Artificial Intelligence and the Right to a Universal Basic Income

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1. Introduction

Alphago's victory over Lee Sedol on March 9, 2016 shocked many people. It was a glorious moment for artificial intelligence, and exemplified how artificial intelligence can surpass human intelligence and possibly threaten jobs. As such fear spreads, people are increasingly interested in universal basic income. Basic income can help people survive in this increasingly jobless world. This is one moral justification for basic income: to preserve the right to human existence. Another justification involves macroeconomics. Although artificial intelligence produces massive quantities of commodities, firms cannot make profit if they can't sell those commodities. Basic income can helpthe economy run. This is the justification of basic income from the macroeconomic point of view.

This paper will try to justify basic income from the view point of property rights. This paper will argue that artificial intelligencebelongs toa common asset, and that we all have rights to the income generated by that asset.

Herbert Simon argued in 2000 that 90% of the income is the result of utilizing social capital; accumulated knowledge by previous generationsmakes up the largest bulk of the social capital. Therefore, on moral grounds, we could argue for a flat income tax of 90%.(Herbert Simon, 2000)

Simon received the Nobel Prize in economics in 1978 for his work on limited rationality (bounded rationality).But he was more than a celebrated economist. He participated in the first workshop on artificial intelligence at Dartmouth College in 1956, and is referred to as one of the fathers of artificial intelligence.[1]

1 The term artificial intelligence was used for the first time during the workshop. By that time,

When Simon said that 90% of income is the result of using common knowledge, most people thought that was an overstatement. Today, 16 years later, as we watch the performances of artificial intelligence with awe, weare able to appreciate the magnitude and power of collectively gathered knowledge. This paper will present interpretations of Simon's argument and show that his statement is not an exaggeration.

The two main concepts of this paperarethe theory of rent in political economy and the Shapley value in cooperative game theory. In section 2, we will describethe role of data in making artificial intelligence, and will show that the data needed for making artificial intelligence were createdon the commons. In section 3, we will analyze the value of artificial intelligence and show that rent comprises a substantial part of the value. In section 4, we will calculate the Shapley value of artificial intelligence and show that in order to guarantee everybody's Shapley value, a certain amount of basic income should be given to everybody.

2. Artificial Intelligence and Data

Artificial intelligence is the intelligence made by humans. Russell and Novig defined it in four different ways: systems that act like humans, systems that think like humans, systems that think rationally, and systems that act rationally.(S. Russell and P. Norvig, 2010) Negnevitsky defined artificial intelligence as "the ability to understand and learn in order to solve problems and make decisions." (M Negnevitsky, 2005, p.22) To think or act like a human, the learning process is indispensable. In Negnevitsky's definition, the learning process is identified as a key component of artificial intelligence.

Research areas of artificial intelligence can be divided into three categories: recognition, inference, and learning. Recognition is the ability to see, hear and speak:character recognition, speech recognition, video recognition, and the like. Inference is the ability to induce a conclusion

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Simon and Newel made an artificial intelligence program called Logic Theorist (LT). LT was able to prove most of the theorems in the second chapter of Principles of Mathematics of Russell and Whitehead. (S. Russell and P. Norvig, 2010, p.22). Simon later developed General Problem Solver (GPS), a far more advanced artificial intelligence than LT. It was the first program that achieved the first goal of artificial intelligence. (Jo Youngim, 2012, p.8) from given facts and rules:proof of theorems, playing games, automatic generation of programs, etc. Learning is the ability of acquiring facts and rules through iterative process. (Jo Youngim, 2012, pp.14-15)

Machine learning is a "field of study that gives computers the ability to learn without being explicitly programmed."(Phil Simon, 2013) In order to learn without explicit programming, vast amounts of data are needed.Machine learning may be definedas a computer algorithm that convert data into intelligent behavior. Machine learning is made possible by three factors: hardware (computing power), learning algorithm, andbig data. In machine learning, computers learn through processes of generalization and abstraction of data. Abstraction is the process of representing the characteristics (features) of the data, and generalization is the process of creating knowledge that can be applied to other materials.(Brett Lantz, 2013)

