	Float	The Amount of Salary Paid Through Bank - Retired Customer
SGRT_KOM_TUT_1	Float	The Amount of Insurance Commission
SIGORTA_FLAG_1	Bit	The Flag of Insurance
TAKIP_FLAG_1	Bit	The Flag of Customer who is insolvent
TAKSIT_TUT_1	Float	The Amount of Loan Installment
TP_CALIS_TUT_1	Float	The Total Amount of Work
TP_URUN_ADET_1	Int	The Number of Total Product
TP_VARLIK_1	Float	Total Assets
TP_VDL_TUT_1	Float	Total amount of Term Deposits
VDL_ORT_TUT_1	Float	The Average Amount of Monthly Term Deposit Account
VDL_TL_FLAG_1	Bit	The Flag of Term Deposit Account
VDSZ_ORT_TUT_1	Float	The Average Amount of Monthly Demand Deposit Account
VDSZ_TL_FLAG_1	Bit	The Flag of Demand Deposit Account
ABONE24_TUT_2	Float	The Amount of Direct Debit Account
ALTIN_BKY_TUT_2	Float	The Amount of Gold Account
ALTIN_FLAG_2	Bit	The Flag of Gold Account
BK_FLAG_2	Bit	The Falg of Personal Loan
BK_ORT_TUT_2	Float	The Average Monthly Amount of Personal Loans

Table A1.1: Customer Information (continued)

BORDRO24_MAAS_TUT_2	Float	The Amount of Salary Paid Through Bank
DBT_KART_FLAG_2	Bit	The Flag of Debit Card
DIALOG_ISL_TUT_2	Float	The Amount of Transactions on The Call Center
DTH_FLAG_2	Bit	The Flag of Foreign Exchange Deposit Account
DTH_ORT_TUT_2	Float	The Average Amount of Monthly Foreign Exchange Deposit Account
GCKM_TAKSIT_ADET_2	Int	The Number of Loan Delay
INTRNT_ISL_TUT_2	Float	The Amount of Transactions on The Internet
KK_FLAG_2	Bit	The Flag of Credit Card
KK_LIMIT_2	Float	The Limit of Credit Card
KKB_BNK_LMT_2	Float	The Limit of Customer in All Banks
KKB_BNK_RISK_2	Float	The Total Risk of Customer in All Banks
KKB_KRD_NOT_2	Int	The Credit Score of Customer
KMH_FLAG_2	Bit	The Flag of Credit Deposit Account
KMH_ORT_TUT_2	Float	The Average Amount of Monthly Credit Deposit Account
KUMULE_NET_KAZANC_2	Float	Cumulated Net Profit
MENKUL_ORT_TUT_2	Float	The Average Amount of Monthly Investment Account
MNKL_FLAG_2	Bit	The Flag of Investment Account
OTMTK_TLMT_FLAG_2	Bit	The Flag of Direct Debit
SGK_FLAG_2	Bit	The Flag Customer who is retired
SGK_MAAS_TUT_2	Float	The Amount of Salary Paid Through Bank - Retired Customer
SGRT_KOM_TUT_2	Float	The Amount of Insurance Commission
SIGORTA_FLAG_2	Bit	The Flag of Insurance
TAKIP_FLAG_2	Bit	The Flag of Customer who is insolvent
TAKSIT_TUT_2	Float	The Amount of Loan Installment
TP_CALIS_TUT_2	Float	The Total Amount of Work
TP_URUN_ADET_2	Int	The Number of Total Product
TP_VARLIK_2	Float	Total Assets

Table A1.1: Customer Information (continued)

