The epistemic value of rationality

Popp, Alexandru W. A.

APOC Services

2008

The Epistemic Value of Rationality

Alexandru W. A. Popp

APOC Services – Research and Development Division

(1)+514-487-5229

ALEXWPOPP@GMAIL.COM

This research was presented at *The 12th International Conference on Foundations and Applications of Utility, Risk and Decision Theory*, Rome, Italy; and *Spain, Italy, Netherlands Meeting on Game Theory*, Foggia, Italy.

Abstract

Models of rational choice use different definitions of rationality. However, there is no clear description of the latter. We recognize rationality as a conceptual conglomerate where reason, judgment, deliberation, relativity, behavior, experience, and pragmatism interact. Using our definition, the game theoretic idealized principle of rationality becomes absolute. Our model gives a more precise account of the players, of their true behavior. We show that the Rational Method (RM) is the only process that can be used to achieve a specific goal. We also provide schematics of how information, beliefs, knowledge, actions, and purposes interact with and influence each other in order to achieve a specific goal. Furthermore, ration, the ability to think in the RM framework, is a singularity in time and space. Having a unilateral definition of rationality, different models and theories have now a common ground on which we can judge their soundness.

Keywords: conceptual conglomerate, traditional rationality, rational method, ration

1. Introduction

In order to have a proper analysis of different 'problems', one must have the appropriate tools. *Rationality* is one such tool exploited in rational choice theories, game theory, decision theory and others, that has been over-used and miss-used. Moreover, contemporary models of management utilize the hidden assumption that the actors involved are rational. However, there is no one true and clear definition of what rationality is.

Our ideas and beliefs about the concept of rationality are not clear. Different models of rational choice use different definitions. Being an abstract concept, it is hard to pinpoint this term. This is the reason why this notion has been misinterpreted. Rationality is a super-system concept. It is a conceptual conglomerate (ConC)[1], where reason, judgment, deliberation, relativity, behavior, experience, and pragmatism interact. Nevertheless, there is no one unified way for all the elements of this ConC to interact. The current models look only at partial interactions and they have limited descriptions.

This paper will show what rationality really is, provide its functional definition, as well as its mathematical characterization. The first part of the paper focuses on previous work done on this topic. In this section, we describe the major aspects and we illustrate certain of the limitations of these models. We characterize Traditional Rationality (TR) as the basic idea of what is believed to be rational in major theories dealing with this concept, more precisely Game Theory and Rational Choice Theory. We show the constraints of the concepts of utility and equilibrium contained in TR. We also describe the standards of preferences and what expectations of future events are.

In the second part of the paper, the Rational Method (RM) is described. We show what a goal is, and prove that the RM is the only way to achieve the former. We describe the foundation that builds to the Rational Method, and so, to the realization of any goal. The term 'ration' is introduces. We also show that ration is a singularity in space and time.

[1] Conceptual Conglomerate is a reference to any specific of elusive system (may the latter be formed by elements, concepts or states).

We end the paper with different general remarks regarding true rationality. Moreover, we will answer throughout the paper to different questions that some of our colleagues pertinently ask.

1.1. Traditional rationality

Figure 3 of the Appendix illustrates the general ideas encompassed in rationality, what is known of 'traditional rationality'. This map is a collection of previous works on the topic. Some characteristics of rational/TR are: way of thinking of individuals; framework; pattern of thinking; context dependent; choice dependent.

Contemporary models use a reasonable approximation of what is rational when referring to TR. Moreover, the same models assume hyper-rationality, meaning that nothing can violate the actors' preferences. There are few problems with hyper-rationality: actors' preferences may be contradictory; preferences are dependent on nature, on the situation; constrains imposed on the actors change the initial preferences; framing. These are only a few of the difficulties that are introduced indirectly.

For Rational Choice Theory (RCT), TR is the deliberation and finding the best course of action (using rationality in any form to distinguish from alternative actions). We see that this definition is extremely general. Another definition for TR is that RCT tries to predict what actual action will be taken. Nevertheless, the *action* aspect is only one part of rationality. *Action* is a consequence of the actor's rationality. In other words, RCT evaluates the actions of actors as symptoms of their rationality, and not actually looking at the root of the canonical basis of rationality.

We will show that even if the assumptions of TR have useful properties and characteristics, they are not accurate and create loopholes in models. For this reason, the latter do not represent accurately reality, the world.

There are three general characteristics (definitions) that are attributed to TR and the actors that use TR (Straffin 1993, pp. 53-54):

(1) **Traditional Rational Player**: A player is rational if it chooses the alternative that has the highest utility.

(2) **Reverse Causality of TR**: The reason why a player chooses a certain strategy is that the specific strategy has the highest utility.

(3) **Comparison of Utility**: If Player 1 (P_1) values an outcome higher than Player 2 (P_2), then P_1 values more the outcome than P_2.

There is an important question that needs to be answered (Feinberg, 2005a)**:** is TR a property of the decision or of the decision maker? We remark that TR is not a property. It is a characteristic. The first definition of RCT puts an emphasis on the decision maker. Yet, the second definition puts it on the decision. Here, we see one aspect of TR relativity between models, and even internal to the same models.