Recent advances in artificial intelligenceis dominated by deep learning.Deep learning is a kind of neural network that mimics human brain structure. Artificial neural network is composed of hidden layer(s) between input and output layers.Deep learning is a neural network with multiple hidden layers. Because of these hidden layers, indeep learning, people do not need to teach the features of data.Instead, computers identify features of dataon their own during the learning process. Because of this, deep learning is also calledfeature representation learning. (Yutaka Matsuo, 2015)

Let us go back to the three factors that makes artificial intelligence possible: hardware, algorithm, and data. Computer hardware has grown exponentially in accordance Moore's law. However, it is important to note that hardware development in itself is not enough for artificial intelligence. Supercomputers were not capable of automatic translation until Google invented a new statistical algorithm. Thus, hardware alone cannot function without an algorithm. However, machine learning, especially deep learning, is not a simple algorithm; it isalgorithm learningfrombig data. Even though neural network algorithmswere developed in 1950s, attempts at creating artificial intelligence were unsuccessful until the 21st century when the Internet began providing big data. Hence, artificial intelligence cannot be made without big data.

The following two cases highlight the role of big data in the development of artificial intelligence. One is data on human knowledge, the other is data on human behavior.

IBM has long tried to create automatic translation by teaching grammar and vocabulary to computers, but failed. The task of teaching a computer not only the rules but also the exceptions turned out to be impossible. In 2004, Google stated a project to scan all the books in the world and provide them for free. Scanneddigital images were converted to text by using OCR software. By2006,Google saved 1 trillion words and 950 billion sentences. In the process, itfound that thereare some books, like the Bible, that have beentranslatedinto other languages. Google used such translated sentences to successfully make automatic translation.(Viktor Mayer-Schonberger and Kenneth Cukier, 2014)Artificial intelligence used for automatic translation is builton the shoulders of many people in the pastand present who spent their lives in translating books into other languages.

Google has become a world-class company with a superior Internet search engine. Previous search engines tried to go to as many sites as possible,and classify and score them according to their assessments. When a user enters a query, they showed the list of sites in descending order of scores. Google's co-founder Larry Page chose a completely different approach. Google's search engine scores a site not according to its assessment, but according to people's assessments. It saves users' click streams, and gives high scores to sites where many people go and stay long. This is the essence of so-called PageRank algorithm. (Sergey Brin and Lawrence Page, 1998) This is the secret of how Google's search engine conquered the cyber space. The smartest artificial intelligence was made possible not by a few geniuses, but by numerous ordinary people using the Internet.

While humans can extract features from data by looking at only a few of them, enormous data are necessary for computers to do the same thing. Google's deep learning downloaded 10 million images from the Internet in order to recognize the image of a cat. (Quoc V. Le et al., 2012) Facebook's Deep Face achieved 97.35% of accuracy in recognizing faces after studying 4 million face pictures. (YanivTaigman et al., 2014) Alphagocollected 160,000 go data from the Internet and studied 30 million strategies in the dataset. (David Silver et al., 2016)

These big data areeither present on the Internet or collected through the Internet. Without the Internet, collecting big data would be a huge expense,or may not be feasible. The Internet has become the treasure island of big data. This is possible because the Internet started as a commons, and remains so.

Lawrence Lessig emphasized that the Internet code (TCP / IP) is free.[2] Here, free means people

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[2] He divides a communication system into three layers: physical layer, code layer, and content layer. Among the three layers, the most important layer is the code layer. He defined a

can access it without permission from anybody; the permission to use is granted by default. First designers of the Internet established the end-to-end (E2E) principle, which states that intermediary nodes should remain as simple as possible, serving the function of data transmission, and application-specific features (intelligent work) should be added at the end nodes. The Internet code should not monitor the person who sends the data, nor the type of data being transmitted. (Lawrence Lessing, 2002) Using the analogy of a basic income, the Internet isuniversal - anyone can access the Internet - and unconditional - you can do whatever you want.

