

Modeling and Analysis of Iran's Nuclear Conflict

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Summary

Iran's nuclear conflict has been a controversial issue since few years ago. It possesses an economic, political and perhaps the military aspects that may change the power equation in the Middle East. Hence the international powers are very sensitive to this issue. However, the conflict over Iran's nuclear program is a multi-player conflict, which addresses the part of the uncertainty that Iran may face in their decision making process. To take into account the uncertainty in decision analysis effectively, the conflict over Iran's nuclear program has been modeled and analyzed using Graph Model for Conflict Resolution. We performed the stability analysis to predict the possible resolutions to the conflict. The analysis result shows that a peaceful resolution for the conflict occurs only if both Iran and UNSC reform their perception on each other. All parties should keep seeking diplomatic efforts to avoid a disaster.

Key words:

Nuclear conflict, Stability analysis, GMCR II, UNSC and IAEA.

1. Introduction

Iran has had a nuclear program for close to 50 years. We first refer to the historical background of the conflict in order to describe what has happened since about 50 years ago. In conflict modeling of any real world problems, a thorough understanding of the dispute is necessary. This understanding can be achieved by referring to the available published literatures, journal articles as well as the historical information from the reliable sources. Accordingly, the historical background of Iran's nuclear conflict is of great importance. Using the historical information, we formally model the conflict so that a stability analysis can be carried out.

The conflict over Iran's nuclear program is a multi-player conflict that possesses an economic, political as well as the military aspects that may change the power equation in the Middle East. That is why; the international powers are very sensitive to this issue. Iran's nuclear conflict has been a controversial issue mainly for the last few years. For the simplicity sake, we consider the time phase, 2006 to 2007, over which the Iran's nuclear conflict occurs would be modeled and analyzed. Players or participants in the conflict those can take actions and have significant impact on other players are to be identified from the historical information.

In this paper, we identify the players, the options or course of actions available to each player, and the player's preferences among the possible outcomes very carefully from the historical information as described in the next section. As the Iran's nuclear conflict is a multi-player conflict, there must be some uncertainty that Iran may face in their decision making process. To take into account the uncertainty in decision analysis effectively, the conflict over Iran's nuclear program has been modeled and analyzed using the Graph Model for Conflict Resolution [11].

We analyzed the current decision of Iran over its nuclear activities, especially focusing on the possible disastrous outcomes that may occur due to this conflict. Finally, we have performed the stability analysis of the feasible outcomes of the conflict to predict the possible resolution or equilibria to the conflict. The technique used for the stability analysis is the algorithm of Fraser and Hipel [13], which is based on the metagame theory of Howard [12].

2. Historical Background

Iran has had a nuclear program for close to 50 years, started with a research reactor purchased from the United States in 1959 [1]. Iran also signed the Nuclear Non-Proliferation Treaty (NPT) on July 1, 1968. Following the revolution in 1979, all nuclear activities were suspended, and two Bushehr power reactors started by a German contractor in 1974, remained unfinished due to Iran-Iraq war [2]. When the war ended, Iran began to rethink its position regarding nuclear energy and resumed its nuclear program. Finally, Iran signed a contract with the Russian Ministry of Atomic Energy in January 1995 to finish the reactors at Bushehr under the guidance of International Atomic Energy Agency (IAEA) [5].

However, the United States tried to convince Russia for canceling the agreement but its entreaties were rejected by Russia. The United States then began to say that the plutonium produced by reactors would be used by Iran for making nuclear weapons. This issue was resolved by Russia in such a way that the nuclear wastes from the Bushehr reactors would be returned to Russia since it has a huge facility for storing the wastes in the southern Siberia. After it appeared that the plutonium issue solved by Russia, the US began claiming again that while the Bushehr reactors cannot be directly used for making nuclear weapons, they will train a generation of Iranian scientists and engineers for operating the reactor, which in turn will prepare Iran for making nuclear weapons.