TP_VDL_TUT_2	Float	Total amount of Term Deposits
VDL_OR_TUT_2	Float	The Average Amount of Monthly Term Deposit Account
VDL_TL_FLAG_2	Bit	The Flag of Term Deposit Account
VDSZ_OR_TUT_2	Float	The Average Amount of Monthly Demand Deposit Account
VDSZ_TL_FLAG_2	Bit	The Flag of Demand Deposit Account
ABONE24_TUT_3	Float	The Amount of Direct Debit Account
ALTIN_BKY_TUT_3	Float	The Amount of Gold Account
ALTIN_FLAG_3	Bit	The Flag of Gold Account
BK_FLAG_3	Bit	The Falg of Personal Loan
BK_OR_TUT_3	Float	The Average Monthly Amount of Personal Loans
BORDRO24_FLAG_3	Bit	The Flag of Customer who take salary through bank
BORDRO24_MAAS_TUT_3	Float	The Amount of Salary Paid Through Bank
DBT_KART_FLAG_3	Bit	The Flag of Debit Card
DIALOG_ISL_TUT_3	Float	The Amount of Transactions on The Call Center
DTH_FLAG_3	Bit	The Flag of Foreign Exchange Deposit Account
DTH_OR_TUT_3	Float	The Avarage Amount of Monthly Foreign Exchange Deposit Account
GCKM_TAKSIT_ADET_3	Int	The Number of Loan Delay
INTRNT_ISL_TUT_3	Float	The Amount of Transactions on The Internet
KK_FLAG_3	Bit	The Flag of Credit Card
KK_LIMIT_3	Float	The Limit of Credit Card
KKB_BNK_LMT_3	Float	The Limit of Customer in All Banks
KKB_BNK_RISK_3	Float	The Total Risk of Customer in All Banks
KKB_KRD_NOT_3	Int	The Credit Score of Customer
KMH_FLAG_3	Bit	The Flag of Credit Deposit Account
KMH_OR_TUT_3	Float	The Average Amount of Monthly Credit Deposit Account
KUMULE_NET_KAZANC_3	Float	Cumulated Net Profit
MENKUL_OR_TUT_3	Float	The Average Amount of Monthly Investment Account

Table A1.1: Customer Information (continued)

MNKL_FLAG_3	Bit	The Flag of Investment Account
OTMTK_TLMT_FLAG_3	Bit	The Flag of Direct Debit
SGK_FLAG_3	Bit	The Flag Customer who is retired
SGK_MAAS_TUT_3	Float	The Amount of Salary Paid Through Bank - Retired Customer
SGRT_KOM_TUT_3	Float	The Amount of Insurance Commission
SIGORTA_FLAG_3	Bit	The Flag of Insurance
TAKIP_FLAG_3	Bit	The Flag of Customer who is insolvent
TAKSIT_TUT_3	Float	The Amount of Loan Installment
TP_CALIS_TUT_3	Float	The Total Amount of Work
TP_URUN_ADET_3	Int	The Number of Total Product
TP_VARLIK_3	Float	Total Assets
TP_VDL_TUT_3	Float	Total amount of Term Deposits
VDL_ORT_TUT_3	Float	The Average Amount of Monthly Term Deposit Account
VDL_TL_FLAG_3	Bit	The Flag of Term Deposit Account
VDSZ_ORT_TUT_3	Float	The Average Amount of Monthly Demand Deposit Account
VDSZ_TL_FLAG_3	Bit	The Flag of Demand Deposit Account
ABONE24_TUT_4	Float	The Amount of Direct Debit Account
ALTIN_BKY_TUT_4	Float	The Amount of Gold Account
ALTIN_FLAG_4	Bit	The Flag of Gold Account
BK_FLAG_4	Bit	The Falg of Personal Loan
BK_ORT_TUT_4	Float	The Average Monthly Amount of Personal Loans
BORDRO24_FLAG_4	Bit	The Flag of Customer who take salary through bank
BORDRO24_MAAS_TUT_4	Float	The Amount of Salary Paid Through Bank
DBT_KART_FLAG_4	Bit	The Flag of Debit Card
DIALOG_ISL_TUT_4	Float	The Amount of Transactions on The Call Center
DTH_FLAG_4	Bit	The Flag of Foreign Exchange Deposit Account
DTH_ORT_TUT_4	Float	The Avarage Amount of Monthly Foreign Exchange Deposit Account

Table A1.1: Customer Information (continued)

GCKM_TAKSIT_ADET_4	Int	The Number of Loan Delay
INTRNT_ISL_TUT_4	Float	The Amount of Transactions on The Internet
KK_FLAG_4	Bit	The Flag of Credit Card
KK_LIMIT_4	Float	The Limit of Credit Card
KKB_BNK_LMT_4	Float	The Limit of Customer in All Banks
KKB_BNK_RISK_4	Float	The Total Risk of Customer in All Banks
KKB_KRD_NOT_4	Int	The Credit Score of Customer
KMH_FLAG_4	Bit	The Flag of Credit Deposit Account
KMH_ORT_TUT_4	Float	The Average Amount of Monthly Credit Deposit Account
KUMULE_NET_KAZANC_4	Float	Cumulated Net Profit
MENKUL_ORT_TUT_4	Float	The Average Amount of Monthly Investment Account
MNKL_FLAG_4	Bit	The Flag of Investment Account
OTMTK_TLMT_FLAG_4	Bit	The Flag of Direct Debit
SGK_FLAG_4	Bit	The Flag Customer who is retired
SGK_MAAS_TUT_4	Float	The Amount of Salary Paid Through Bank - Retired Customer
SGRT_KOM_TUT_4	Float	The Amount of Insurance Commission
SIGORTA_FLAG_4	Bit	The Flag of Insurance
TAKIP_FLAG_4	Bit	The Flag of Customer who is insolvent
TAKSIT_TUT_4	Float	The Amount of Loan Installment
TP_CALIS_TUT_4	Float	The Total Amount of Work
TP_URUN_ADET_4	Int	The Number of Total Product
TP_VARLIK_4	Float	Total Assets
TP_VDL_TUT_4	Float	Total amount of Term Deposits
VDL_ORT_TUT_4	Float	The Average Amount of Monthly Term Deposit Account
VDL_TL_FLAG_4	Bit	The Flag of Term Deposit Account
VDSZ_ORT_TUT_4	Float	The Average Amount of Monthly Demand Deposit Account
VDSZ_TL_FLAG_4	Bit	The Flag of Demand Deposit Account