Tim Berners-Lee created another commons called the World Wide Web on the Internet commons. Making HTTP and HTML, he furthered the unconditional and universalprinciple. He gave WWW freely to the world, famously sayingthat he would make the world rich, not himself.[3]

On theInternet commons, people collected andshared their knowledge on Wikipedia. Watson used this collective intelligence tobeat human champions in Jeopardy.As more people search the Internet, search engines become smarter. People who post their favorite photos help create artificial intelligence that recognizes images. People who sharetheir photos with their friends help createDeepFace. People who play, talk, buy, sell andwork on the Internet produce big data, and that big data in turn creates artificial intelligence.

3. Artificial Intelligence and Rent

Assuming that high profit is generated from artificial intelligence, what is the source of its income? In this section, we will try to answer the question in the context of political economy. First, let us review three closely related concepts: extra surplus value, rent, and monopoly profit.[4]

Extra surplus value is defined as the difference between social value and individual value. If a company using new knowledge produces the same amount of commodities with fewer hours than

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communication system as free if the code layer is free. (Lawrence Lessing, 2002)

[3] The year 1990 was a very busy year for Berners-Lee. He was married, decided to abandon the intellectual property of the WWW, and on Christmas Day he turned on the switch of the first Web server on earth. (Businessweek, 2002. 3. 4).

[4] In this paper, rent means differential rent.

social average, that company earns an extra surplus value. In this case the laborer using new knowledgeis counted as producing more value."The exceptionally productive labor operates as intensified labor; it creates in equal periods of time greater values than average social labor of the same kind."(K. Marx, 1867, p.223).

We are going to define exchange in two successive stages. In the first stage,we distinguish between equal value exchange and unequal value exchange. If 1 hour's labor of more productive laborer can be replaced only with 2 hours' labor of average laborer in a competitive market, we say they have equal value. In equal value exchange, the exchange ratio is proportional to value ratio.

In the next stage, we divide equal value exchange into equal labor exchange and unequal labor exchange. Assume thatA's labor produces twice as many products as B's labor in the same period of time. And assume further that if we switch the external means of production between A and B, then B's labor produces twice as many products as A's labor. In this case we should treat A and B's labor as equal labor.

Table 1. Monopoly profit, extra surplus value, and rent

	Unequal value exchange		Equal value exchange
	Unequal labor exchange	Equal labor exchange	Unequal labor exchange
	Monopoly profit	Extrasurplus value	Rent
Source of profit	Absence of competition	New knowledge	External means of production
Dynamic process	Disappearsby competition	Disappearsby knowledge diffusion	Does not disappear by competition or knowledge diffusion

While monopoly profit belongs to the category of unequal value exchange, rent and extra surplus value belong to equal value exchange.In a competitive market, there is no way for other laborers with inferior knowledge or external means of production to make the same amount in the same period of time. Rent belong to unequal labor exchange, while extra surplus value belongs to equal labor exchange.[5] Rent disappears when we switch external means of production between laborers, but extra surplus value does not, because the source of excess profit is new knowledge. Extra surplus value disappears when the new knowledge is available to other laborers, but rent does not, because the source of excess profit is external means of production.

Let us apply the above analysis to the case of artificial intelligence. As analyzed in the previous chapter, artificial intelligence is composed of hardware, algorithm, and data. First, consider the case where excess profit of artificial intelligence originates from superior hardware.In this case, excess profit belongs to extra surplus value, if we assume that superior hardware embodies new knowledge. However, this state of affairs does not last long, because hardware market is competitive and the knowledge embodied in hardware diffuses quickly. The fact that most artificial intelligence companies do not make hardware supports the above argument. Even if excess profit arises due to superior hardware, artificial intelligence companies cannot enjoy it because they have to buy hardware at a price including excess profit.