In February 1998, the U.S. State Department re-affirmed American opposition to the Iranian nuclear program, arguing that the nuclear reactors could be used for military purposes [3]. Besides, a considerable event in Iran's nuclear history was an announcement made in August 2002 that Tehran has built a vast uranium enrichment plant at Natanz, and heavy water plant at Arak without informing IAEA [3]. Furthermore, the President Khatami declared the construction of the facilities at Natanz for uranium enrichment in Feb. 2003. The disclosure about Natanz turned Iran nuclear issue into a significant crisis.

Mohammad ElBaradei, the head of IAEA, accompanied by a team of inspectors visited Iran. After finding traces of highly enriched uranium at Natanz, Mr. ElBaradei urged Iran to sign an additional protocol for more intrusive inspections. In October 2003, after meeting with French,

German and UK foreign ministers, Tehran agreed to stop producing enriched uranium, and formally decided to sign the protocol. One month later Mr. ElBaradei reported that there is "no evidence" that Iran was pursuing nuclear weapons. But in Jun 2004 Tehran was criticized by the IAEA for trying to import magnets for centrifuges and for not offering "full, timely and pro-active" co-operation with inspectors. The IAEA then ordered Iran to stop preparations of large-scale uranium enrichment [4]. After IAEA's order the governments of Great Britain, France and Germany (EU-3) began a series of negotiations with Iran. In November 2004, Iran agreed to stop all enrichment activities during talks with the EU-3 and waited for proposals from the Europeans [2].

For more than two years the EU-3 were negotiating to find a diplomatic solution to the international conflict over Iran's nuclear program, but they were unable to strike a sustainable deal with Tehran [6]. Meanwhile, the China and Russia's attempts at finding a reasonable resolution were failed, because Tehran formally rejected an offer from Moscow to enrich uranium for its nuclear program in Russia. Iranian officials insist upon Iran's right to enrich uranium on its own soil [7].

On September 15, 2005, at the United Nations high-level summit, President Ahmadinejad stated the Iran's right to develop a civil nuclear-power program under the NPT. In January 2006 Iran officially announced the resumption of its uranium enrichment program. This was another milestone of Iran's nuclear conflict that began a new phase in conflict and escalated the dispute. The duration for which the conflict is observed and analyzed in this paper would be after this event (after uranium resumption in January 2006 till December 2007).

In June 2006, five permanent members of UNSC (United Nations Security Council) China, France, Russian Federation, United Kingdom and United States including Germany (G5+1) agreed on an incentive package offer to Iran to convince Iran to suspend enrichment. Iran rejected the G5+1 package offer. On December 23, 2006 the resolution 1737 was unanimously passed by the UNSC. In the resolution, the Council resolved to lift the sanctions if Iran suspends the "suspect activities" within 60 days to satisfy the IAEA [8].

On March 24, 2007 the UNSC decided to tighten the sanctions and adopted a new resolution 1747 when the IAEA's report confirmed that Iran had failed to halt uranium-enrichment activities [9]. The resolution 1747 re-affirms that Iran shall implement the UN Resolution 1737. But, Iran has not suspended its uranium enrichment program yet [2].

Since Sept. 2007, the United States along with France, the United Kingdom have advocated passing a new resolution on Iran with tougher sanctions but Russia and China refused to discuss the possible new sanctions against Iran until the IAEA reports on Tehran's disclosure of its past suspicious nuclear work [10]. Since the head of the IAEA reported some recent cooperation between Iran and the IAEA in November 2007, the group 5+1 could not reach a unanimous agreement over a new resolution.

3. Strategic Analysis of the Conflict

We execute the analysis of the conflict in two steps. First, the historical information of the conflict is organized systematically and ascertains the players, options, and each player's preferences among the possible outcomes. A stability analysis is then performed in order for predicting the possible resolutions or equilibria to the conflict.

We model the conflict now using the Graph Model for Conflict Resolution technique [11]. The concepts of graph theory, set theory and game theory are used in this technique. The decision support system GMCRII [17] is used to model and analyze the Iran's nuclear conflict. To use GMCRII, the decision makers in the conflict, their options and their preferences are defined as [11]. Iran's nuclear conflict is considered for the time phase, 2006 to 2007. We identified the players or participants for the above mentioned phase of the conflict those can take actions and have significance to the other players. The following section describes the mentioned elements of Iran's nuclear conflict.

