Suggestion and Evaluation of a Model which Express Career Behavior and Social Network using Multi-Agent Simulation

Masato Ikami
Graduate School of Information Science and Technology, Aichi Prefectural University
Aichi, Japan
im171001@cis.aichi-pu.ac.jp

Yoichi Utsunomiya
Graduate School of Information Science and Technology, Aichi Prefectural University
Aichi, Japan
id141001@cis.aichi-pu.ac.jp

Takashi Okuda
Department of Information Science and Technology, Aichi Prefectural University
Aichi, Japan
okuda@ist.aichi-pu.ac.jp

ABSTRACT

The main concern of our research is the individuals on the near future. To simulate career behavior on the near future, we have tried to make and evaluate a model that express career behavior. However, in that model has not considered relationships between individuals. Thus, the model is need to be modified. The purpose of this paper is to suggest a modified model and to evaluate it.

KEYWORDS

Career Behavior, Social Network, Multi-Agent Simulation

ACM Reference Format:
Masato Ikami, Yoichi Utsunomiya, and Takashi Okuda. 2017. Suggestion and Evaluation of a Model which Express Career Behavior and Social Network using Multi-Agent Simulation. In *Proceedings of 5th International Conference on Human-Agent Interaction, Next Generation Human-Agent Interaction Workshop, CITEC, Bielefeld, Germany, October 2017 (NGHAI'2017),* 4 pages.

1 INTRODUCTION

Recently, the industrial structure has changed because of the evolution of Information and Communication Technology (ICT), Artificial Intelligence (AI) and robots[1]. Frey and Osborne pointed out that individuals need to enhance their **social skills** in order to adapt for a new industrial structure[2]. In this paper, we define the term **social skills** to include not only skills of communicate with someone but also attitude of individuals such as curiosity or persistence, flexibility.

The aim of our study is to be a motivation to enhance social skills for individuals. We have tried to make and evaluate a model that express career behavior of individuals[3]. However, in that model has not considered relationships between individuals. Thus, the model is need to be modified. The purpose of this paper is to suggest a modified model and to evaluate it.

In this paper, we first see some related works. We then explain the modified simulation model in detail. Next we discuss numerical examples result from simulate the modified model. Finally, we conclude by evaluation of the model and listing up future work.

2 RELATED WORKS

It is important to be success in career for individuals because of the career is great majority in individuals life. As far as researches on career success was concerned, there are roughly two approaches. The first approach is an approach from objective career such as wealth, position, honor which can be object compare with others[4]. The second approach is an approach from subjective career that means not point of view as evaluating target but who will be evaluating[5]. Recently, personal preferences have diversified. Thus it should be emphasized that in respect of decision making of career, individual decisions are more important than organization one. Therefore research has been very active in approach from subjective career such as job satisfaction, adaptability and learning motivation[6][7]. Nakashima's studies are good examples. He created an estimation model using data from original survey and evaluated consciousness of career, job satisfaction and stability orientation by regression analysis[8][9][10].

Let us now turn to topic of changing the industrial structure. It is widely known that the development of ICT and AI greatly changes the industrial structure. Frey and Osborne analyzed in detail that how much 702 jobs will be automated in the future based on data from the US department of labor. As a result, it was concluded that about 47% of the total US employments will be automated in a decade to two decades[2]. We need frequently to remind ourselves of this study.

Therefore in this research, we try to approach from a subjective career considering the predict that the future industrial structure will change. Specifically, we express the industrial structure with changes and the behavior of individuals career using an agent-based model. We then aim to present useful data for individuals by evaluating our simulation model.

3 THE MODIFIED MODEL

Let us start with a review of the modified model. Figure 1 depicts overview of the model. The model consists of a *Job Space JS*, *Job Agents* $JA(x, y)(1 \leq x \leq X, 1 \leq y \leq Y)$ and *Individual Agents* $IA_i(1 \leq i \leq N)$. See later for each of details.

3.1 Job Space *JS*

We use the term **Job Space** *JS* to refer to an industrial structure. **Job Space** is expressed in the two-dimensional plane of the category of industries $x(x = 1, 2, ..., X)$ and the type of occupations $y(y = 1, 2, ..., Y)$. Note a job is represented by (x, y).

Next we consider demand of jobs. Let $\omega_{xy}(t)$ be the amount of the job (x, y) demand at time t. There are two types of changing $\omega_{xy}(t)$. Table 1 lists the main features of the two types of changing $\omega_{xy}(t)$.