Next, consider the case where excess profit arises due to a new algorithm. In this case, excess profit belongs to extra surplus value. The company that developed the new algorithm can enjoy excess profit until the algorithm is available to other companies. This situation also cannot last long, because algorithmsdiffuse quickly. Many algorithms developed by academicsare published in journals, and are widely available. Hundreds of thousandsof students have already viewed the on-line lecture on artificial intelligence of CebastianThrun, who developed Google's autonomous vehicle.

It seems rational that companies that develop new knowledge try to keep them in secrete for a long time, in order to extract as much excess profit as possible from the knowledge. But modern artificial intelligence companies are doing the exact opposite. Facebook and Google published their artificial intelligence algorithms in academic journals. They even made their algorithms available as open source, so that anyone can use them freely.[6]They chose to give up some of the

5This paper does not take into consideration differences in internal endowments. Cf. Phillipe Van Parijs, 2003.

[6]On January 16, 2015, Facebook made their deep learning modules for Torch (http://torch.ch/) open source, before any other competitors (Venturebeat, Techcrunch, Facebook Blog, 16 Jan 2015). On November 11, 2015, Google unveiled the machine learning technology, Tensorflow (http://tensorflow.org)' as an open source in 'The Magic in the Machine' event in Tokyo. (Cha

extra surplus value arising from their algorithms.

Under these circumstances, the biggest source of excess profit remainingis the profit arising from data.It is interesting that platform businesses like Google, Facebook, Baidu, and Amazon are leading artificial intelligence. People share their knowledge, behavior, and thoughts on provided service platforms. Such data accumulate into big data, and platform businesses own this big data. As analyzed in the previous chapter, big data play important role in making artificial intelligence. Platform businesses now have an additional source of profit in addition to advertisement: big data and artificial intelligence.

People may produce data voluntarily and consciously, or platforms may record people's online behavior. In any case, platforms get data without additional labor input. Even in the case where platforms record people's behaviors, no additional labor is needed because software bots record them automatically. From these facts, we can conclude that excess profit arising from data belong to rent. People leave data after staying on platforms. Prosumers produce data, and software bots collect them. Platforms make artificial intelligence using the big data.

Most of the profits arising from artificial intelligence belong to the category of rent. Although rent belongs to equal value exchange, rent is an unfair income because it also belongs to unequal labor exchange. In order to correct such unfairness,it is necessary to tax those rents and then distribute the revenue as a basic income. Prosumers who participated in the production of big data should have the property right to basic income. In the age of artificial intelligence, basic income is a method to stop the expropriation of prosumers.

4. Artificial Intelligence and the Shapley value

In this section we will suggest the Shapley value in cooperative games as a rationalization for basic income in the age of artificial intelligence. (Shapley, 1953)[7] We will redefine the gloves market game which Shapley analyzed in detail (Shapley and Shubik, 1969) as an artificial intelligence game, and calculate the Shapley value of data and algorithm. To make explanations

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Wonyoung, 2016)

[7]LlyodShapley(1923-2016)wonthe Nobel Prize in economics in 2012.

simple, we assume there is only one platform owner who can access data and apply artificial intelligence algorithms, so that we will treat the only platform owner as the only algorithm owner.

A. Market equilibrium in an artificial intelligence game

We will ignore hardware and assume that there are two players (player 1 and 2) who provide data, and one player (player 3) who provides algorithm. When one data and one algorithm form a coalition, artificial intelligence worth 1 (trillion) dollar is made. Since only one data is necessary, the other one data is redundant.