3.1 Decision Makers

As figured out by reviewing the historical background, before January 2006 the United States, Russia and China, the EU-3, IAEA, and Iran were the key players in the conflict. But the time phase we consider for the conflict, after resumption of uranium enrichment by Iranian in

January 2006, the United States, Russia, China and EU-3 tried to unify their views regarding Iran's nuclear program and express them under the UNSC's resolutions [6-7]. So, we consider UNSC, IAEA and Iran as the key decision makers (DMs) in the conflict for the mentioned phase. Options or possible actions that can be taken by each player are shown below.

3.1.1 The United Nations Security Council (UNSC)

The UNSC is the branch of the United Nations charged with the maintenance of international peace and security. Its power includes the establishment of peacekeeping operations, the establishment of international sanctions regimes, and the authorization for military action [14]. The Security Council consists of five permanent members (China, France, Russia, the United Kingdom and the United States), which have veto power over any resolution, and ten temporary members, which are elected for two years by the United Nations General Assembly. The UNSC has a significant role in the conflict, and its decisions can lead dispute to different equilibriums. According to the UNSC's function and power, the UNSC's options over the Iran's nuclear conflict are as follows [14].

Options:

1. Tighten the sanctions by adopting a new resolution (New Resolution).
2. Take military action against Iran (Military Action).
3. Close Iran's nuclear dossier and return it to IAEA (Close Dossier).

Preferences:

Although the permanent members of UNSC always have the same point of view on Iran's nuclear conflict, the UNSC's resolutions are explicitly adopting to US influence. So, the best way to understand the UNSC's preferences is to look at the US's thoughts. Obviously, the US and its allies will not tolerate an atomic Iran [10]. As the consequence, even Iran answers to all of IAEA's questions, closing of Iran's dossier will be considered as the least preferred option. Taking military action is not the most preferred option on the other hand. So, tightening sanctions to urge Iran for suspending its uranium enrichment program would be the most preferred option, the military action could be the next one and returning Iran dossier to IAEA remains as the last choice to UNSC.

3.1.2 International Atomic Energy Agency (IAEA)

The IAEA was formed as the world's "Atoms for Peace" organization in 1957 within the United Nations family and seeks to promote the peaceful use of nuclear energy and to inhibit its use for military purposes [15]. The IAEA pursues this mission with three main functions: inspections of existing nuclear facilities to ensure peaceful use, inspection of standards to ensure the stability of nuclear facilities, and as a hub for the sciences seeking peaceful applications of nuclear technology [15]. After the IAEA's Board of Governors vote to report Iran to the UNSC in February 2006 [13], IAEA hasn't stopped its negotiation with Iran and its inspectors are still going to Iran to monitor Iran's nuclear sites. The Director General of IAEA, Mohamed ElBaradei, hopes to resolve the problem by cooperation between Iran and the IAEA and reach an agreement with Iran about its nuclear program. Based on the role of IAEA, the following options are found to be considered for the conflict.

Options:

1. Reach an agreement with Iran and recommend UNSC to close Iran's dossier (Agreement).
2. Support the complete suspension of Iran's uranium enrichment program (Support Resolution).

Preferences:

Looking at the IAEA's functions and duties, it is expected to retain impartial to this conflict. In other words, IAEA's action depends on whether Iran's cooperation with IAEA is satisfactory. To keep IAEA as an unbiased party, the best model for IAEA's preferences among its possible options is to consider them all equally preferred [13].

3.1.3 The Islamic Republic of Iran

It is assumed that Ayatollah Khamenei has the final word for decision making in Iran. To understand where Iran will go, one should look carefully at what he said on March 21, 2007 in the Iranian city of Mashhad. He declared: "However, if they intend to exploit the U.N. Security Council and take illegal actions, we can and will act similarly" [16]. The message of these words is quite clear.