Moreover, Game Theory (GT) uses two major assumptions regarding the player (the rational player, an ideal person) (Damme 1983, pp. 1–2):

(4) **Assumption 1.** The player can analyze the game, i.e. he is sufficiently intelligent.
(5) **Assumption 2.** Von Neumann/Morgenstern's utility function can express the player's preferences.

1.2. Other characteristics of Traditional Rationality

Characterizing someone of rational or irrational is actually characterizing the latter's conformity to the standards of rationality (Nathanson 1985, pp. 35). Nevertheless, these standards are unclear. Even though one may argue that (1), (4), and (5) form these principles, we do not believe so. We will see later that rationality does not have standards. It is a method. This is the reason why one cannot assign rationality, in the traditional sense of rationality, to anybody. Some consider rationality as the means (practical and efficient) to achieve an end. For these, there is no specified method of achieving the 'desired' end. "Achieving the end no matter the means" is pragmatism. It is true that in pragmatism there may be rationality (and vice-versa), but rationality is not limited only to pragmatism.

For a player to be rational, he or she needs experience. Ayer (Blanshard 1962, pp. 25) argued that "'being rational' entails being guided in a particular way by past experience.". However, experience is not only P_1 having some action in some environment. Experience depicts a ConC that is more complicated. It is: 1. interaction with the environment; 2. it is acquiring information; 3. it is transforming this information into knowledge; 4. it is having the ability to reason and deliberate regarding the knowledge obtained. We will see in section 2.3 the different types of information and how the latter is transformed in beliefs and knowledge. For now, we point out that experience by itself is meaningless, unless there is a lesson to be learned from it. By learning, we understand the acquisition and 'adaptation' of concepts and patterns. We note that without learning, there is no rationalization.

Moreover, the rationalists "have held that a belief or action is rational if it is based on skillfully carried out deliberations and that a person is rational to the degree that he tends to base his beliefs and actions on rational deliberation" (Nathanson 1985, pp. 37). This definition of rational belief/action is evasive. Actions are rational to the extent that a person employs the rational methodology. As for rational beliefs, they are 'rational' if they are also reached through the rational methodology and have as foundation correct information and knowledge.

1.3. Utility and equilibrium

Having (1) through (5), we conclude that the player's goal is to maximize the utility function and choose the strategy that guarantees this function. There is no other objective for the player.

Davis (1970, pp. 52) stipulated that "an utility function is simply a 'quantification' of a person's preferences with respect to certain objects." However, we have to note that 'quantification' is a construct. It is a scale for an object that holds a value over some range. The range can be set by the individual, by the opponent, by nature, or by the modeler.

Moreover, utilities are personal. Therefore, how can one know what utilities and what utility function P_1 has? In certain games (the prisoner's dilemma, chicken, ultimatum game, matching pennies, stag hunt, etc.), it is the modeler that determines the utilities, and the utility function is always the same:

achieve the highest utility. Rabin (1993) and Dufwenberg and Kirchsteiger (2001) have made advancements regarding different models that take in consideration the opponents perceptions and their influence on the utilities of the game. Moreover, Levine (1998) and Fehr and Schmidt (1999) have models that are more *fair* taking into account the opponents' preferences in the utilities. In nature, the reasons for which individuals assign value to things can be demonstrated to be irrational (yet, irrationality is the antonym of rational; not knowing what rational is, we cannot determine what is irrational).

In GT, the players do not determine the utility values. Values to different outcomes are assigned in the model, and the modeler assumes their independent utilities regarding the players. Again, we see that it is the modeler that determines the range of quantification. Yet, the utility values attributed in a game are personal and should not take in consideration the modeler. They should be independent from the modeler.

Homo Economicus (HE) is self-interested and classifies rationality though his own utility-maximization decisions in a vacuum of norms and values. His norms and values are the only ones that exist. In other words, HE is rational in the sense that its welfare is defined by the optimization of the utility function of the perceived opportunities. Simply, HE is selfish.

We know that many predictions of behavior that are based on HE do not work. When the assumption of HE was introduced in certain games, and these games yielded different results than those expected, researchers were surprised. The games that model HE behavior employ tautological assumptions to a certain degree. This is the first step in understanding why current theoretical models give different results than what would happen in reality. This is also the case for GT. Using (4) and the belief that actors believe that their opponents behave in the same manner as them (Feinberg, 2005, pp.97), we actually have two assumptions:

(6) **Assumption 3.** P_1: I am rational;

(7) **Assumption 4.** From P_1's perspective, P_2 is rational.

Furthermore, Nash equilibrium (NE) has a universal 'condition' that it is the best response, assuming that the players are rational. Yet, the concept of NE is also determined by the modeler, because it is the latter that determines the utilities

of the players. There is some literature that stipulates that the Nash rational is not a necessary consequence of rationality, or a reasonable empirical proposition (Bernheim, 1984). Moreover, Pearce (1984) holds the view that for strategies to be rational, the NE is not necessary or sufficient.

