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GAME THEORY AND A NEW INSIGHT INTO HOW THE CUBAN MISSILE CRISIS WAS RESOLVED

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Abstract

The purpose of this article is to investigate the Cuban Missile Crisis with new approaches. For this purpose, we analyse this crisis in two static and dynamic approaches. In the static approach, we look at the crisis through the perspective of credible threats. In the dynamic approach, the crisis is modelled using several game theoretic models. The models allow us to analyse the interplay of the capabilities and the feasibility objectives of each player after a conflict with the other player's objectives and capabilities. The dynamic system of games has significant implications as an important insight for modelling strategic interactions in which players pursue goals for increasing their personal interests. Our findings give insight into how the two countries reached a compromise in the Cuban Missile Crisis.

Key words: Cuban Missile Crisis, international relations, credible threats, dynamic system of games, rationality, prediction

Introduction

Game theory provides the theoretical underpinnings of analytical techniques and their application in social research. Indeed, many fields of science have benefited

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from game theoretic models (Askari et al. 2019; Rapoport et al. 1976). Dynamic games provide a framework for modelling the behaviour of players in situations where there are dynamic strategic interactions (Ungureanu 2017; Yeung and Petrosian 2017). Robinson and Goforth (2005) and Van Long (2011) provide surveys of models of dynamic games in industrial organisation. In the *Theory of Games and Economic Behavior*, Morgenstern and Von Neumann write: "We repeat most emphatically that our theory is thoroughly static. A dynamic theory would unquestionably be more complete and therefore preferable" (1953: 44). Eshaghi and Askari recently introduced a new method of modelling in game theory, named the dynamic system of strategic games (Eshaghi and Askari 2018).

In a dynamic system of strategic games, such as the game maker game and the strategy-maker game, the pair of rational actions and new properties of games are presented, and with the help of these properties, the dynamics of players' behaviours are studied. According to this feature, strategic games were divided into two classes, strategy maker games and games that were not strategy maker. Also, both strategy maker games and games that were not strategy maker were themselves divided into two groups. In this article, we present the required concepts and terms, outline some advantages of this modelling, and prove two propositions. Here, we consider strategic 2×2 games with perfect information. If a game produces other games, it is called a game maker game. In general, if the games $g_1', g_2',..., g_n'$ generate games $g_1', g_2',..., g_n'$ then g_i and g_i' are called producer and produced, respectively. In the dynamic system of games after the choice of strategy or rational action pairs is made by the players by entering into the new games, the productive game is out of reach. Therefore, the producer games are out of reach of the players, and they can influence the selection of strategies and games in the future only as a history of the system. (For more details about the dynamic system of games, refer to Eshaghi and Askari 2018; Eshaghi et al. 2019; Asghari et al. 2021; Babaei and Gordji 2022.)

As an application of the dynamic system of strategic games, we model the conflict between the Soviet Union and America after the Second World War to October 28, 1962. The Cold War was a state of geopolitical tension after the Second World War between powers in the Eastern Bloc and powers in the Western Bloc. Prior to 1957, Cuba had for many years been under the complete economic and political control of the United States. In late 1956 a revolution to overthrow the Batista regime was initiated by Fidel Castro, which triumphed in 1959. The situation was made more unstable by the unsuccessful US-sponsored Bay of Pigs invasion and a declaration by the Soviet Union of its willingness to aid Cuba in defending itself against the US (Fraser and Hipel 1982; Zagare 2014). Countries like the Soviet Union and the US also belong to different models of international relations and political systems. For modelling the Cuban

Missile Crisis, we divide the period into five smaller periods, and in each of those periods we examine static games with perfect information.

The outline of the article is as follows: in section 2, we introduce the Threat game and credible and non-credible threats. In section 3, we model the conflict between the Soviet Union and the US after the Second World War to October 28, 1962. Section 5 concludes.

