A PROJECT REPORT

ON

"AGENT-BASED MODELING FOR SIMULATION OF TELECOM SERVICES"

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UNDER THE GUIDANCE OF

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Ashish Kumar
Shivam Agrahari
Shivam Shukla

ABSTRACT

An agent-based model (ABM) is a class of computational models for simulating the actions and interactions of autonomous agents (both individual or collective entities such as organizations or groups) with a view to assessing their effects on the system as a whole.Agent-based modeling is related to, but distinct from, the concept of multi-agent systems or multi-agent simulation in that the goal of ABM is to search for explanatory insight into the collective behavior of agents obeying simple rules.It combines elements of game theory, complex systems, emergence, computational sociology, multi-agent systems, and evolutionary programming.Our project aims at developing an agent based model for simulation of telecom services. Also we exploited this model for market and risk analysis.

Github url-

`https://github.com/shivamagrahari/ABM-for-simulation-of-telecom-services`

Contents

List of Figures

Chapter 1

Introduction

Problem Statement of the project:To develop an ”Agent-based model for simulation of telecom services”.

Following applications are also implemented based on the simulation of telecom market :

- Business Analysis
- Risk Analysis

1.1 Motivation

As we know that any environment which involves various agents is going to be very complex. Also, under such scenario analysis of that enviornment becomes a troublesome job if done manually, because these environment carry huge number of possibilities within themselves.

A similar example of such environment is telecom market. Telecom market do have huge number of agents which includes large number of users, telecom service providers and regulator(moderator).

Telecom service providers are the agents who offer telecom services to the users. Users are meant to avail the services offered by the providers. Regulator sits at the top of the hierarchy and governs the overall market by setting up the constraints and forcing every agent to follow them effectively.

Our project aims at simulating telecom market having above mentioned agents as its constituents and thus plotting the reality of market in the computer screen. Also we used this simulation in order to analyze the market(Business analysis) and calculation of risk involved(Risk analysis) for any client(viz telecom service proviers).

Chapter 2

Technologies Used

2.1 Pseudo Random Number Generator (PRNG)

Pseudo Random Number Generator(PRNG) refers to an algorithm that uses mathematical formulas to produce sequences of random numbers. PRNGs generate a sequence of numbers approximating the properties of random numbers.

PRNGs are suitable for applications where many random numbers are required and where it is useful that the same sequence can be replayed easily. Popular examples of such applications are simulation and modeling applications.

Characteristics of PRNG are as follows:

- Efficient: PRNG can produce many numbers in a short time and is advantageous for applications that need many numbers
- Deterministic: A given sequence of numbers can be reproduced at a later date if the starting point in the sequence is known.Determinism is handy if you need to replay the same sequence of numbers again at a later stage.
- Periodic: PRNGs are periodic, which means that the sequence will eventually repeat itself. While periodicity is hardly ever a desirable characteristic, modern PRNGs have a period that is so long that it can be ignored for most practical purposes.

  Java Math random() method :- The java.lang.Math.random() method returns a pseudorandom double type number greater than or equal to 0.0 and less than 1.0. We have tailored Math.random() function according for carring out our task.

2.2 Abstract Window Toolkit (AWT)

Abstract Window Toolkit (AWT) is a set of application program interfaces (API s) used by Java programmers to create graphical user interface (GUI) objects. Package java.awt Contains all of the classes for creating user interfaces and for painting graphics and images.

We have used AWT package for creating pie chart in order to represent the results effectively.

2.3 ArrayList

ArrayList is a part of collection framework and is present in java.util package. It provides us dynamic arrays in Java. Though, it may be slower than standard arrays but can be helpful in programs where lots of manipulation in the array is needed. We have used ArrayList for storage of strategies picked up by providers at a particular instance and washing them off when next instance comes in.

Syntax:- ArrayList arrli = new ArrayList(size);

- ArrayList inherits AbstractList class and implements List interface.
- ArrayList is initialized by a size, however the size can increase if collection grows or shrunk if objects are removed from the collection.
- Java ArrayList allows us to randomly access the list.

2.4 Libraries used

- jcommon-1.0.8.jar

  JCommon is a free general purpose Java class library that is used in several projects at www.jfree.org, including JFreeChart and JFreeReport.