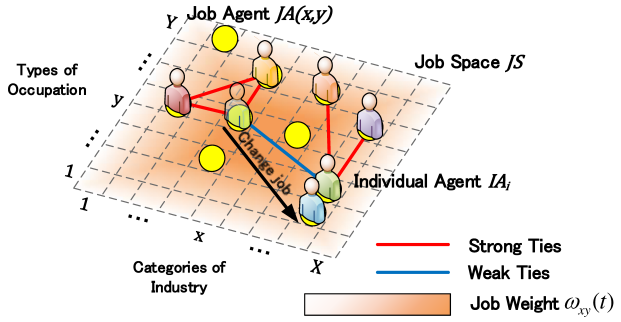

Figure 1: Overview of the Modified Model

Table 1: The Main Features Each of Types

Name		Interval	Change Value	Target Jobs
Local Change		18 months	small amount	specific
Whole Change	Pattern 1	15 years(one time)	$\omega_{xy}(t)/2$	all
	Pattern 2	15 years and 30 years(two times)	$\omega_{xy}(t)/4$	
	Pattern 3	30 years(one time)	$\omega_{xy}(t)/5$	

The first can be called **Local Change (LC)**. Simply stated, LC is a change that demands of some specific jobs has increase or decrease due to widespread of using ICT or social phenomena. Increase of demand in care worker because of aging population provides an example. We supposed that LC occurs every 18 months according to Moore's law[11].

The second can be called **Whole Change (WC)**. WC is a large-scale change due to the appearance of general purpose AI. WC can be divided into three patterns according to the document [2][12]. The first pattern is the lowest change of demands in three patterns. Frey and Osborne showed that workers in the US will be about half of the current in a decade to two decades[2]. Thus the first pattern has all of demands be half of the current in 15 years. Added to this, another change of demand will occur in the second pattern. Take a company "Good AI" at Czech for example. "Good AI" aim to 2030 years be the realize possible year of general purpose AI. When we suppose that general purpose AI will emerge at 2030, general purpose AI will be pretty popular in society in 2045[12]. Therefore, in the second pattern, in addition to halving all of demands in 15 years, the demands will halve further in 15 years. As a result, the second pattern have all of demands be quarter of the current demands. The third pattern is the highest change of demands in three patterns. Inoue predicted that only 10% of the population in Japan will be able to work sufficiently in thirty years[12]. Thus the third pattern have all of demands be a fifth of the current in thirty years because of the number of workers in Japan in 2015 is about half that of the population[13].

In this subsection, we have discussed jobs on industrial structure with demands and that change. With these points in mind, let us look at **Job Agents**.

3.2 Job Agents $JA(x, y)$

A job agent $JA(x, y)$ represent a job (x, y). Difference of job agents and jobs is the number of them and some attributes. Firstly, a job agent $JA(x, y)$ is born at a job (x, y) position. However, note if the demand of a job $\omega_{xy}(t)$ is zero, job agents will not born at the position. Similarly, when $\omega_{xy}(t)$ be zero caused by LC or WC a job agent at the position (x, y) disappear.

Second, each of job agents has their information such as salary, reward, and environment. Now let $I_{xy}(t)$ be the level of their information at time t. Also, we consider each of job agents has to decide whether to employ an individual agent. Thus let $\theta_{xy}(t)$ be the threshold for determining whether to employ an individual agent at time t.

To sum up, always holds that the number of job agents is fewer than jobs and the lifetime of job agents are decided by the demand of these job agent position. Job agents has their information $I_{xy}(t)$ and threshold $\theta_{xy}(t)$ as attributes. Individuals sometimes try to have work at a job agent and sometimes tries to change it. In order to discuss these behavior, we need to turn to next subsection **Individual Agents**.

3.3 Individual Agents IA_i

An individual agent represents a person. Firstly we explain some attributes of individual agents in section 3.3.1, then we discuss the having job and changing it behavior of individual agents in section 3.3.2.