Credible and non-credible threats

The recently introduced static Threat game is an extension of the Chicken game (Askari et al. 2020). The Threat game has a Nash equilibrium of pure strategy, while the Chicken game has two equilibria with pure strategy. This new game includes three strategies *F, T,* and *TF.* In the Threat game, strategy *F* means any driver doesn't use the brakes on the route and uses the only steering wheel to pull over, which is an invalid threat (because by holding the steering wheel, the player can swerve to the right or left before the crash). Strategy *T* means that the player doesn't use the steering wheel on the route and uses only the brakes to stay on the route, and this is a threat-deterrent (because by using the brakes, the player can stay on the road and not deviate from the path, and the other player must either use the brakes or deviate from the path to avoid an accident or continue on her/his path and lead to an accident). Strategy *TF* means that the player doesn't use the steering wheel and brakes on the route and only goes straight, and this is a strictly credible strategy.The Chicken game does not have a dominant strategy, but the Threat game has a dominant strategy.

Using the new game, the threats were divided into three categories. The first category includes non-credible threats. The term non-credible threat refers to the fact that even if one of the players has threatened the opposite party to use a specific strategy, if there is then a situation where he is forced to put his threat into action, being rational he will not execute the threat (Bolt and Houba 2006; Sun and Sun 2018; Zegart 2020). Threats which are not credible are not worth mentioning because the opposite party does not take them seriously, and therefore they will not have any affect on the change of the opponent's strategy in the game. The second category includes credible-deterrent threats to deter and prevent struggles, in which a player threatens the opponents to select a strategy in order to warn the opponent, and the opponent believes the player possesses the ability to execute the threat. This is exactly the concept ordinary people apply to nuclear weapons. The weapons are not for attacking, but for deterrence. The third category includes a strictly-credible threat aiming to destroy the opponent, in which case the player has the necessary and sufficient motivation to carry out a threat even if the situation leads to a struggle.

Since the occurrence of this event 60 years ago, the Cuban Missile Crisis is a case which has been highly important in international affairs, and decision-making theorists and game theorists have made several efforts to analyse it. Well-known theorists such as Schelling, Fraser and Hipel, and Zagari have modelled the Cuban Missile Crisis (Fraser and Hipel 1982; Schelling 1980; Zagare 2014). By analysing the crisis using the Meta-game theory, Howard concluded that the two parties involved in the crisis reached a compromise (Howard 1971). Brams proposed a dynamic modelling framework called Theory of Moves to model this crisis (Brams 1944).

Here, using the Threat game, we analyse the Cuban Missile Crisis (see Table 1). Conceptually we start the analysis from when the US noticed the construction of missile sites in Cuba. In this game, the US had three strategies: forcing the Soviet Union to eliminate its missiles through mass media (S), blockade Cuba and seek a solution through diplomatic channels (B), and attacking Cuba (SB). The Soviet Union had three strategies: announcing that it sought to intensify the hostilities (S), keeping the missiles there and searching for a solution through diplomatic channels (B), or attacking the US (SB).

In this game, iterated elimination of strictly dominated strategies allows us to solve the game. For both players, SB is strictly dominated by (B). By eliminating this strategy, players have two strategies, S and B. Now for both players, S is strictly dominated by B. So the game equilibrium is (B.B), that is, the two countries use a credible-deterrent strategy to prevent an atomic war. In other words, the blockade of Cuba by the US and keeping the missiles there by the Soviet Union, along with the use of a diplomatic channel, was the same as engaging a brake against atomic war by both players. Therefore, this static analysis gives a logical insight as to why the two countries reached a compromise in the Cuban Missile Crisis.