- jfreechart-1.0.1.jar

  JFreeChart is a class library, written in Java, for generating charts. Utilising the Java2D APIs, it currently supports bar charts, pie charts, line charts, XY-plots and time series plots.

2.5 Analytical Hierarchy Process(AHP)

Service provider provide different Qos parameter with different quality-of-service levels. Hence, the QoS parameters are not the same for all service provider.

The comparison of different QoS parameters is a common problem in multiple criteria decision making.There is a well-known method called simple additive weighting (SAW) to perform comparison of quality attributes of quality parameter.We use it in order to boil down the parameters to single value. We use the SAW method to perform QoS normalization.

The AHP is commonly applied in provider selection. Generally, it is very difficult for any user to compare provider unless the criteria for service provider selection are defined, and the AHP defines clear criteria and helps to arrive at a consensus decision. In our work, scores are assigned to QoS parameters using the AHP, based on user criteria.

Chapter 3

Architecture

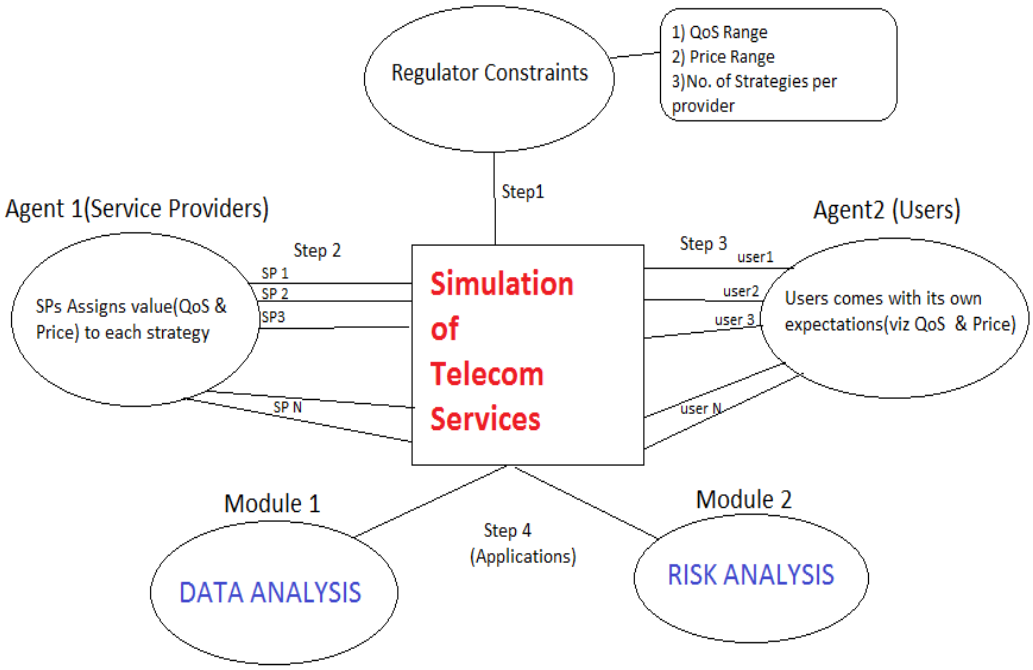


Figure 3.1: Flow Diagram

Chapter 4

Implementation

4.1 Process Flow

1. First of all, we have classified users in 3 categories
   a. Price conscious (20%)
   b. QoS conscious (20%)
   c. Average price and QoS conscious (60%)
2. Allocating a provider for a user which is very close to his expectations.
   Flow is as follows:-
   a. User will enter his expectation