In a game where there is equilibrium, an NE, if one player deviates from the path of achieving the equilibrium, he is considered irrational, in the traditional sense of rationality. We note that TR is bivalent. There are two explanations for this deviation. 1) P_1 (being the deviator) does not have the ability to reason about the achievement of equilibrium. He fails Assumption 1. In this case, equilibrium is the goal. 2) P_1 does not want to achieve equilibrium. Here, equilibrium is not a priority. Maybe P_1 achieved his goal and for him, he is rational[2]. The player may be satisfysing. From the modeler's point of view, the player is not rational because he did not achieve equilibrium, and, in the same time, obstructed P_2 to achieve it also.

> Von Neumann and Morgenstern succeeded in demonstrating two things about … utilities. First, it is always possible in principle to convert a player's consistent preferences among outcomes of a game into utilities. Secondly, if a player applies the principle of maximization …to the expected utilities rather than to the expected monetary values of the available strategies, then this player is in fact choosing according to his or her tastes. This is called the principle of maximizing *expected utility*. (Colman 1982, pp. 19–20)

We notice that even von Newman and Morgenstern acknowledge the fact that utilities are theoretical. Propositions of utility of choice also fluctuate in time and environments. This is caused by the indirect influence of hyper-rationality. Moreover, when an actor frames an outcome, the former influences the utility of that outcome**.**

[2] Traditional Rationality is relative.

1.4. Preferences and expectations

We also have to note that preferences play a central roll in any theory that has the concept of TR as an element. In economics, preferences are said to be rational if and only if they are complete and transitive (actors can compare all alternatives and the comparisons are consistent). Using TR means that the actors will chose the most preferred option. However, if uncertainty is present, the independence axiom is added to the model.

Independence axiom: If $X > Y$, then $pX + (1 - p)Z > pY + (1 - p)Z$ for all Z and $p \in (0,1)$, where X, Y, Z are lotteries.[3]

Rational expectations bridge the realm of expectations and the RCT framework. It is not the actions that are the main focus, but expectations of future events undergone by actors. These future events are actually best guesses of the future taken in consideration all available information. Expectations are considered to be, under uncertainty, what is likely to happen. They can be realistic or not. Yet, these models say nothing about human behavior besides the fact that the actors behave 'rationally'.

The rational expectations model assumes that people do not make systematic errors when predicting the future. Any expectation that differs from the actual outcome is only random deviation. However, any expectation cannot be fully rational because the future cannot be predicted. Potential future events can only be partially predicted.

Thus, using the methods described before, can we quantify rationality using (1) through (5)? If we are able to do so, how do we 'quantify' rationality, or the degree of rationality? TR, per se, cannot be quantified. TR is bivalent: an actor is rational or it is not. There are no degrees of TR. One cannot be 'more rational' than another. Being defined as it is, TR is bounded by the choice of the highest utility and the Principle of TR (Stahl 1999, pp. 122).

Principle of TR: Every player wishes to come out as well off as possible.

---

[3] The independence axiom is attributed to Dr. P.A. Samuelson. Econometrica 1952 vol.20, 661-679, has short but interesting contributions by H. Wold, G. L. S. Shackle, A. S. Manne, A. Charnes, E. Malinvaud, and P. A. Samuelson regarding 'strong independence axiom'.

The Principle of TR does not tell us anything about the method of achieving the highest welfare. For this reason, we state that the principle of TR is more like an aspiration than an actual principle. A player can incorporate this objective in its values. However, by doing so, the player would become HE. Newell (Newell 1982) uses a different principle of rationality with which we are partially in agreement:

Newell principle of rationality (NPR): If an agent has knowledge that one of its actions will lead to one of its goals, then the agent will select that action.

2. Rational Method

2.1. The goal

We use the following definitions:

Definition 1. A goal is a personal 'target' that an individual wants to accomplish given some standards.

Definition 2. Rationality is a method of deliberation of achieving a specific goal.

A goal is an abstract concept. It is an outcome that an individual attempts to transform in a fact. We note that an action per-se is not a goal, unless the goal is the specific action.

For the rational method (RM), the *Goal* is to achieve a specific goal. It has no connection with maximizing the utility function, unless the latter is the goal. We remark that any strategy is a method. However, strategic approach for GT has no connection with cleverness. For us, as well as for the RM, cleverness means having the most efficient method of achieving a specific goal. We will discuss cleverness and intelligence in section 2.3.

We also notice that common knowledge of rationality (CKR) is the assumption that the same definition of rationality is at work. Yet for TR, there is no information about what the other player wants and what standards of

rationality (models) are employed, except assumptions 3 and 4. Aumann's definition of common knowledge (Aumann, 1976) cannot be employed in this case. Having RM, we may be tempted to use CKR as an assumption. In fact, Aumann's CKR is knowledge in the RM framework.