Table A1.1: Customer Information (continued)

ABONE24_TUT_5	Float	The Amount of Direct Debit Account
ALTIN_BKY_TUT_5	Float	The Amount of Gold Account
ALTIN_FLAG_5	Bit	The Flag of Gold Account
BK_FLAG_5	Bit	The Falg of Personal Loan
BK_OR_TUT_5	Float	The Average Monthly Amount of Personal Loans
BORDRO24_FLAG_5	Bit	The Flag of Customer who take salary through bank
BORDRO24_MAAS_TUT_5	Float	The Amount of Salary Paid Through Bank
DBT_KART_FLAG_5	Bit	The Flag of Debit Card
DIALOG_ISL_TUT_5	Float	The Amount of Transactions on The Call Center
DTH_FLAG_5	Bit	The Flag of Foreign Exchange Deposit Account
DTH_OR_TUT_5	Float	The Avarage Amount of Monthly Foreign Exchange Deposit Account
GCKM_TAKSIT_ADET_5	Int	The Number of Loan Delay
INTRNT_ISL_TUT_5	Float	The Amount of Transactions on The Internet
KK_FLAG_5	Bit	The Flag of Credit Card
KK_LIMIT_5	Float	The Limit of Credit Card
KKB_BNK_LMT_5	Float	The Limit of Customer in All Banks
KKB_BNK_RISK_5	Float	The Total Risk of Customer in All Banks
KKB_KRD_NOT_5	Int	The Credit Score of Customer
KMH_FLAG_5	Bit	The Flag of Credit Deposit Account
KMH_OR_TUT_5	Float	The Average Amount of Monthly Credit Deposit Account
KUMULE_NET_KAZANC_5	Float	Cumulated Net Profit
MENKUL_OR_TUT_5	Float	The Average Amount of Monthly Investment Account
MNKL_FLAG_5	Bit	The Flag of Investment Account
OTMTK_TLMT_FLAG_5	Bit	The Flag of Direct Debit
SGK_FLAG_5	Bit	The Flag Customer who is retired
SGK_MAAS_TUT_5	Float	The Amount of Salary Paid Through Bank - Retired Customer
SGRT_KOM_TUT_5	Float	The Amount of Insurance Commission

Table A1.1: Customer Information (continued)

SIGORTA_FLAG_5	Bit	The Flag of Insurance
TAKIP_FLAG_5	Bit	The Flag of Customer who is insolvent
TAKSIT_TUT_5	Float	The Amount of Loan Installment
TP_CALIS_TUT_5	Float	The Total Amount of Work
TP_URUN_ADET_5	Int	The Number of Total Product
TP_VARLIK_5	Float	Total Assets
TP_VDL_TUT_5	Float	Total amount of Term Deposits
VDL_ORT_TUT_5	Float	The Average Amount of Monthly Term Deposit Account
VDL_TL_FLAG_5	Bit	The Flag of Term Deposit Account
VDSZ_ORT_TUT_5	Float	The Average Amount of Monthly Demand Deposit Account
VDSZ_TL_FLAG_5	Bit	The Flag of Demand Deposit Account