Figure 4.1: User's expectation

b. Now we will create area of inspection

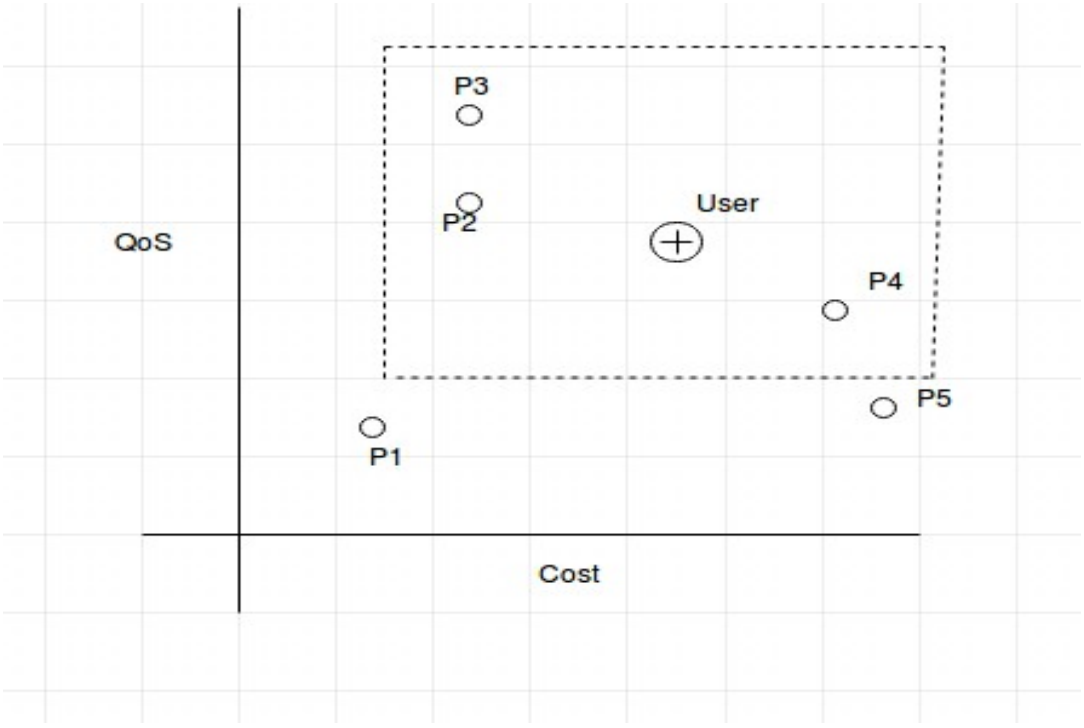


Figure 4.2: Area of inspection

c. Check for the presence of suitable provider in region 1, region 2 , region 3 and region4 (ORDER MATTERS). Also, if provider is found in one region, we will not check for remaining regions for obvious reasons.