Hence, the following options can be considered for Iran regarding the conflict.

Options:

1. Cooperate with IAEA and answer clearly all the IAEA's questions (Cooperate).
2. Suspend all uranium enrichment activities temporarily and talk to West (Suspension).
3. Persist to operate enrichment program, leave the NPT and escalate the conflict to a war (Escalate).

Preferences:

According to the message [16], if the United States of America robs Iran of what Iranians perceive as their nation's legitimate rights, then Iran will expel IAEA inspectors, shut down its monitoring devices, and go beyond peaceful enrichment in contravention to the NPT. Thus, escalating the conflict to a war is not the least preferred option to Iran. If Iran cannot reach a strong agreement with the IAEA, as its most preferred option, uranium suspension would not be expected and Iran prefers to persist on enrichment as its undoubted right.

3.2 Feasible Outcomes

In game theory or conflict analysis, if there are n options then the total number of possible outcomes would be 2^n . Accordingly, in our Iran's nuclear conflict, 2^8 or 256 possible outcomes exist based on the number of players and possible options as identified in sections 3.1.1, 3.1.2 and 3.1.3. In practice, however, there are many outcomes or states that cannot occur, and must be removed before conflict analysis. From these 256 possible outcomes, there are four types of infeasible states [13] exist and should be removed. Table 1 shows all the removed outcomes. A dash means the entry can be either one or zero.

Table 1: Outcomes removed from Iran's nuclear conflict

Removable outcomes		Reasons
Type 1	(- 1 1 - - - -) (1 - 1 - - - -)	Mutually exclusive options for UNSC
	(- - - 1 1 - -)	Mutually exclusive options for IAEA
	(- - - - 1 - 1) (- - - - - 1 1)	Mutually exclusive options for Iran

Type 2	(0 0 0 - - - -)	UNSC will take at least one of its options
	(- - - 0 0 - - -)	IAEA will make a recommendation
	(- - - - - 0 0 0)	Iran will react selecting at least one options
Type 3	(- - - - 1 1 - -)	Mutually exclusive among Iran and IAEA
	(- - 1 - - - 1)	Mutually exclusive among Iran and UNSC
	(- 1 - - - - 1)	
Type 4	(1 1 - - - 1 1 -)	USNC will not adopt a new resolution & will not take military action if Iran cooperates with IAEA & suspend her nuclear activities.
	(0 - - - 1 - - -)	USNC will adopt a new resolution if IAEA recommends.
	(- 1 - - - - 0)	If USNC take military action then Iran will also escalate conflict.

The infeasible states were removed by using three option constraints of decision support system GMCRII [17]. A brief description of each constraint along with an example is given below.

Mutually exclusive options:

Type 1 and 3 infeasible outcomes were removed using this option as shown in Table 1. An ideal example is that the UNSC cannot proceed with both closing Iran's dossier and taking military action (See Fig.1).

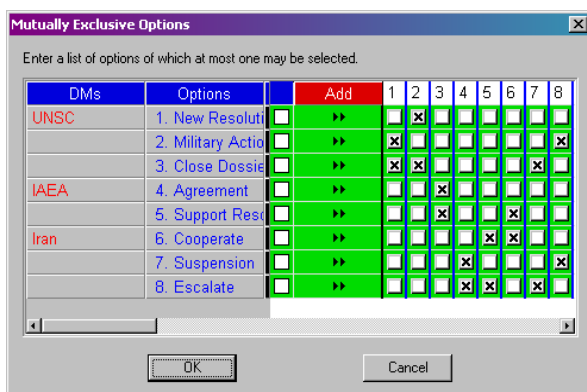


Fig. 1 Mutually exclusive options to remove infeasible outcomes.

At least one option:

In this technique, at least one option must be selected from the set of specified options. These constraints are used to remove Type 2 infeasible outcomes as shown in Table 1. For an example, the IAEA should take at least one of its options (See Fig. 2).