APPENDIX A.2

Table A2.1: The Analysis of Data

Parameters	Min	Max	Mean	Std. Dev
Initial Date	01.01.1900 00:00	27.11.2007 00:00	--	--
Year of The Customer	6	110	52.410	11.312
sicil no	3	110	14.268	6.963
KK_LIMIT_1	0	61286	28.481.536	21.106.714
TP_VARLIK_1	0.000	122.275.600	181.016	826.138
GCKM_TAKSIT_ADET_1	0.000	164.362.892.520	46.966.493	832.864.584
VDSZ_ORT_TUT_1	0.000	140.708.427.490	43.842.704	731.462.102
KMH_ORT_TUT_1	-62.660	352.121.260	542.559	4.485.665
VDL_ORT_TUT_1	0.000	304.224.060	67.369	1.524.553
MENKUL_ORT_TUT_1	0.000	95.752.938.910	32.520.722	525.323.038
BK_ORT_TUT_1	0.000	22.778.185.460	2.760.503	114.338.392
VDSZ_TL_FLAG_1	0.000	765.267.890	3.949.017	16.428.668
DTH_ORT_TUT_1	0.000	0.000	0.000	0.000
BORDRO24_FLAG_1	0.000	36.548.332.550	12.004.939	220.720.214
INTRNT_ISL_TUT_1	0.000	0.000	0.000	0.000
DIALOG_ISL_TUT_1	0.000	11.501.971.220	1.630.442	65.958.035
BORDRO24_MAAS_TUT_1	0.000	119.396.480	63.707	1.494.635
SGK_MAAS_TUT_1	0.000	0.000	0.000	0.000
ABONE24_TUT_1	0.000	0.000	0.000	0.000
TP_URUN_ADET_1	0.000	0.000	0.000	0.000
ALTIN_FLAG_1	0.000	0.000	0.000	0.000
NAR_FLAG_1	0.000	0.000	0.000	0.000
KK_LIMIT_2	0.000	0.000	0.000	0.000

Table A2.1: The Analysis of Data(continued)

TP_VARLIK_2	0.000	226.306.610	183.420	1.191.411
GCKM_TAKSIT_ADET_2	0.000	167.812.870.610	46.431.008	840.663.722
VDSZ_ORT_TUT_2	0.000	143.564.939.870	43.302.733	737.302.454
KMH_ORT_TUT_2	-79.670	342.982.720	556.439	4.638.657
VDL_ORT_TUT_2	0.000	139.642.830	61.422	797.146
MENKUL_ORT_TUT_2	0.000	96.054.268.940	32.008.130	523.446.486
BK_ORT_TUT_2	0.000	23.233.737.130	2.731.675	115.353.243
VDSZ_TL_FLAG_2	0.000	755.396.890	4.059.061	16.632.616
DTH_ORT_TUT_2	-3.640.620	1.095.725.740	842.708	5.946.078
BORDRO24_FLAG_2	0.000	45.700.761.350	12.046.663	252.294.792
INTRNT_ISL_TUT_2	0.000	2.276.070	12.080	43.232
DIALOG_ISL_TUT_2	0.000	11.501.971.220	1.608.403	65.436.017
BORDRO24_MAAS_TUT_2	0.000	119.396.480	62.921	1.482.488
SGK_MAAS_TUT_2	0.000	202.521.320	164.914	1.220.768
ABONE24_TUT_2	0.000	73.170.050	255.122	2.249.653
TP_URUN_ADET_2	0.000	12.404.080	36.336	172.812
ALTIN_FLAG_2	-5.529.170	164.994.893.720	49.424.856	825.809.167
NAR_FLAG_2	0.000	383.087.200	152.698	3.329.021
KK_LIMIT_3	0.000	242.269.490	39.586	1.492.537
TP_VARLIK_3	0.000	36.162.160	184.431	631.126
GCKM_TAKSIT_ADET_3	0.000	169.171.718.540	45.898.736	841.280.360
VDSZ_ORT_TUT_3	0.000	144.144.459.720	42.674.906	735.458.452
KMH_ORT_TUT_3	-101.540	356.603.830	580.657	4.747.499
VDL_ORT_TUT_3	0.000	76.139.650	62.115	580.906
MENKUL_ORT_TUT_3	0.000	98.205.666.340	31.541.611	527.828.286
BK_ORT_TUT_3	0.000	23.338.576.970	2.701.970	114.902.097
VDSZ_TL_FLAG_3	0.000	870.000.000	4.253.693	17.735.482

Table A2.1: The Analysis of Data(continued)