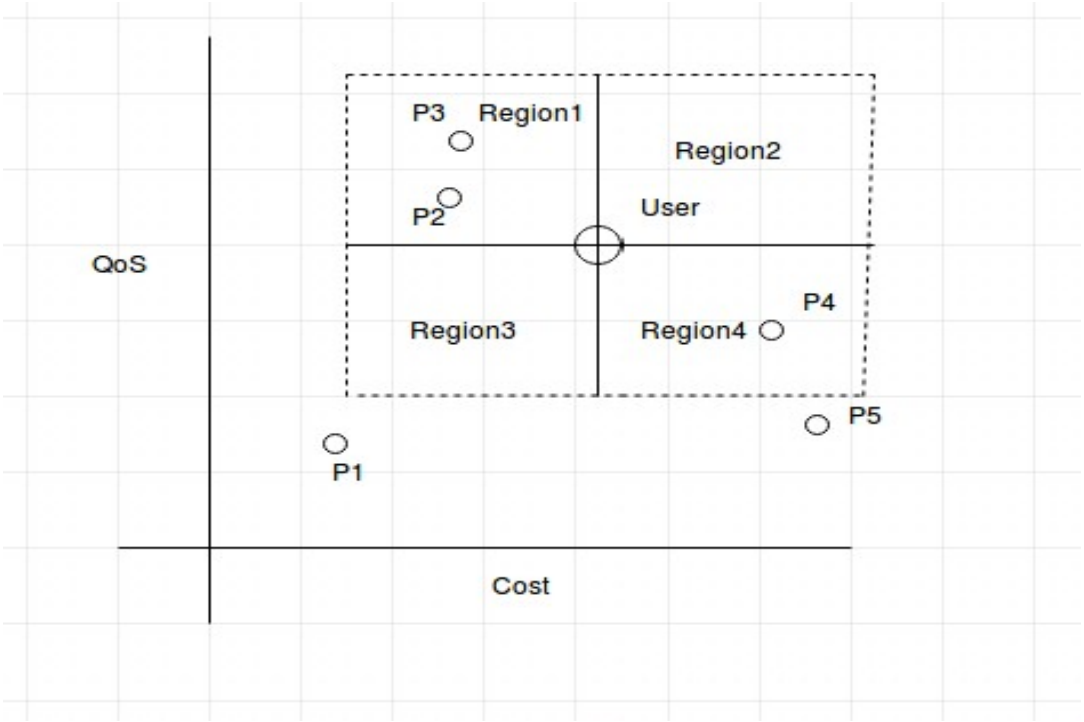


Figure 4.3: Finding the apt provider

d. Allocate user to a provider

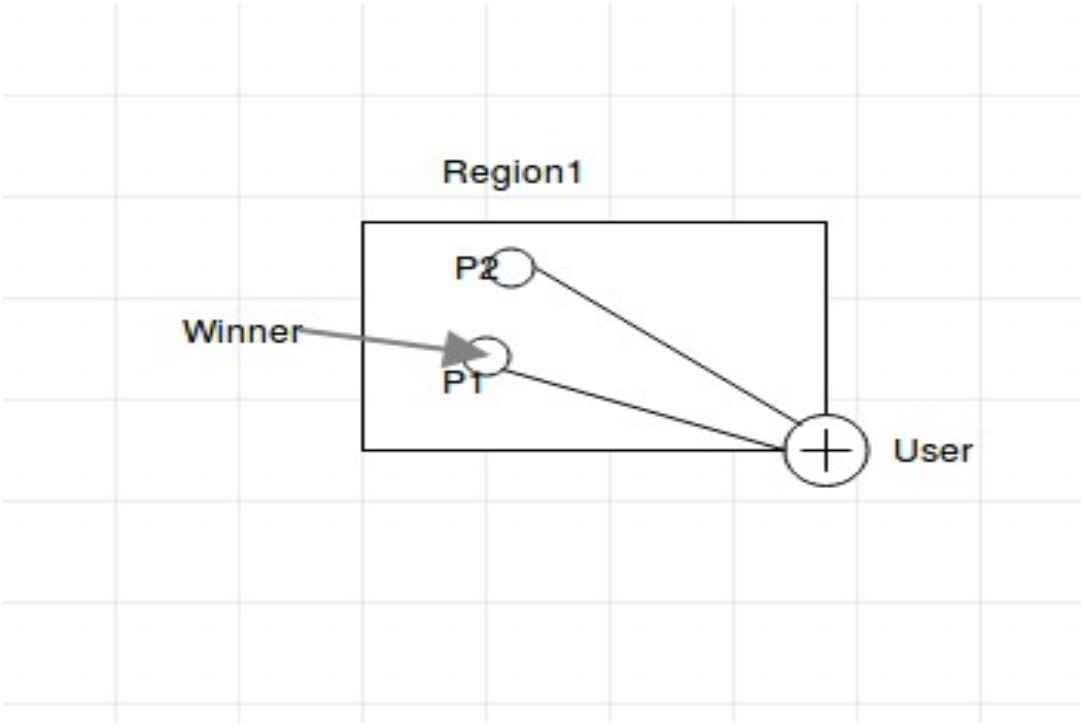


Figure 4.4: Winner(who grabs the user)

4.2 DSIC Algorithm

we used DSIC (Dominant Strategy Incentive Compatible) algorithm in order to know which provider is best suited for a particular customer.

a. User will select that provider for which (cost/QoS) as expected by user is as close as possible to the (cost/QoS) provided by telecom service provider.

b. Service provider who grabs the user will get the corresponding payoff which is equal to the cost of the plan purchased by the user.

Chapter 5

System Testing

This project is used for simulation for telecom market. We simulated the telecom market(1000 iterations) and checked whether it follows Game theory principle or not.

5.1 Market Analysis and illustration of game theory

Test ID	Price Constraint	QoS constraint	Nash Equillibrium percent	Highly polarised market percet	Moderately polarised market percent
T01	[150,170]	[10,20]	4.600694	73.3073	22.092014
T02	[160,190]	[20,30]	1.6927084	88.15105	10.15625
T03	[120,150]	[10,30]	0.34722224	97.35243	2.300347

Clearly,above results are in accordance to game theory which says that market remains stable(nash equillibrium) for a small amount of time.Other than that it remains polarized due to the presence of intelligent rational agents.