In cooperative game theory, groups that players can make are called coalitions. Excluding empty coalition, there are seven possible coalitions: {1}, {2}, {3}, {1,2}, {1,3}, {2,3}, {1,2,3}. A coalition with only 1 player is called singleton. A coalition with all players is called grand coalition. Worth of a coalition vis defined as the value that members of a coalition can be guaranteed to make. In the above artificial intelligence game, the worth of coalitions are as follows.

v(1) = v(2) = v(3) = v(1,2) = 0

v(2,3) = v(1,3) = v(1,2,3) = 1

A payoff is the value (money or utility) distributed to each player, anda payoff vector can be expressed as x = (x_1, x_2, x_3). The sum of all players' payoff is expressed as x(N). That is,x(N) = $x_1 + x_2 + x_3$. The sum of payoffs in a coalitionS is expressed as x(S). For example, whenS = {1,3}, x(S) = $x_1 + x_3$.

When a distribution distributes all the values of grand coalition, it is called Pareto efficient. The conditions for Pareto efficiency are as follows.

$$x(N) = x(1,2,3) = x_1 + x_2 + x_3 = v(N)$$

When every player's payoff is greater than or equal to the worth of that singleton, we say the distribution satisfies individual rationality. The conditions for individual rationality are as follows.

$$x_1 \geq v(1)$$
$$x_2 \geq v(2)$$
$$x_3 \geq v(3)$$

When a payoff distribution satisfies the following conditions, we say the distribution has coalition rationality.

$$x(1,2) = x_1 + x_2 \geq v(1,2)$$
$$x(1,3) = x_1 + x_3 \geq v(1,3)$$
$$x(2,3) = x_2 + x_3 \geq v(2,3)$$

A payoff distribution which has both individual rationality and coalition rationality is defined as a core. In the above artificial intelligence game, a core satisfies the following conditions.

$$x_1 \geq 0,\ x_2 \geq 0,\ x_3 \geq 0$$
$$x_1 + x_2 \geq 0$$
$$x_1 + x_3 \geq 1$$
$$x_2 + x_3 \geq 1$$
$$x_1 + x_2 + x_3 = 1$$

The only solution to satisfying all of the above conditions is $x_1 = 0$, $x_2 = 0$, $x_3 = 1$. This is the only core in this artificial intelligence game. In this core, although the value 1 is the result of cooperation of players, player 3 takes all the value, while player 1 and 2 get nothing.

Shapley proved that competitive market equilibrium is in the core.(Scarf, 1962) Applying this theorem, in the above artificial intelligence game, market equilibrium must coincide with the only core. That is, $x_1 = 0$, $x_2 = 0$, $x_3 = 1$ is the only possible market equilibrium.

Why does player 3 take all the value in the market equilibrium? Thiscan be explainedin view of the bargaining process. Let's say that in the beginning, players 1 and 3 form a coalition and agree to share the value of coalition equally (1/2 each). Player 2 is left out, and may bargain with player 3, suggesting a higher payoff for player 3 (player 2 takes 1/3, player 3 takes 2/3). Hence, the initial coalition between 1 and 3 will be blocked.Then, player 1 may suggest that he will give 3/4 of the coalition value to player 3, and so on. This bargaining process continues until player 3 takes all the value of 1.

B. The Shapley value in the artificial intelligence game

The Shapley value is defined as follows. (Shapley, 1953) When three players form a coalition in random order, there are 6 possibilities: (1,2,3), (1,3,2), (2,1,3), (2,3,1), (3,1,2), (3,2,1). The Shapley value is defined as an average of each player's contribution in all cases, under the assumption that all cases have equal probability.

In the above game, the Shapley value is calculated as follows. Let m_1, m_2, $m_3$be each player's contribution in one case. For example, when the order is (1,2,3), as v(1) = 0, v(1,2) = 0, v(1,2,3) = 1 ,it follows that m_1 = v(1) = 0, m_2 = v(1,2) - v(1) = 0, m_3 = v(1,2,3) - v(1,2) = 1 . As shown in the next table, calculating each player's contribution in 6 cases, summing them for each playerand dividing the sum by 6 gives the Shapley value for each player. In this game, the Shapley value vector is (1/6, 1/6, 4/6).