Table 1   Threat game

USA		Soviet Union	
	S	**B**	**SB**
S	0, 0	–3, 3	–2, 2
B	3, –3	1, 1	–3, –5
SB	2, –2	–5, –3	–6, –6

Analysis of the Cuban Missile Crisis with a dynamic approach

The Soviet Union and US relations after the Second World War were sometimes strained. But the most important and dangerous crisis in the Soviet Union and US relations, which put the world on the edge of a devastating war, followed the establishment of Soviet missile bases in Cuba. The Soviet Union wanted to establish a massive arsenal of heavy weapons there in order to become the largest military station in the Caribbean. But Khrushchev's trick was ultimately revealed. In October 1962 a US spy plane discovered a missile launch site to the west of Havana, which confirmed the establishment of medium-range missiles in Cuba (May and Zelikow 2002). To confront the danger of that threat to US security, the president convoked a war council, and for one week a serious and secret discussion was held in the White House. In this council, different suggestions were proposed, including bombing the missile launch platform, or an all-out military attack on Cuba and military occupation of the country. On 22 October 1962 Kennedy then informed the American people that the Soviet government had established missile bases in Cuba, a distance of one hundred miles from American beaches, and warned them that this presented a threat to the country's security. In the same announcement he told the Soviet government that it must remove its missile bases from Cuba. Following this, he issued an order for a naval blockade of Cuba to prevent the transfer of the Soviet's new missile equipment to Cuba (Kennedy 1969). This issue became a world crisis for one week. (For more information about the Cuban Missile Crisis, see Blaschke 2016; Crall and Martin 2013; and Gibson 2012.)

In this section, we propose a different model from the static one-play interaction of the Soviet Union and the US in in the Cuban Missile Crisis. Now we will use a dynamic system of games to model the relations between the Soviet Union and the US after the Second World War leading up to October 28, 1962. To this end, we divide the period into five smaller periods, and in each of those periods we examine static games with perfect information. The first period is from the end of the Second World War to October 13, 1962, which is represented by game g_1. The second period from October 14 to 22 is represented by games g_2 and g_3. The third period is from October 23 to 25 and is represented by games g_4, g_5, g_6 and g_7. The fourth period is from October 26 to 27 and is represented by games g_8 and g_9. And finally, the day of October 28 is represented by game g_{10}.

Relations between the Soviet Union and the US after the Second World War and during the 1950s constituted a Deadlock game in which they manifested minimal desire to cooperate with each other. As a result, both countries selected the non-cooperation strategy. The Deadlock game g_1 is shown in Figure 1. The row player (player 1) is the Soviet Union and the column player (player 2) is the US. The players' set of actions include cooperation $_1C$ and defect $_1D$. Players' preferences in this node are the same order preferences of strategic game g_1. The game's Nash equilibrium is $(_1D,_1D)$. In g_1, dominant action $_1D_1$ is defect and dominated action $_1C_1$ is cooperation for player 1. Also, this game has a dominant action of defect $_1D_2$ and dominated action of cooperation $_1C_2$ for player 2. In other words, game g_1 is an action maker of order (2, 2). The only pair of rational actions for the players is $(_1D,_1D)_{1,2}$. Based on the players being rational, they select dominant action $_1D_1$ and dominant action $_1D_2$ for the continuation of the game. According to its dominant action, the Soviets were convinced in July 1962 to implement their Atomic Missile Establishment plan in Cuba in order to confront the US's growing expansion.

Action $_1D_1$ leads to Hostage game g_2. The Soviet Union wanted to surprise the US. In this game, the Soviet Union has two possible actions: either cooperate $_2C$ through removing the missiles or defect $_2D$ and maintain the missiles. The US could reveal the issue $_2C$ or keep it secret $_2D$. The game Nash equilibrium is $(_2D,_2D)$. This game has a dominant action of defect $_2D_1$ and a dominated action of cooperation $_2C_1$ for player 1. The dominant action $_2C_2$ for player 2 is revealing the issue and the dominated action $_2D_2$ is keeping it secret. The only pair of rational actions for both players is $(_2D,_2C)_{1,2}$.