3.3.1 Attributes of Individual Agents. Each of individual agents has the following six attributes:

- $\rho_{ij}(t) = \begin{cases} 0 \\ 1 \\ 2 \end{cases}$: relationship with $IA_j (j \neq i)$ at time t
- $S_i(t)$: specific or general skills required in job agents at time t
- Sc_i: scope of job agents to list up when changing job agents
- $H_{(x,y)i}$: hope of working job agent (x, y) information $I_{xy}(t)$ such as salary, reward and communication
- $R_{(x,y)i}(t)$: real information of working job agent (x, y) at time t such as salary, reward and communication
- $sty_i(t)$: satisfaction of working at time t

In this paper, we use the theory what Granovetter calls *The Strength of Weak Ties*[14] to express the relationships between individuals. Specifically, when $\rho_{ij}(t)$ is zero, IA_j is a perfect stranger to IA_i. If $\rho_{ij}(t)$ is one, IA_j is a relationship of *Weak Ties* who meet several times a year to IA_i. Similarly, if $\rho_{ij}(t)$ is two, IA_j is a relationship of *Strong Ties* such as family or close friends to IA_i.

$S_i(t)$ is defined as specific or generic skills. As some examples of specific skills is programming and English skills, Japanese skills. On the other hand as some examples of generic skills is flexibility and persistence. In simulation we suppose both of specific and generic skills have three types of skills, and each of skills have zero to 100 as a parameter.

We should notice that individuals think conditions of jobs such as salary and reward, corporate culture. To express in the simulation model, $H_{(x,y)i}$ and $R_{(x,y)i}(t)$, $I_{xy}(t)$ these are attributes of jobs condition has three types of conditions: salary, reward and communication. In simulation, we express each of conditions level 1 to 10 in integer.

3.3.2 Behavior of Individual Agents. Let the state of IA_i at time $t = 0$ be the initial state. In the initial state, IA_i randomly selects

a job agent $JA(x, y)$ which satisfies $H_{(x,y)i} \leq I_{xy}(0)$. If IA_i has the skills $S_i(0)$ that exceeds the employing threshold $\theta_{xy}(0)$ for the selected job agent $JA(x, y)$, IA_i can work. Now we suppose $\theta_{xy}(0) = S_i(0) = 0$. Therefore all IA_i should be able to work without selecting a job agent again.

In this paper, we suppose the time changes from t to $t + 1$ when one month has passed. IA_i raises their skills $S_i(t)$ and updates their real information $R_{(x,y)i}(t)$ on the job in a month through.

IA_i decides satisfaction $sty_i(t)$ of the job agent $JA(x, y)$ in a month. We get $sty_i(t)$ by adding result of compared $H_{(x,y)i}$ with $R_{(x,y)i}(t)$ and result of compared $R_{(x,y)i}(t)$ with other agents $IA_j (1 \leq j \leq N, j \neq i)$ real information $R_{(x,y)j}(t)$. Hence, satisfaction $sty_i(t)$ of IA_i at time t is

$$sty_i(t) = (1 - \alpha_i)(H_{(x,y)i} - R_{(x,y)i}(t)) + \alpha_i \left(R_{(x,y)i}(t) - \frac{1}{M} \sum_{j=1}^{N} R_{(x,y)j}(t) \right). \quad (1)$$

Note the following two points. Firstly, we regard to the number of agents who are in *Strong Ties* with IA_i by M, and real information on individual agents $R_{(x,y)j}(t)$ which are not *Strong Ties* are regarded as zero. Secondly, α_i is a constant represent susceptibility of IA_i to *Strong Ties* agents job. As α_i is larger, the satisfaction $sty_i(t)$ of IA_i is strongly influenced by agents with *Strong Ties*, the smaller, is strongly influenced by the job agent $JA(x, y)$ which IA_i works.

IA_i decides whether change or not jobs using $sty_i(t)$. If IA_i decided to don't change job, IA_i continues working at the job. On the other hand, if IA_i decided to change job, IA_i needs to select a new job. Also, when the job agent disappears due to $\omega_{xy}(t)$ be zero, IA_i needs to select a new job. Because of this, choices of new job for IA_i depends on scope Sc_i, *Strong Ties* and *Weak Ties*. Specifically, when Sc_i is close to 0, IA_i considers choices of new job only a set of agents which is *Strong Ties*. Otherwise, IA_i considers not only a set of *Strong Ties* but also a set of *Weak Ties*.

When IA_i changes jobs, there may be a change in the $\rho_{ij}(t)$, and the change depends on the Euclidean distance of the *Job Space JS* between IA_i and IA_j.

Behavior of individual agents can be summarized in the following way:

(1) Individual agents look for work
(2) Individual agents enhance skills of them and knows real conditions of jobs
(3) Individual agents get satisfaction from real conditions and *Strong Ties* friends
(4) decision making of whether change job or not

4 NUMERICAL EXAMPLES

In this section, we see some numerical examples using the modified model. Let the simulation period be 40 years(480 months), which is considered to be the general working years of individuals in Japan. Then calculate the individuals satisfaction after 40 years. Perform this simulation 30 times to find the average of the satisfaction for various attributes. Table 2 shows the conditions of the simulation.