Table 2. The Shapley value in a simple AI game

Order	m_1	m_2	m_3
1,2,3	0	0	1
1,3,2	0	0	1
2,1,3	0	0	1
2,3,1	0	0	1
3,1,2	1	0	0
3,2,1	0	1	0
Sum	1	1	4
The Shapley value	1/6	1/6	4/6

The Shapley value is one of the method of distributing the value of grand coalition 1. Compared to the distribution values in a market equilibrium (0, 0, 1), the Shapley value distributes not 0, but 1/6, to two players who provide the data. In this game, core and Shapley value differ, so the Shapley value cannot be attained by market mechanism alone. To distribute according to the Shapley value, the government need to intervene. One possible policy is to tax the market income of algorithm owner by 50%, and then give every person 1/6 as a basic income.

C. The Shapley value and basic income

The Shapley value can be derived inductively from a set of desirable axioms. Shapley proved that the only distribution method that satisfy the following four conditions is the Shapley value: efficiency (Pareto efficiency), symmetry(equal contributors are treated as equal), null player property(player who contributes nothing gets nothing), and additivity (the sum of the values of two games equals the value of sum of two games).(Shapley, 1953) Null player property and additivity axiom can be replaced with one axiom of strong monotonicity: the player who contributes more gets more.(Young, 1985; Peters, 2008)

The Shapley value is fair. It is based on "fair account of each person's contribution." (Shapley and Shubik, 1969: 340) Based on the above theorems, we see that the Shapley value has the following characteristics: (1) player who contributes nothing gets nothing,(2) players who contribute equallyget equally, and (3) player who contributes more gets more.These three characteristics can be summarized as contribution-fairness.

Another important property of the Shapley value is that it measures players' contribution notin one fixed order, but in every possible order. This property can be called equality of opportunity.Equality of opportunity means that nobody is excluded from the distribution, even if he is unemployed. In other words, the Shapley value measures player's potential contribution.The Shapley value distributes payoff even to the unemployed.

For a fair distribution, we need to measure each individual's contribution under the condition of equality of opportunity. This argument can be rationalized in many ways. Think of John Rawls' principles of justice.(Rawls, 1999) In primitive state, under the veil of ignorance, we do not know in which order individuals will form coalitions. Specifically, we do not know who will be unemployed in a given case. Under such circumstances, the only fair way to measure individual contribution is measuring it in every possible order.

The Shapley value seeks efficient and contribution-fair distribution under the condition of equal opportunity. Basic income is a policy that guaranteesevery individual his Shapley value efficiently.

D. Shapley values in various artificial intelligence games

Let us assume that there are three players providing data, and one player providing algorithm. And assume further that in order to make artificial intelligence, 1 algorithm and 2 data are needed. In this case, just like the case before, the only core is (0, 0, 0, 1). As market equilibrium is in the core, the player who provides algorithm (platform owner) take all the value. This is unfair, because data providers get nothing.

Table 3. The Shapley value in another AI game

Order	m_1	m_2	m_3	m4	Order	m_1	m_2	m_3	m4
1,2,3,4	0	0	0	1	3,1,2,4	0	0	0	1
1,2,4,3	0	0	0	1	3,1,4,2	0	0	0	1
1,3,2,4	0	0	0	1	3,2,1,4	0	0	0	1
1,3,4,2	0	0	0	1	3,2,4,1	0	0	0	1
1,4,2,3	0	1	0	0	3,4,1,2	1	0	0	0
1,4,3,2	0	0	1	0	3,4,2,1	0	1	0	0
2,1,3,4	0	0	0	1	4,1,2,3	0	1	0	0
2,1,4,3	0	0	0	1	4,1,3,2	0	0	1	0
2,3,1,4	0	0	0	1	4,2,1,3	1	0	0	0
2,3,4,1	0	0	0	1	4,2,3,1	0	0	1	0
2,4,1,3	1	0	0	0	4,3,1,2	1	0	0	0

2,4,3,1	0	0	1	0	4,3,2,1	0	1	0	0
Sum						4	4	4	12
The Shapley value						1/6	1/6	1/6	1/2

The Shapley value of this game is (1/6, 1/6, 1/6, 1/2), as shown in the table above. The player who provides algorithm gets 1/2, and the three players who provide data get 1/3 each. In order to guarantee everybody his Shapley value, we need to collect 2/3 of income through tax and distribute the revenue equally among 4 persons as a basic income.