Action $_1D_2$ leads to the Self-Serving game g_3. In g_3 the US has two actions: either it cooperates $_3C$ by doing nothing or it defects $_3D$ through a blockade of Cuba. The Soviet Union also has two actions: either it cooperates $_3C$ to remove missiles through the diplomatic channel or it defects $_3D$ and maintains the missiles. The game Nash equilibrium is $(_3C,_3D)$. Game g_3 is action maker of order (2, 1). This game has a dominant action of defect $_3D_{1,2}$ and a dominated action of cooperation $_3C_{1,2}$ for player 2. Pairs of rational actions for the players are $(_3C,_3D)_{1,2}$ and $(_3D,_3D)_1$.

Action $_2D_1$ leads to the Chicken game g_4. In g_4 the Soviet Union has two possible actions: either it does not attack the US $_4C$ or it attacks the US $_4D$. The US has two possible actions: either it does not attack the Soviet Union $_4C$ or it attacks the Soviet Union for retaliation $_4D$. The game Nash equilibria are $(_4C,_4D)$ and $(_4D,_4C)$. Game g_4 is action maker of order (2, 0). In other words, this game is not action maker for the players. The players' pairs of rational actions are $(_4C,_4C)_{1,2}$, $(_4D,_4C)_1$ and $(_4C,_4D)_2$.

Action $_2C_2$ leads to the Stag Hunt game g_5. In g_5 the US has two possible actions: either through diplomacy it seeks a solution $_5C$ or through diplomacy it puts pressure on the Soviet Union $_5D$. The Soviet Union has two possible actions: either it seeks a solution $_5C$ through diplomacy or it thinks about crisis intensification $_5D$. The game Nash equilibria are ($_5C$, $_5C$) and ($_5D$, $_5D$). Game g_5 is action maker of order (2, 0). The players' pair of rational actions are ($_5C$, $_5C$)$_{1,2}$ and ($_5D$, $_5D$)$_{1,2}$.

The pair of rational actions ($_3C$, $_3D$)$_1$ leads to another Stag Hunt game g_6. In g_6 the Soviet Union has two possible actions: either it does not break the blockade $_6C$ or it breaks the blockade $_6D$. The US has two possible actions: either it does not have a conflict $_6C$ with the Soviet ships or it has a conflict with the Soviet ships $_6D$. The game Nash equilibria are ($_6C$, $_6C$) and ($_6D$, $_6D$). Game g_6 is action maker of order (2, 0). The players' pair of rational actions are ($_6C$, $_6C$)$_{1,2}$ and ($_6D$, $_6D$)$_{1,2}$.

Action $_3D_2$ leads to Chicken game g_7. In g_7 the US has two possible actions: either it does not attack the Soviet Union $_7C$ or it attacks the Soviet Union $_7D$. The Soviet Union has two possible actions: either it does not attack the US $_7C$ or it attacks the US in a retaliatory invasion $_7D$. The game Nash equilibria are ($_7C$, $_7D$) and ($_7D$,$_7C$). Game g_7 is action maker of order (2, 0). The players' pairs of rational actions are ($_7C$, $_7C$)$_{1,2}$, ($_7D$, $_7C$)$_1$ and ($_7C$, $_7D$)$_2$.

Based on players' rationality and strategic preferences, players selecting pairs of rational actions ($_4C$, $_4C$)$_{1,2}$, ($_5C$, $_5C$)$_{1,2}$ and ($_6C$, $_6C$)$_{1,2}$ move to Coordination game g_8. In g_8 the Soviet Union has two possible actions: either it issues the command for its ships not to move toward Cuba $_8C$ or it thinks about resolving the crisis through negotiation $_8D$. The US has two possible actions: either it issues the command that its ships not confront the Soviet ships $_8C$ or it thinks about resolving the crisis through negotiation $_8D$. The game Nash equilibria are ($_8C$, $_8C$) and ($_8D$, $_8D$). Game g_8 is action maker of order (2, 0). The players' pairs of rational actions are ($_8C$, $_8C$)$_{1,2}$ and ($_8D$, $_8D$)$_{1,2}$.