The choices that actors have are set to be *modal*-rational by nature; modal-rational because 'rationality' is a goal driven method. One may have the goal (π), but not the method of achieving it. In this case, π is not a goal. It is a stationary potential future event[4].

A great deal of experimentation has confirmed that decision makers do not always behave according to laws of rationality[5]. GT incorporates these *laws* in its models in the manner we have seen. Therefore, GT's architecture does not model real situations. GT yields conclusions that are not fully suitable in the real world. For this reason, we see the need to have a unified definition and methodology when analyzing rationality in any theory and model. And most importantly, we must have a definition that illustrates accurately real life situations and actors.

2.2. Rational method

Rationality is a method, and it is sequential. Figure 1 illustrates the fours steps that characterize the rational method.

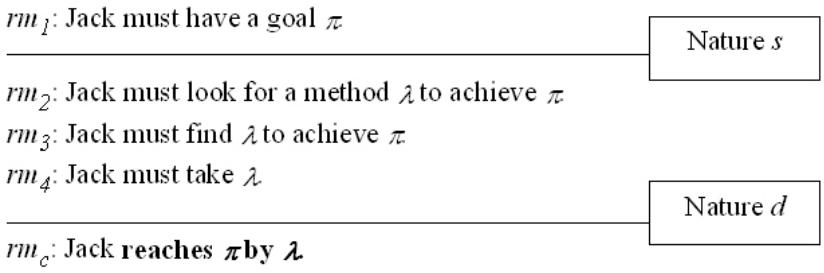

Figure 1

[4] We have to note that a stationary potential future event is not necessarily an expectation.
[5] The laws of rationality for GT, and even for RCT, are more assumptions than laws. A law is empirically tested (and retested), and the former represents accurately reality.

An individual sets himself a specific goal, π. He must look for a method, λ, in order to achieve this goal. The individual may find multiple methods of achieving the goal. Once he finds the appropriate method, the individual must take the desired method. This methodology will ensure, but not guarantee, the achievement of the specific goal. Once the method is chosen, and it is enacted, Nature can put constrains in the achievement of the goal.

We note that only after the completion of one of the steps, an individual moves to the subsequent step.

This entire process is called true rationality or RM. We remark that it can be presumed that more efficient the path (the method) to achieve the goal, the higher the rationality. For the RM, as well as for the TR, there are no higher or lower degrees of rationality. For us, an individual uses RM or not. This assumption of higher degree of rationality is actually a measurement of the ability to reason, and it is not an assumption. We will see in section 2.3 how this ability to reason is characterized.

As we stated before, we are partially in agreement with NPR. The reason is that the latter looks only at rm_4. However, there are three other steps that need to be completed before arriving to the most efficient path to achieve a specific goal. Moreover, the first definition of TR in RTC also focuses only on rm_4.

Corollary 1: If rm_1 to rm_4, then we have the conclusion of the four steps, rm_c.

Without rm_1, there is no RM because RM is a goal driven method. rm_1 is considered the foundational element of the RM. Some may not even consider rm_1 a step in the RM. However, rm_1 is existential to RM, therefore, incorporated in RM. rm_2 is the internal thinking process of finding the set Λ of all available means of achieving a specific goal. Section 2.3 deals with this aspect. In rm_3, Jack chooses λ out of set Λ. λ is linked to π because λ is a mapping function to π. The logical argument is:

$$\pi$$
$$\lambda \rightarrow \pi$$
$$\lambda$$
$$\therefore \pi, \text{ by Modus Ponens.}$$

The effect of a method that leads to π, is π.

We note that Nature is not present in Corollary 1.

Corollary 2: If rm_1 to rm_4, and Nature *d* is present and diverges Jack from his path, then we have a partial rm_c.

For us, a partial rm_c refers to a lower lever of π that Jack reached. We point out that goals have different degrees due to satisfycing.

Let $\Lambda=\{\lambda 1, \lambda 2, \lambda 3, \ldots\}$, and $f(\lambda)$ be a mapping function of λ to π. Nature being present, we have $f\kappa(\lambda)$, with κ power of deviation of Nature over $f(\lambda)$. $f\kappa(\lambda) = \kappa\pi$. As κ is the power of influence, we set $0 \leq \kappa \leq 1$. If $\kappa = 0$, π is not reached. If $\kappa = 1$, π is reached because Nature *d* is not present. If $0 < \kappa < 1$, π is partially reached. We note that the deviation coefficient κ is inverse proportional to the influence of Nature *d*.

In any system, as scientists, we have to take in consideration the environment. In our case, the environment is set as Nature. Any environment has its own limitations and liberties. Jack may have the appropriate method to achieve his goal. Because of last-moment influence of Nature, Jack is obstructed to fully reach his goal. In this case, Jack could have done nothing. One cannot blame him for not contemplating all aspects of the environment. An individual does not necessarily know how and to what degree the environment influences his method λ.

Corollary 3: If rm_1 without rm_2 to rm_4, and Nature *s* is supportive of Jack, then we have a partial rm_c.