In this paper, we show four results with some attributes. First, we show a result dividing individuals by levels of salary desire in section 4.1. Then, we show results by levels of reward and communication desire in section 4.2, section 4.3. Finally we discuss a result dividing individuals by count of change jobs in section 4.4.

Table 2: Conditions of the Simulation

Condition Name	Value
Number of Jobs $X \times Y$	20×20
Demand $\omega_{xy}(t)$	$0 \leq \omega_{xy}(t) \leq 2.0$
Number of individuals N	100
Period of Simulation	480 steps

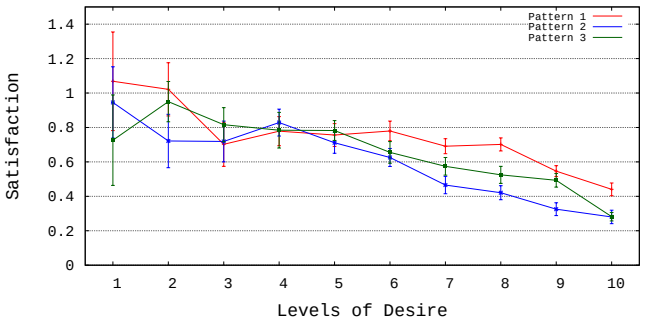

Figure 2: Satisfaction Compared with Levels of Salary Desire

4.1 The Result of Compared with Levels of Salary Desire

Figure 2 shows that the results of individual satisfaction compared with levels of salary desire. The difference of line colors denote which WC pattern are used. There is a variation shown by $P95\%$ in each of lines. We should not overlook the variation is great when the levels of salary desire are low.

We can see in this figure that the lines become gentle decrease from salary level is 1. Compare the red line, the blue line and the green line in Figure 2. In this figure, we notice that WC pattern 2 is the strictest change pattern in spite of pattern 3 is the highest decrease demand change pattern. We need to clear why pattern 2 is stricter than pattern 3. Figure 2 implies that individuals should change to low levels of salary desire to get high satisfaction.

4.2 The Result of Compared with Levels of Reward Desire

The results of individual satisfaction compared with levels of reward desire is shown in Figure 3. Similarly, we can see in the figure that the lines become more gentle decrease without pattern 2 from levels of reward is 1. However, it is interesting to note that highest satisfaction is middle of levels in pattern 2. We consider that Figure 3 suggests individuals should have moderate levels of reward desire.

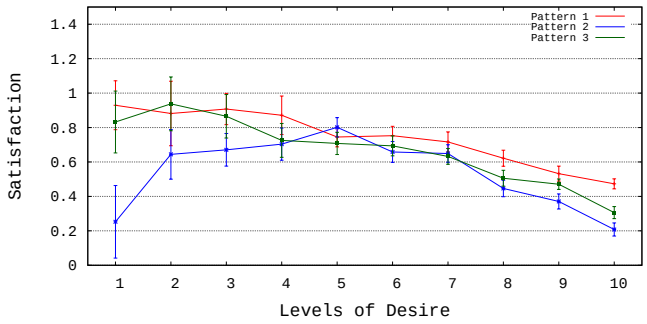

Figure 3: Satisfaction Compared with Reward Desire Levels

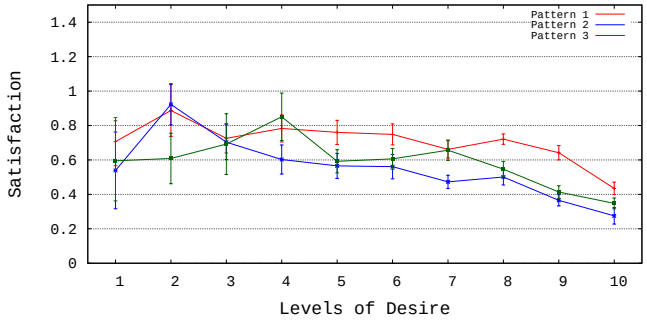

Figure 4: Satisfaction Compared with Levels of Communication Desire

4.3 The Result of Compared with Levels of Communication Desire

Figure 4 shows that the results of individual satisfaction compared with levels of communication desire. Compare this figure with Figure 2 and Figure 3 below. We notice that Figure 4 is the gentlest figure between levels of desire in these figures. Thus we can suppose that levels of communication desire are not effective to individual satisfaction compared with other job conditions.

