SIMULATING AGENT EMOTION IN A VIRTUAL SUPER MARKET

Utility Function Based Approach

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Abstract: This paper reports a method of simulate an Agent emotion in a Virtual Super Market environment. Utility Function is the key to depict people's emotion especially in the satisfaction feelings. This method finished the process from the emotion to the decision. Agent will act emotionally according to the Utility.

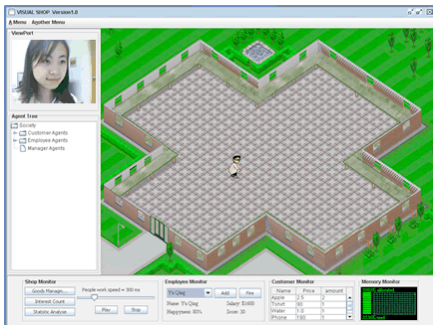
Key words: Virtual Super Market, Utility Function, Lagrange Interpolating Polynomial

1. INTRODUCTION

Our project is a multi-agent system – agent based virtual super market, what we try our best to do is to make all the agents act as the real person who cares about the financial situation and also we aim to simulate a smart manager agent. The manager's decision is based on the huge and exact history data. On some level, agent's emotion is a crucial factor affected his behavior. Although we simplified the emotion calculating, you can see that it does its work very well.

2. THE VIRTUAL SUPER MARKET

The Virtual Super Market[10][12] gives birth to three different kinds of Agents[9][11], customer agents, employee agents and manager agents. In this project, we use the utility function and the interpolation formula to simulate the Employee Agents' Emotion in the salary satisfaction feelings.



3. SIMULATING EMPLOYEE'S EMOTION

The employee concerns himself with the pay level. Firstly, we will talk about his salary utility function. Then we will talk about the behavior affected by the utility function. Generally speaking, we follow two steps to get the emotion simulating.

3.1 Step one: salary utility function.

According to Daniel Bernoulli's solution of St. Petersburg Paradox[6][7]: (i) that people's utility from wealth, u (w), is not linearly related to wealth (w) but rather increases at a decreasing rate - the famous idea of diminishing marginal utility, $u'(y)>0$ and $u''(y)<0$; (ii) that a person's valuation of a risky venture is not the expected return of that venture, but rather the expected utility from that venture. This is shown as Figure 1.

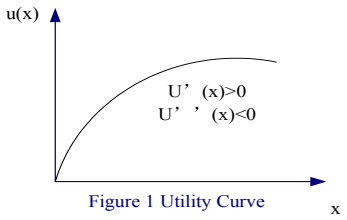


Figure 1 Utility Curve

We can see that the employs satisfaction feeling function can be defined according to the following consideration:

1) We shall talk about the values between [a, b].

2) How can we get the Utility Function? Firstly, we know that the curve can be approach a parabola[1]. Secondly, we will ask the employee many questions like:

- How about $c a month? c∈[a, b]
- How much money could satisfy you? Maybe the answer is d, d∈[a, b]

The answer should be formed into percent format. Then we get a set of numbers:

X	a	c	d	b
Y	U(a)	U(c)	U(d)	U(b)

Then we use the Lagrange Interpolating Polynomial [1][2][13]. The Lagrange interpolating polynomial is the polynomial $P(x)$ of degree $n-1$ that passes through the n points $(x_1, y_1 = f(x_1))$, $(x_2, y_2 = f(x_2))$, ..., $(x_n, y_n = f(x_n))$, and is given by

$$P(x) = \sum_{j=1}^{n} P_j(x) \quad \text{where} \quad P_j(x) = y_j \prod_{\substack{k=1 \\ k \neq j}}^{n} \frac{x - x_k}{x_j - x_k}$$

Given a triplet (a, c, d) and the respective functional values (U (a), U(c), U(d)), If currently the employee’s pay is $e a month, then we can figure out the utility value by calculating:

$$u(e) = \frac{(e-c)(e-d)}{(a-c)(a-d)} \times u(a) + \frac{(e-c)(e-d)}{(c-a)(c-d)} \times u(c) + \frac{(e-c)(e-d)}{(d-a)(d-c)} \times u(d)$$

Finally, we can get the employee happiness degree u(e).