5.2 Test Cases for Risk calculations

Test ID	Price Constraint	QoS constraint	Client's parameters(Price,QoS)	Prone to Risk percentage	Safe percentage
T01	[150,170]	[10,20]	[168,13]	80.37	19.63
T02	[160,190]	[20,30]	[165,27]	12.67	87.33

These results do follow our intuition i.e. if a client provides less QoS at a very high cost(test case T01), he is prone to risk and is in danger of being washed off from the market. However, if he provides good QoS at a cheaper price(test case T02), he follows a good hold in the market and hence safe percentage is on the higher side.

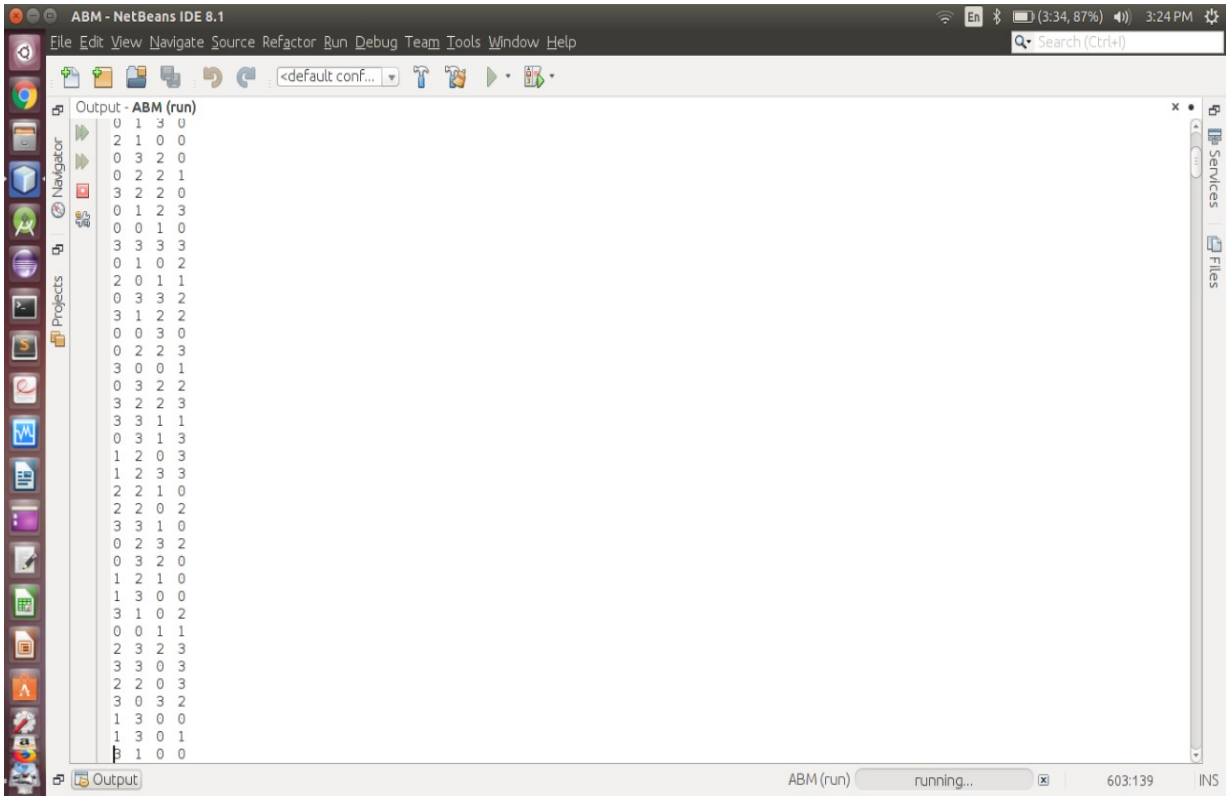
Note: Testing should be performed manually