In above of section 4, we saw some results with levels of job conditions desire. Totally, it is clear that individuals should not have high levels of job conditions desire to get high satisfaction, but we must not forget that this suggestion occurs from our calculating algorithm of individual satisfaction. In next subsection we discuss a result of differences of count of change jobs.

4.4 The Result of Compared with Count of Change Jobs

The result of individual satisfaction compared with count of change jobs is shown in Figure 5. The difference of bar graph colors indicate how many times did individuals change jobs.

From the standpoint of a difference of WC patterns, there are histograms similar to others. On the other hand, from the standpoint of difference of count of change jobs in one pattern, there are two points that we should state. First, we can see that the satisfaction of individuals who experienced four or more times of change

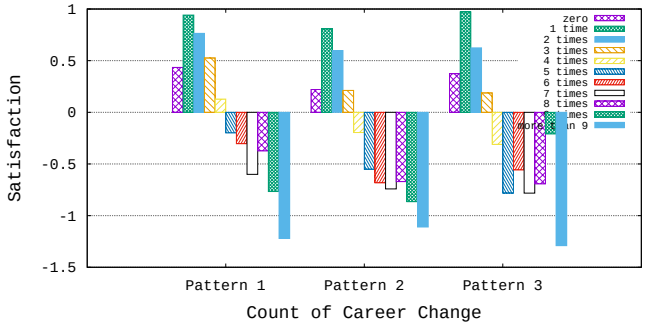

Figure 5: Satisfaction for Differences of Count of Jobs

jobs are negative. This point shows the same result as the satisfaction survey of the Ministry of Internal Affairs and Communications (MIC) statistics bureau conducted in 2006[15]. Second, it can be seen that satisfaction of a person who experienced one or two times of change jobs is greater than of a person who have never experienced. This may account for the what behavior of individuals should be in near future.

5 CONCLUSIONS

In summary, we added relationships between individuals to the model[3] which expresses individuals career behavior. We then have performed some simulations under changing WC patterns. As the result, we conclude that the modified model is suitable when compared with the document [15] and we suggest changing jobs moderate. However, there is room for further investigation. As a future work, we need to conduct a questionnaire survey for students and confirm the effectiveness of this study. In respect of the simulation model, we should reconsider algorithm of individual satisfaction and it is sounds interesting that to add some new agents such as robots or AI agents to the industrial structure.

REFERENCES

[1] Ministry of Internal Affairs and Communications (MIC). 2016. *Present State and Future of Artificial Intelligence (AI).* (in Japanese)
[2] Carl B. Frey and Michael A. Osborne. 2013. *The Future of Employment: How Susceptible Are Jobs to Computerisation?.*
[3] M. Ikami, Y. Utsunomiya, T. Okuda. 2017. *A Study of Career Development based on Multi-Agent Simulation in Paradigm Shift.* (in Japanese)
[4] Hughes C. Everett. 1958. *Men and Their Work.*
[5] Hall T. Douglas and Chandler E. Dawn. 2005. *Psychological Success: When the Career Is a Calling.*
[6] Ronald Inglehart. 1997. *Modernization and Postmodernization: Cultural, Economic, and Political Change in 43 Societies.*
[7] Andrea E. Abele and Daniel Spurk. 2009. *The Longitudinal Impact of Self-efficacy and Career Goals on Objective and Subjective Career Success.*
[8] T. Nakashima. 2015. *Empirical Research on Career Consciousness among Female Public Servants.* (in Japanese)
[9] T. Nakashima. 2010. *Career Consciousness among Young Public Servants with High Job Turnover: how Does Stability Influence Career Consciousness?.* (in Japanese)
[10] T. Nakashima. 2011. *The Relationship between Working Conditions and Continued Employment among Workers at Youth Support Station.* (in Japanese)
[11] Gcordon E. Moore. 1965. *Cramming More Components onto Integrated Circuits.*
[12] T. Inoue. 2016. *The Future of Artificial Intelligence and Economy.* (in Japanese)
[13] Ministry of Internal Affairs and Communications (MIC). 2016. *Labor force Survey in 2015.* (in Japanese)
[14] Mark S. Granovetter. 1973. *The Strength of Weak Ties.*
[15] Ministry of Internal Affairs and Communications (MIC). 2006. *Percentage of Change in Permanent Employment by Satisfaction on Gender, Age, Educational Background.* (in Japanese)