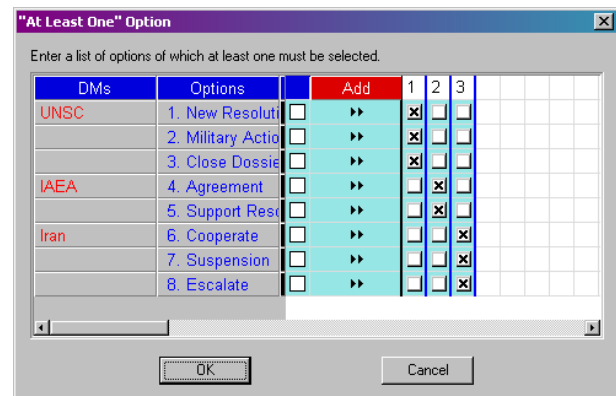


Fig. 2 Option used to removing Type 2 infeasible states.

Necessary conditions:

Type 4 infeasible outcomes were removed by using the necessary conditions. Fig.3 shows the dialog box of GMCRII for entry of the necessary conditions. The determination of feasibility of a state under necessary conditions is carried out by first checking whether the state satisfies the upper pattern. If it does not match upper pattern then it is considered as feasible. If the state does match upper pattern, then one must also check if lower pattern is satisfied [17]. For instance, the UNSC will not adopt a new resolution and will not take military action if Iran cooperates with IAEA and suspend uranium enrichment (See Fig.3).

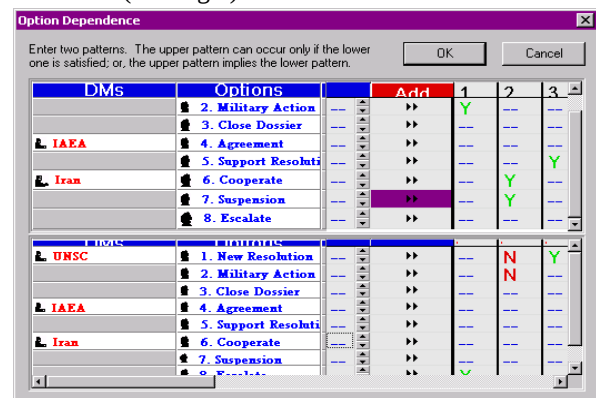


Fig.3 Necessary conditions to remove Type 4 infeasible states.

After removing all 245 infeasible states using the above mentioned three option constraints, there are only 11 feasible outcomes, which are summarized in Table 2.

Table 2. Feasible states of the Iran's nuclear conflict model

UNSC											
New Resolution	1	0	1	0	1	0	1	0	1	1	1
Military Action	0	0	0	0	0	0	0	1	1	0	1
Close dossier	0	1	0	1	0	1	0	0	0	0	0
IAEA											
Agreement	1	1	1	1	0	1	1	1	1	0	0
Support Resolution	0	0	0	0	1	0	0	0	0	1	1
IRAN											
Cooperate	1	1	0	0	0	1	0	0	0	0	0
Suspension	0	0	1	1	1	1	0	0	0	0	0
Escalate	0	0	0	0	0	0	1	1	1	1	1
State labels	1	2	3	4	5	6	7	8	9	10	11

Let us now execute the stability analysis of these feasible outcomes. To start, we need to create a preference vector for each player by ranking the outcomes in descending order from the most preferred outcome to the left to the least preferred on the right. The preference vectors for each player are shown in Table 3.

Table 3. Preference vectors for each player

UNSC	6	5	3	4	1	10	7	11	9	2	8
IAEA	1	2	3	4	5	6	7	8	9	10	11
IRAN	2	1	9	8	11	10	7	4	6	5	3

The preference vector for the UNSC is created by considering the following assumptions:

1. The most preferred outcomes are the situation that Iran suspends all of its uranium enrichment activities without any aggressive action.
2. If Iran does not cooperate with IAEA, the UNSC will force Iran by adopting a new resolution.
3. After adopting a new resolution, taking military action by UNSC is not improbable.
4. The UNSC will close Iran dossier iff Iran accepts to suspend the uranium enrichment.