This is the case when Jack sets himself a goal, but does not have time to engage in rm_2 to rm_4. There is a *p* probability of potential possibilities that this may happen in real life situations. Even if in most cases *p* is 0, we have to acknowledge this possibility.

The proof of Corollary 3 is a combination of the proof of Corollary 1 and Corollary 2, having g(s) as the mapping function to π, and μ the support power of Nature. We note that μ is directly proportional to the influence of Nature s.

The probability of Corollary 3 is minimal. For this reason, this corollary can be neglected. However, we felt the necessity of stating it in order to have a complete understanding of the world.

Theorem 1. *The RM and Corollary 3 are the only ways to achieve a goal.*

Proof 1. Corollary 1 and 3 can be combined to provide the proof of this theorem. The same rational of Modus Ponens applies in this case also.

Proof 2. a different proof is to use the reduction to absurdity argument. What ways are there to achieve π? By the definition of the goal, it is the individual that attempts to transform an outcome in a fact. Therefore, Jack must actively be engaged in this process.

Let us call π a specific goal, and π^* a goal in general. π^* can be achieved by mistake, or by influence of Nature. However, there is no method involved, no RM. Also, Corollary 3 does not apply in this case because Jack did not intend to be actively involved in reaching the specific goal. π^* is not a specific goal. It is a *wish*. We have to notice that π^* may happen or not, depending on Nature. This type of nature is not Nature s, because π^* is not a specific goal, and RM does not apply in this case.

An individual has to reach the threshold of willingness to achieve the goal. This is how wishes are transformed in goals. Reaching this threshold, which enables the drive to achieve the goal, is manifested by the work done through steps rm_1 to rm_4.

The difference between π and a wish is that a goal entails willingness to put effort in accomplishing it. A wish has no willingness of work involved.
If the goal is achieved by other means, π is not a goal per se.

Lemma of theorem 1. *The RM does not guarantee reaching the goal.*

Proof. Using the RM ensures the path of achieving π, but does not guarantee the actual achievement of π. Reaching the goal is a future event. As stated before, future events cannot be fully predicted. Moreover, Nature is always present. This Lemma is a specific case of Corollary 2 where $\kappa = 0$.

2.3. Schematics of RM to achieve π

Having a rationality method is not enough. We also have to understand how Jack arrives to and uses the RM. We provide the subsequent schematic that is composed of the following ConCs: I – information; B – belief; K – knowledge; O – purpose; Ξ – actions; π – goal (end result). All these ConCs are specific and relative to the individual.

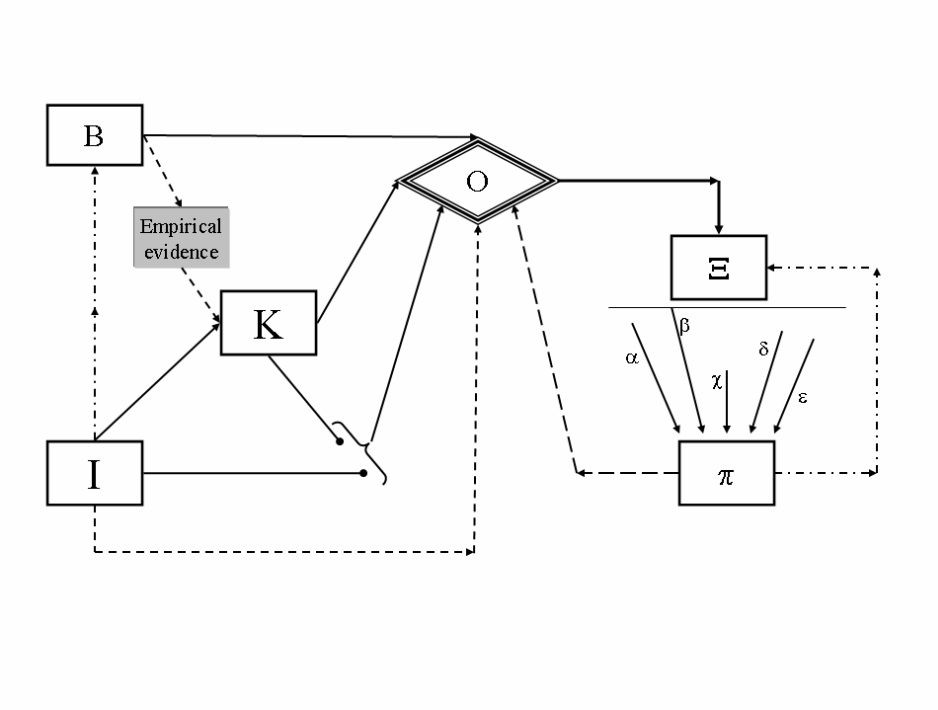

Figure 2

Information can be acquired through different fashions. One of the most important ways is through experience, meaning through interaction, direct or indirect, with the environment.

There are a few types of information that are interesting to us. *Fresh information* is the information that an individual is introduced to in the present. *Sedimental information* is the information that had time to store itself and create

either values or beliefs. *Residue information* is the information that did have time to sediment, but was neglected because it did not correspond with the values or beliefs of the individual. *Concealed information* is the information that an individual analyzed, but did not have time to sediment itself. All these types of information are looked at from the individual's perspective.