More broadly, let us assume that there are n players who provide data, and (n+1)th player provides algorithm. Assume further that in order to make artificial intelligence, only 50% of data are necessary; the other 50% of data are redundant. In market equilibrium, the unique player who provides algorithm takes all the value. But his Shapley value is$\frac{n+2}{2(n+1)}$. The sum of Shapley values of players who provide data converges to 1/2 as the number of players increase to infinity. Each player gets $\frac{1}{2(n+1)}$ of value. The sum of basic income for all players is also 1/2.[8]

5. Concluding Remarks

Artificial intelligence comprises of hardware, algorithm, and data. Numerous recent feats by artificial intelligence (Watson, Alphago, etc) highlight the impressiveness of deep learning algorithm.Thisis an algorithm that allows computers to learn from big data. The Internet provides valuable big data for artificial intelligence. The Internet has become a huge commons on which people play, talk, and study. The prosumers on the Internet are participating in making artificial intelligence.

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[8]We can calculate the Shapley value of algorithm player as follows. There are $\frac{n}{2}+1$ cases where algorithm provider's contribution becomes 1, which include 1 case where the algorithm provider's position is the last, and n/2 cases where the algorithm provider's position is in the second half. We assume that n is an even number. As there are $n!$orders in each case, there are $\left(\frac{n}{2}+\right.$ *1n!*orders in total. The ratio of this number to *(n+1)!* (the total number of orders)is *n+22(n+1)*, which is the Shapley value of the algorithm provider.

If excess profit of artificial intelligence originates fromthe algorithm, it belongs to extra surplus value in political economy. Since extra surplus value disappears by competition, it cannot be a permanent source of excess profit. Many platform businesses made their artificial intelligence algorithm available as open source. They choose this strategy to make their platforms bigger by giving up some part of the extra surplus value. Excess profit originating from data belongs to rent. Rent is unfair because it originates from unequal labor exchange. Prosumers who provide the data are exploited when they receive nothing in return for their efforts. Basic income is a policy to correct this unfair situation.

The Shapley value is the average of each player's contribution in every order of play. The Shapley value measures each player's contribution in every possible order. The Shapley value seeks efficient and contribution-fair distribution under the condition of equal opportunity. Basic income is a policy that guarantee every individual his Shapley value.

Under the assumptions of this paper, according to the Shapley value, players who provide data should get about half of the value produced by artificial intelligence. In market equilibrium,the unique algorithm provider takes all the value. To guarantee everybody his Shapley value, it is necessary to tax the income of algorithm provider, and distribute the revenue equally as a basic income.

Herbert Simon's argument that the vast majority of income originates from collective knowledge is not an exaggeration in the current age of artificial intelligence. Of course, under the assumptions of this paper,suitabletax rate is 50%, not 90%, as James Meade suggested. Since everybody contributes data to artificial intelligence, we all have the right to share the profit. Basic income is an efficient and fair solution.

Recently when Soumaya Keynes asked "are you among the group of technologists who favor a basic income?",WWW inventor Tim Berners-Lee answered that he supports basic income because it is efficient and simple, and it is one of the tools that could correct massive global inequality brought about by technology. (Kate McFarland, 2016) If Berners-Lee is aware ofthe critical importance of the WWW in making artificial intelligence possible, his support for basic income may grow even stronger. Everybody has the right to basic income.

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