3.2 Step two: Behaviors affected by the emotion.

So, what will happen if the salary does not satisfy the employee? Asking for giving a raise or not, what is his choice?[8]

We firstly turn to the concept of "risk aversion"[3][4][5] which, intuitively, implies that when facing choices with comparable returns, agents tend to choose the less-risky alternative, a construction we owe largely to Milton Friedman and Leonard J. Savage (1948).

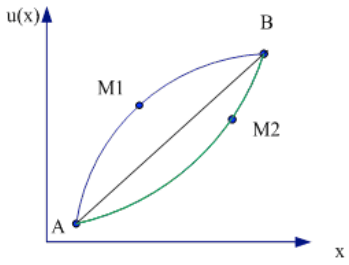


Figure 3 New Utility Function

Point M1 shows the agent is Risk-Averse, on the contrary, point M2 is Risk-Loving, and this agent loves risk. In this case, he will ask for raises. If M2 is chosen, he will not ask for it.

In this project the happiness degree can be calculated by the Lagrange Interpolating Polynomial mentioned above. The angry degree is caused by comparing with other's salary degree. In this project, the angry degree is simplified by the following formula:

Given the angry degree, $f(x_0, x_1, ...x_n)$, x_i represent the employee's salary, x_0 represents his own salary.

$$f(x_0, x_1, ...x_n) = \frac{\sum_{i=1}^{n}(x_i - x_0)}{(n-1)x_0}$$

If $f(x_0, x_1, ...x_n)$>0.4 this employee will reset his salary utility. Then according to his risk attitude, he will ask for raises or not.

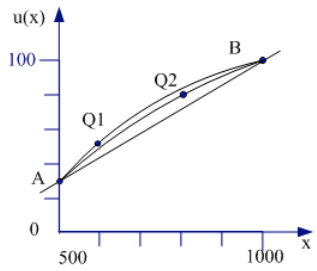
Suppose that we have three real people playing the employee. We can see their faces through the camera shown in the up-left corner to recognize who he is. They should answer two questions:

a) How about \$600 a month? $600 \in [500, 1000.]$

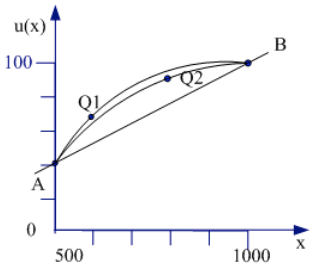
b) How about \$800 a month?

The answer is shown below:

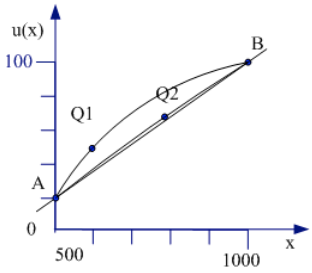
questions	Employee A	Employee B	Employee C
(i) $600	0.55	0.7	0.5
(ii) $800	0.8	0.9	0.7



Employ A's utility



Employ B's utility



Employee C's utility

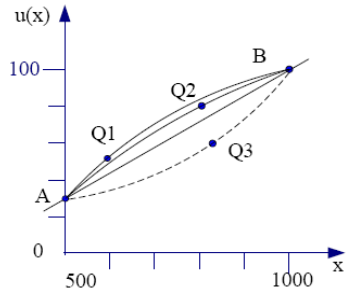


Figure 4 New State

Currently the salary set is (510, 850, 600), f_A (510,850,600)=0.435. His angry degree is 0.435 > 0.4, He will think about his new salary amount he wants, suppose that it is 825, the satisfaction degree is 60%. Let's look at his utility curve:

Now his new state is Q3, He has changed into a risk loving people, so he will ask the manager to give him a raise.

4. FUTURE WORK

Here we build up the employee's emotion model, and there are other factors affecting the emotion like the workload, the existing emotion model is too simple to depict a real people. And the customer's emotion model is another import part in this project. This is what we will try to do in our future work.

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