Chapter 6

Screenshots of Project

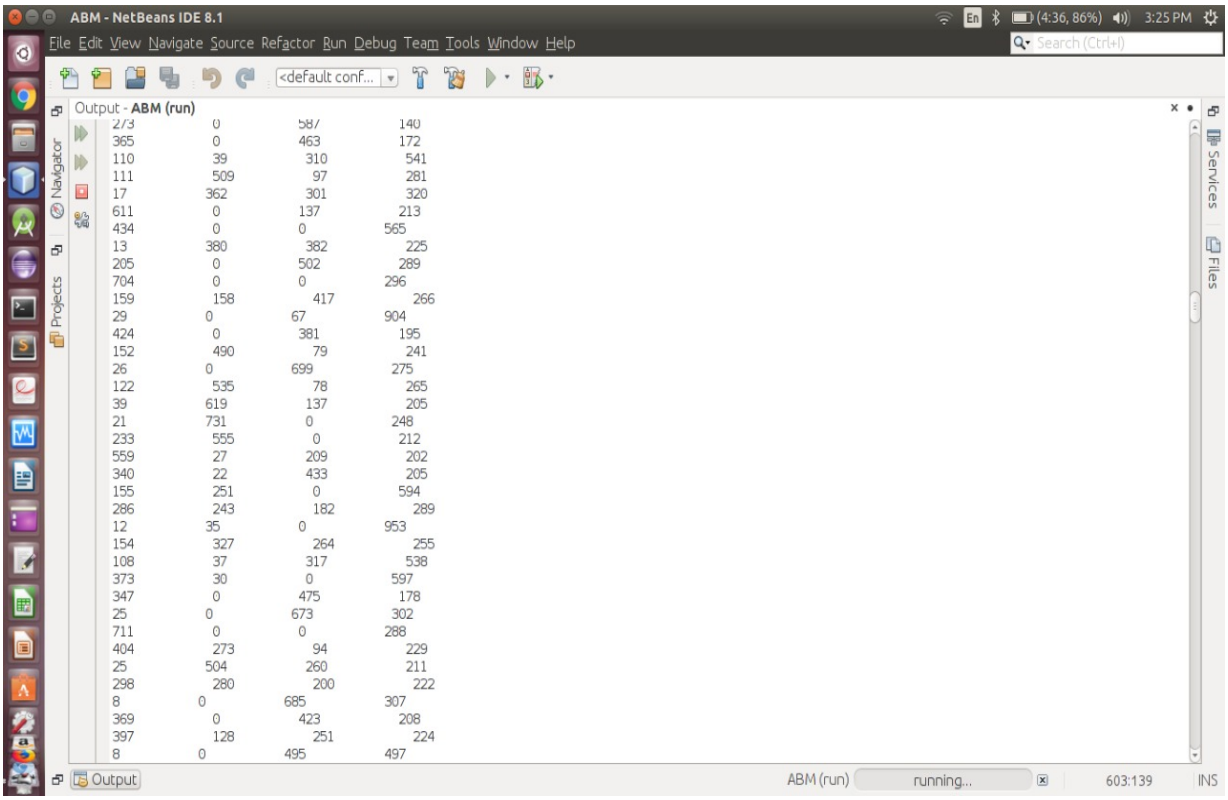
6.1 Picked Strategy

This picture depicts the set of strategies picked up by the providers at a particular instance while iterating thousand times.