Using these types of information, an individual strives to enlarge the means set Λ, and eventually, coordinate between means and ends.

A belief is a mental state, the result/conclusion of internal contemplation that manifests itself as an attitude vis-à-vis a concept. An important observation that psychology demonstrated is that information shapes beliefs. Thus, we state that Beliefs are derived from certain evidence or information.

Through information and sound evidence of proper beliefs, knowledge is created. Moreover, one increases knowledge through cognitive processes.
We remark that knowledge can have many meanings. For us, knowledge is information acquired directly, indirectly or deductively, and has a potential purpose. In other words, knowledge is information connected to intent, information that is ready to be used in an action. We note that the information transformed into knowledge enables a wider range of purposes.

For us, purpose is the elementary motive in achieving an intention. Knowledge and beliefs enable purposes. We also notice that every purpose has its own knowledge and belief systems.

Definition 3. An action is a state or process forming an organized activity in the course of accomplishing an objective.

One essential property of actions is that they require at least one purpose. Ξ is the set of actions available to the individual. Jack must define his goal before one can suggest a course of action. In addition, actions are determined by purposes. Through deliberation, an individual uses different standards of knowledge and beliefs (through purposes) to consider possible actions.

We point out that there are different potential actions available to reach a specific goal. One can use Occam's razor to analyze them, however this is not necessary.

One must use its *reason* as the path from action to attainment of the goal of the action. The actual process of thinking from action to goal and vice-versa is called deliberation. The latter is a pattern of thoughts. The main question that Jack asks is *How can I achieve this goal?* There are three major types of reasoning (Hartshore 1958, vol.5, para. 145): 1. deductive, from general to particular; 2. inductive, from particular to general; and 3. abductive, from best available information to best explanation.

In the end, the actions of a player determine the (full, partial, or unfulfilled) achievement of the desired goal.

We have to note that the concept of intelligence is quite important in our process. Intelligence, for us, is the 'expression' of sets of principles that are complex in nature. This process enables us to model, predict and manipulate the environment at different degrees. We realize that the higher degree of intelligence would yield more options, more paths to achieve a goal.

Through the description of the RM, we see that the goal and the achievement of the specific goal are the acumens of our approach. However, we have to notice that there are situations where the main goal is not achieved in a single attempt. Our RM can be employed for the achievement of any sub-goal. Accomplishing all the appropriate sub-goals, would lead the decision maker to his main goal.

Deliberating, Jack uses all the information and knowledge that he has in order to achieve the goal. In analyzing and choosing his action(s), Jack must take in consideration possible intervention of outside factors once the action is taken. Nature imposes different situations. These situations may or may not have constraints. Depending on the environment (closed, open, controlled, etc.) in which Blue is, Nature can intervene at different degrees. It is Jack's duty to foresee, at his best capacity and with the information available, possible influences of the environment. However, this does not mean that Blue must anticipate *all* variations in Nature. If Jack deviates from his goal because of outside intervention(s) of Nature, which Jack could have not anticipated, then Jack is not responsible for the failure. Moreover, Jack cannot be considered irrational. He used appropriately the RM. He may be consider as having a lower ability to reason, less intelligent, but not irrational. If however, he could have

anticipated Nature's influence, then Jacktook the wrong decision, the wrong action.

2.4. Ration

The RM refers to the attainment of any goal. From one perspective, RM is self-interested because it looks at a goal that an actor has acknowledged. Moreover, the RM has no connection with moral or ethical values, just as HE. The principal drive for HE is the achievement of the highest welfare. For RM, it is the goal and the way to achieve this goal. The only manner that moral or ethical values can be incorporated is through the establishment of moral or ethical goals. We call 'ration' the ability to reason in the RM framework.

Theorem 2. *Ration is a singularity in time and space.*

Proof. For every π, the schematic apparatus of Figure 2 does not change, the skeleton of relations do not change. However, the content of the elements of the apparatus change.

Through time, and therefore through experience, information changes; it enriches itself; beliefs change, disappear, or are reinforced; knowledge augments or decreases. All these elements determine shifts in purpose, and change the set Λ of available actions.

Any change in space and time is a change in the experience. This is the logic why ration is a singularity, and it does never happen twice in the same manner.

3. Further remarks

3.1 Everything that we do, we do with a purpose, consecutively to achieve a goal. In order to achieve π, there is a possibility that smaller goals, sub-goals, have to be accomplished sequentially. This is not contradictory to our RM. An individual uses our methodology to satisfy the particular sub-goals. The sub-goals

are treated as regular singular goals. Once all the appropriate sub-goals are archived, π is achieved by default.

We also note that all the rm_i are sub-goals of RM. One must satisfy these sub-goals, in order to arrive at π.