DTH_ORT_TUT_3	0.000	0.000	0.000	0.000
BORDRO24_FLAG_3	0.000	45.814.401.560	11.840.316	250.448.742
INTRNT_ISL_TUT_3	0.000	0.000	0.000	0.000
DIALOG_ISL_TUT_3	0.000	5.030.908.570	1.357.127	40.133.263
BORDRO24_MAAS_TUT_3	0.000	133.748.390	53.039	1.395.914
SGK_MAAS_TUT_3	0.000	0.000	0.000	0.000
ABONE24_TUT_3	0.000	0.000	0.000	0.000
TP_URUN_ADET_3	0.000	0.000	0.000	0.000
ALTIN_FLAG_3	0.000	0.000	0.000	0.000
NAR_FLAG_3	0.000	0.000	0.000	0.000
KK_LIMIT_4	0.000	0.000	0.000	0.000
TP_VARLIK_4	0.000	108.577.890	188.679	818.922
GCKM_TAKSIT_ADET_4	0.000	191.269.655.640	45.317.275	918.091.657
VDSZ_ORT_TUT_4	0.000	166.799.011.990	42.243.808	812.659.249
KMH_ORT_TUT_4	-73.880	384.947.770	618.083	4.966.320
VDL_ORT_TUT_4	0.000	106.107.550	68.070	819.692
MENKUL_ORT_TUT_4	0.000	99.653.522.470	31.309.483	530.119.003
BK_ORT_TUT_4	0.000	22.993.767.620	2.646.183	112.716.679
VDSZ_TL_FLAG_4	0.000	895.796.640	4.442.097	18.681.239
DTH_ORT_TUT_4	-3.640.600	1.243.433.100	961.949	6.621.894
BORDRO24_FLAG_4	0.000	48.672.084.400	11.502.431	258.573.351
INTRNT_ISL_TUT_4	0.000	2.583.330	13.321	47.220
DIALOG_ISL_TUT_4	0.000	12.270.809.700	1.778.479	70.768.815
BORDRO24_MAAS_TUT_4	0.000	472.002.150	65.056	2.554.633
SGK_MAAS_TUT_4	0.000	398.864.760	195.346	2.022.881
ABONE24_TUT_4	0.000	66.883.960	130.603	1.420.830

Table A2.1: The Analysis of Data(continued)

TP_URUN_ADET_4	0.000	12.173.720	43.814	191.502
ALTIN_FLAG_4	-1.499.500	171.322.063.110	48.486.058	838.520.356
NAR_FLAG_4	0.000	420.732.000	231.462	4.571.281
KK_LIMIT_5	0.000	296.447.760	53.274	1.910.089
TP_VARLIK_5	0.000	108.577.890	188.994	796.915
GCKM_TAKSIT_ADET_5	0.000	191.569.794.180	44.314.144	908.813.941
VDSZ_ORT_TUT_5	0.000	167.644.576.830	41.347.289	806.155.750
KMH_ORT_TUT_5	-586.390	410.666.410	605.418	4.798.216
VDL_ORT_TUT_5	0.000	190.563.470	67.850	1.101.719
MENKUL_ORT_TUT_5	0.000	100.521.671.100	30.664.054	519.667.665
BK_ORT_TUT_5	0.000	22.538.401.410	2.559.275	109.403.719
VDSZ_TL_FLAG_5	0.000	891.700.040	4.541.385	18.687.654
DTH_ORT_TUT_5	-564.150	28.804.810	66.039	283.923
BORDRO24_FLAG_5	0.000	66.792.062.000	11.367.794	320.514.383
INTRNT_ISL_TUT_5	0.000	2.583.330	13.741	47.819
DIALOG_ISL_TUT_5	0.000	29.100.622.500	1.968.100	132.453.211
BORDRO24_MAAS_TUT_5	0.000	204.400.100	49.054	1.386.483
SGK_MAAS_TUT_5	0.000	201.355.980	200.278	1.254.543
ABONE24_TUT_5	0.000	77.698.960	200.519	1.291.657
TP_URUN_ADET_5	0.000	9.468.200	44.428	190.282
ALTIN_FLAG_5	-3.277.010	189.854.857.420	47.932.465	898.619.890
NAR_FLAG_5	0.000	412.883.730	226.535	4.443.716

C.V.

Name Surname : İlknur Kalender

Address : Vadi Park Evleri No:7
Büyükc ekmece / İstanbul

Place of Birth, Year of Birth : Şişli, 1986

Foreign Language : English

Primary School : AHMET HAŞİM İLKÖĖRETİM OKULU, 1996

Middle School : ÇAPA ATATÜRK İLKÖĖRETİM OKULU, 1999

Highschool : CİBALİ LİSESİ, 2003

University : BAHÇEŞEHİR ÜNİVERSİTESİ, 2008

Graduate School : BAHÇEŞEHİR ÜNİVERSİTESİ, 2011

Institute : Graduate School of Natural and Applied Sciences

Graduate Program : M.S. Program Computer Engineering