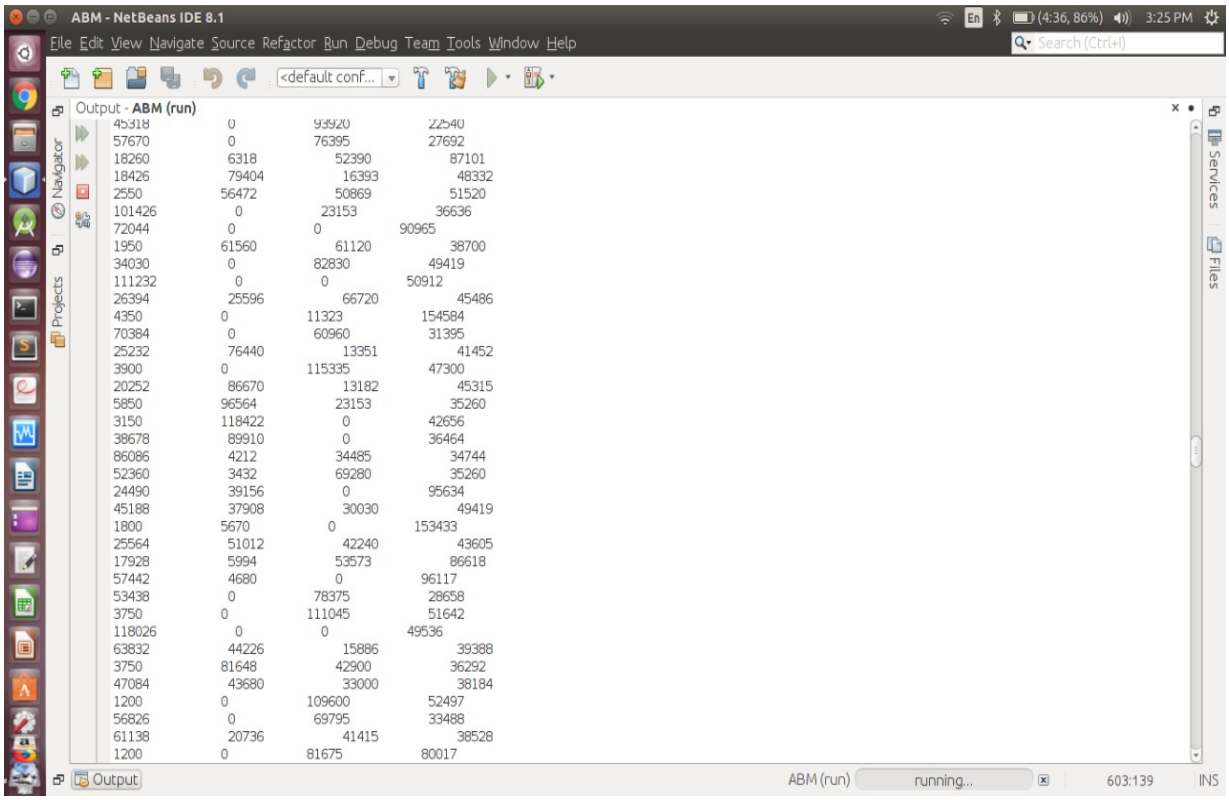
6.2 User Distribution

This picture depicts the distribution of users as per the DSIC(Dominant Strategy Incentive Compatibility mechanism) algorihtm.



6.3 Service Providers Payoff

Following picture depicts the payoff allocated to every service provider. Payoff of a provider is given by the number of users it grabbed multiplied by the cost of plan purchased by the user.



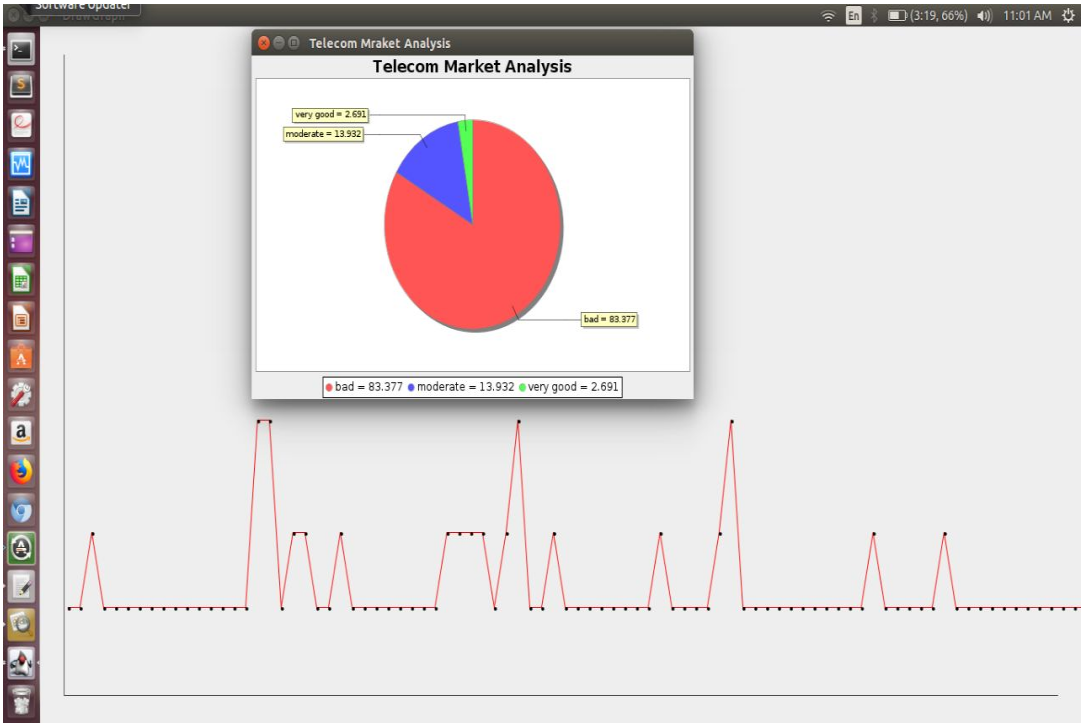
Chapter 7

Application

7.1 Telecom Market Analysis

Here we divided results(i.e. no. of users for every service providers) of market into three types as follows :