3.2 Using the distribution axiom of modal logic where *necessary* $(A \rightarrow B) \Rightarrow$ *(necessary* $A \rightarrow$ *necessary B)*, we realize that if it is necessary that the RM leads to the accomplishment of a specific goal, then it is necessary to use the RM, which leads necessarily to the accomplishment of the specific goal.

3.3 The RM has no link with preferences. As stated before, preferences play a central role in any theory or model that deals with traditional rationality. We have demonstrated that true rationality is a method. If one is to employ any method, one cannot look at its own preferences while using the method. An individual has preferences regarding certain goals. However, the RM does not distinguish between them and does not form any utilities regarding these goals. Once Jack decides the 'preference' of a goal, he must take the RM in order to accomplish that goal. Preferences are outside the RM.

3.4 **Observation**: Ration has no principles outside of RM.

We state that a principle is the fundamental component of a set of rules or standards. Ration is an ability, the ability to reason in a precise framework. This framework is the RM. Our methodology has operational principles. However, any other principle that is outside RM cannot be incorporated in this framework while keeping the operational value intact. Any moral or ethical principles that a player has can be incorporated only in the pursuit of ethical or moral goals. Again, the RM does not state anything about moral or immoral goals, just how goals can be achieved. However, ethics can be and are incorporated by the ethical individual as boundaries or standards of the actions available.

3.5 We feel obliged to respond to Feinberg (2005b) regarding 'maximum amount of rationality' (MAR). We have seen that rationality is bivalent and therefore, MAR cannot exist. Yet, Jack may refer to different degrees of ration because the ability to reason has different degrees. As stated before, having more information, more knowledge would increase the ability to reason, thus giving it different scales.

3.6

> While economic man maximizes ... administrative man, (organization man) satisfices…. Human beings … satisfice because they have not the wits to maximize. (Stahl 1999, pp. 122)

People satisfice because it is easier, and because their ability to reason varies. From an economic perspective, satisficing is the acumen of an individual to achieve a minimal level of a goal, the minimal value of that goal. Jack is not attempting to get the maximum possible value. He just wants to be content. For our purposes, we say that the players use bounded ration, where some limits are put on ration for various reasons. Satisficing is a conditional ration, which is any constrain on ration or on the methodology to achieve a specific goal. Most of the time these conditions are imposed by nature.

4. Conclusion

a. We recognize rationality as a super-system concept, a conceptual conglomerate where reason, judgment, deliberation, relativity, behavior, experience, and pragmatism interact.

Rationality is both a *method* and a *sequence*. The Rational Method is characterized by four steps. Showing the sequence and quantifying it enables us to have a mathematical model for rationality. This mathematical model enables us to determine the level of reason that a player uses. Moreover, our working definition of rationality can be quantifiable.

As in real situations, Nature is present, and we have to take it in consideration. We demonstrated that if one employs the rational method, one would reach the desired goal. We also showed that Nature can be either beneficial or detrimental. In both cases, we illustrated the different scenarios. With or without Nature's influence, we have proven that our rational methodology is the only manner to reach a goal. However, if Nature fully diverges with the scope of the individual, the RM does not ensure the accomplishment of a player's goal. We also have described the network of elements that interact in the reasoning process of an individual. Information plays the first step in the achievement of a

goal. Our actions are determined by information, beliefs, knowledge and purposes. Moreover, our actions determine the fulfillment of a desired goal. We described ration as the ability of reasoning using the rational method frame. We realize that ration, as well as any other thinking process, is a singularity in space and time.

b. Decision opportunity is frequent; however, taking the 'right' decision can be disputed. What would be considered as the *right* decision? For us, the right decision is a decision that reaches the desired goal, taking the appropriate method. If an alternative does not lead to the desired goal, then the decision is wrong. It is a fact that people do mistakes. There are a few explanations which are equal in importance and latter research should take them in consideration. People take wrong decisions because they have wrong information; because they use wrong assumptions; because they have a low ability to reason; because the methods used in rationality are not the appropriate ones. Should we consider these people irrational? Or, do our models that try to explain the world are out of focus and do not explain the world accurately? Irrational people are not taken out of the game (as some may argue). They play games also, because they are in social situations as well.

Postulate: Any individual that is in a situation plays a game.

c. We point out that the majority of economists are faith-based, using Assumption 1, instead of being realistic. The evidence drawn from current rational choice models points to a very important fact: RCT is limited and it is ideal.

The current TR models that are used are incomplete because they use partial definitions. Being incomplete, some of their definitions should not be assumed or believed. These partial definitions are only small pieces of a greater puzzle. What we tried to do in this paper is to complete the picture by putting all the pieces together in order to be able to move on a higher level/dimension to perceive the *ensemble* view. The result is having a unified understanding and theory of what is true rationality: it is a method.

d. Having a unilateral definition of rationality, we surpass one major obstacle preventing the development of any authoritarian unified theory.

Furthermore, different models and theories now have a common ground on which we can judge their soundness.