It is already mentioned in section 3.1.2 that the IAEA's action depends on Iran's cooperation with IAEA. To keep IAEA as an unbiased party, the best model for IAEA's preferences among its possible options is to consider them all equally preferred.

The following assumptions are considered for identifying Iran's preference vector:

1. Closing the dossier in the UNSC and returning it back to the IAEA, without adopting a new resolution.
2. Iran's cooperation with IAEA would be furthered as far as new resolution has not been adopted by UNSC.
3. After adopting a new resolution, Iran would leave the NPT and would escalate the conflict to a war.
4. Uranium suspension is the least preferred option for Iran.

4. Stability Analysis

A stability analysis is carried out for evaluation of the conflict, and a stability analysis tableau has been created as illustrated in Table 4.

Table 4. Stability analysis tableau for Iran nuclear conflict

UNSC											
Overall stability	x	x	x	x	E	E	x	x	x	x	x
Player stability	r	r	r	s	r	r	r	u	u	u	u
Preference vector	6	5	3	4	1	10	7	11	9	2	8
UIs				3				10	7	1	7
IAEA											
Player stability	9										
Preference vector	r	r	r	r	r	r	r	r	r	r	r
IRAN											
Player stability	r										
Preference vector	1	2	3	4	5	6	7	8	9	10	11
UIs											
	r	r	r	r	r	r	u	u	u	u	u
	2	1	9	8	11	10	7	4	6	5	3
							1	2	2	10	1
								4			7

A stable state is a situation in which the players do not have any incentive to move to another state. When a player has the ability to change to a new outcome unilaterally, the player is said to have unilateral improvement (UI), from the original outcome to the new outcome. A UI is indicated in Table 4 by writing it below the outcome in the preference vector from which the player has the UI.

In conflict analysis, some outcomes can be judged to be equally preferred, and this is indicated by a bridge placed across the equally preferred outcomes. For example, outcomes 5 and 3 for Iran in Table 4 are considered equally preferred. An outcome is stable for an individual player if it is not reasonable for him to move from the outcome by switching his strategy. A rational outcome for a player does not have a UI because the player cannot improve his strategy without affecting the other players. A rational outcome, unstable outcome and equilibrium are marked as “r”, “u” and “E” in Table 4. An outcome has overall stability and is called equilibrium if it is stable for all players and hence constitutes a possible solution to the conflict. Accordingly, the possible solutions to the conflict are found to be shown in Table 5.

Table 5: Equilibrium for the conflict

UNSC		
New Resolution	1	1
Military Action	0	0
Close dossier	0	0
IAEA		
Agreement	1	0
Support	0	1
Resolution		
IRAN	1	0
Cooperate	0	0
Suspension	0	1
Escalate	1	10
State labels		

Since outcome 1 is more preferred than 10 for both Iran and UNSC, it is likely that state 1 be the dominant equilibrium. Outcome 1 indicates that despite Iran's agreement with IAEA and IAEA's report over Iran's satisfactory cooperation, the UNSC tightens the sanctions by adopting a new resolution. This indicates that if Iran does not suspend uranium enrichment, her cooperation with IAEA would not deter UNSC from adopting a new resolution.

5. Conclusion

The conflict over Iran's nuclear program has been modeled and analyzed using the Graph Model for Conflict Resolution. The analysis result shows that Iran will not suspend uranium enrichment, and the UNSC will tighten sanctions by adopting new resolutions regardless of Iran's cooperation with IAEA. Since Iran mistakenly perceives

that the UNSC is not extremely aggressive and the UNSC assumes that Iran will not escalate the conflict if new resolution adopts or military attack happens, a peaceful resolution to the conflict seems to be unlikely. A peaceful resolution for the conflict occurs only if both Iran and UNSC reform their perception about each other. In other words, Iran should consider the military attack as a serious option of UNSC, and take the previous resolutions seriously. The UNSC needs to perceive that Iran may escalate the war if any military action occurs. All parties should keep seeking diplomatic efforts in order to avoid a disaster.

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