- Good :- Nash equilibrium represents the good market that is every provider has equal or very close to equal hold in the market.
- Moderate:- this refers to a condition between Good and Bad market.
- Bad :- This refers to a condition where any one of the providers is in the verge of getting wiped out of the market since he has almost negligible hold in the market.

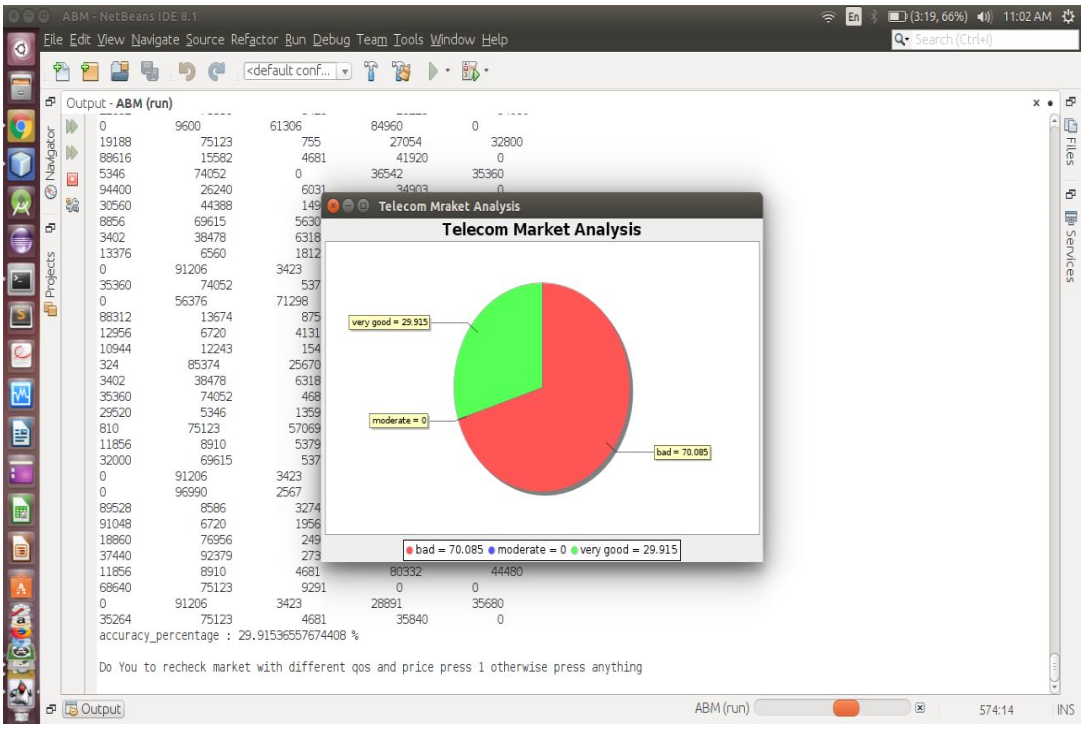


7.2 Risk Analysis

Suppose new entrant wants to make entry to telecom market. We can suggest him whether he is prone to risk of being washed off from the market or not. We can tell the risk in terms of percentage.

Flow is given below:-

- Client mentions its cost and QoS he is going to have.
- We will simulate the market using our model with (n+1) providers and m users.
- for every user being allocated to client , we will increment the count of users being allocated to client.
- At the end, we will calculate how many times our client has grabbed sufficient number of users and represent it in the percentage form.



Chapter 8

Challenges and Future Scope

8.1 Future Scope

- While classifying users according to their interests(viz QoS conscious,price conscious or relevance conscious) we have not taken the region(where market exists) into account, instead we hard coded them. So this model is valid for one country where such distribution exists but fails in some other country. We will address this issue in future.
- Right now this model is based on ”one plan and multiple strategies”. We will address this issue by extending to ”multiple planed and multiple strategies”.

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