Appendix

MAP OF TRADITIONAL RATIONALITY

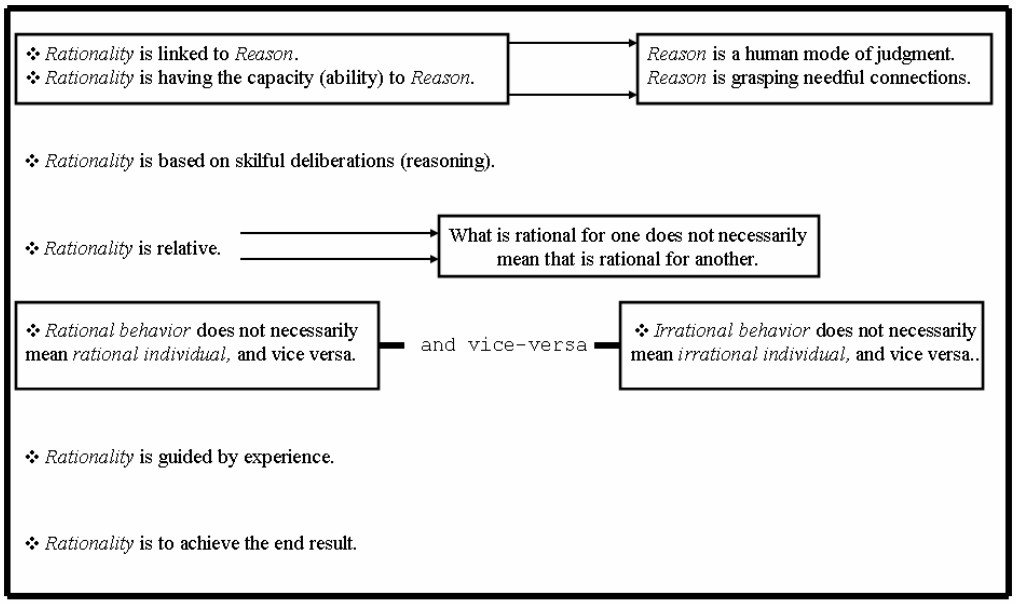

Figure 3

References

Aumann, J. Robert (1976). *Agreeing to disagree.* The Annals of Statistics vol. 4, no. 6, pp. 1236-1239.

Barker, S.F. (1965). *The Elements of Logic*. McGraw-Hill.

Bernheim, D. (1984). *Rationalizable strategic behavior*. Econometrica, vol. 52, pp. 1007-1028.

Blanshard, Brand (1962). *Reason and Analysis*. Open Court Publishing Company.

Colman, Andrew M. (1982). Ga*me Theory and Experimental Games: The Study of Strategic Interaction*. Pergamon Press.

Damme, Eric van. (1983). *Lectures Notes in Economics and mathematical Systems: Refinements of the Nash Equilibrium Concept*. Springer–Verlag.

Davis, Morton D. (1970). *Game Theory. A Nontechnical Introduction*. Basic Books.

Dufwenberg, M., Kirchsteiger, G. (2001). *A theory of sequential reciprocity. Discussion paper*. University of Vienna.

Ellsberg, D. (1956). *Theory of the Reluctant Duelist.* American Economic Review, vol. 46, pp. 909-923.

Fehr, E., Schmidt, K. (1999). *A theory of fairness, competition, and cooperation*. Quart. J. Econ., vol. 114, pp. 817-868.

Feinberg, Y. (2005a). *Subjective reasoning – dynamic games*. Games and Economic Behavior, vol. 52, pp. 54-93.

Feinberg, Y. (2005b). *Subjective reasoning – solutions*. Games and Economic Behavior, vol. 52, pp. 94-132.

Hartshorne, C. and Weiss, P. eds. (1958). *Collected Papers of Charles Sanders Peirce*. I-VII vols., Harvard University Press.

Levine, D. (1998). *Modeling altruism and spitefulness in experiments*. Rev. Econ. Dynam. vol. 1, pp. 593-622.

Moschovakis, Y. N. (1994). *Notes on Set Theory*. Springer-Verlag.

Nathanson, Stephen (1985). *The Ideal of Rationality*. Humanities Press International.

Newell, A. (1982). *The knowledge level*. Artificial Intelligence, vol. 18, pp. 87-127.

Newell, A. (1990). *Unified Theories of Cognition.* Harvard University Press.

Pearce, D. (1984). *Rationalizable strategic behavior and the problem of perfection*. Econometrica, vol. 52, pp. 1029-1050.

Pearl, J. (2000). *Causality: Models, Reasoning, and Inference*. Cambridge University Press.

Rabin, M. (1993). *Incorporating fairness into game theory and economics*. Amer. Econ. Rev. vol. 83, pp. 1281-1302.

Shanahan, M. (1997). *Solving the Frame Problem.* MIT Press.

Simon, H. (1961). *Administrative Behavior*. Macmillan.

Stahl, Saul. (1999). *A Gentle Introduction to Game Theory*. American Mathematical Society.

Straffin, Philip D. (1993). *Game Theory and Strategy*. The Mathematical Association of America.

Wald, H. (1952). *Notes on strong independence axiom*. Econometrica, vol.20, pp. 661-679.