Based on players' rationality and strategic preferences, players selecting pairs of rational actions ($_5C$, $_5C$)$_{1,2}$, ($_6C$, $_6C$)$_{1,2}$ and ($_7C$, $_7C$)$_{1,2}$ move to game g_9. In g_9 the Soviet Union has two possible actions: either it removes the missiles from Cuba $_9C$ or it maintains the missiles in Cuba $_9D$. The US has two possible actions: either it removes its blockade of Cuba $_9C$ or maintains its blockade of Cuba $_9D$. The game Nash equilibria are ($_9C$, $_9C$) and ($_9D$, $_9D$). Game g_9 is action maker of order (2, 2). In g_9 the weak dominant action $_9C_1$ for the Soviet Union is removing the missiles and its weakly dominated action $_9D_1$ is maintaining the missiles. For the US the weakly dominant action $_9C_2$ is removing its blockade and the weakly dominated action $_9D_2$ is maintaining its blockade. The players' pairs of rational actions are ($_9C$, $_9C$)$_{1,2}$, ($_9D$, $_9D$)$_{1,2}$, ($_9D$, $_9C$)$_1$ and ($_9C$, $_9D$)$_2$.

Based on players' rationality and strategic preferences, players selecting pairs of rational actions $(_8C, _8C)_{1,2}$ and $(_9C, _9C)_{1,2}$ move to Win-Win game g_{10}. In this game both players have two possible actions, cooperation $_{10}C$ and defection $_{10}D$. The game Nash equilibrium is $(_{10}C, _{10}C)$. With this the players have no desire to continue and so this completes the system.

The dynamic system of games with strategic games between the Soviet Union and the US is represented by the graph in Figure 1. The history of the system is as follows.

In Figure 1, if the Chicken game had a dominant action even for one player, an atomic war would probably have occurred. This weakness of not having the dominant action in this game causes the players to consider their strategic preferences and not to use tactical preferences inside the game. In other words, players prefer strategic preferences over tactical preferences. Recognising this is important for understanding why the two countries reached a compromise in the Cuban Missile Crisis.

$$H = \left\{ \begin{array}{l} \left\{g_1, _1D_1, _1D_2 \right\}, \left\{_1D_1, \left\{g_2, _2D_1, _2C_2 \right\} \right\}, \left\{_1D_2, \left\{g_3, _3D_2, (_3C, _3D)_1 \right\} \right\}, \\[6pt] \left\{_2D_1, \left\{g_4, (_4C, _4C)_{1,2} \right\} \right\}, \left\{_2C_2, \left\{g_5, (_5C, _5D)_{1,2}, (_5C, _5D)'_{1,2} \right\} \right\}, \\[6pt] \left\{(_3C, _3D)_1, \left\{g_6, (_6C, _6D)_{1,2}, (_6C, _6D)'_{1,2} \right\} \right\}, \left\{_3S_1^1, \left\{g_7, (_7C, _7C)_{1,2} \right\} \right\}, \\[6pt] \left\{(_4C, _4D)_{1,2}, (_5C, _5D)'_{1,2}, (_6C, _6D)_{1,2}, \left\{g_8, (_8C, _8C)_{1,2} \right\} \right\} \\[6pt] \left\{(_5C, _5D)_{1,2}, (_6C, _6D)'_{1,2}, (_7C, _7D)_{1,2}, \left\{g_9, (_9C, _9C)_{1,2} \right\} \right\} \\[6pt] \left\{(_8C, _8C)_{1,2}, (_9C, _9D)_{1,2} \left\{g_{10} \right\} \right\} \end{array} \right\}$$

Conclusion

A dynamic system of games helps us to analyse an event by dividing it into different periods and dynamically using several games. This enables the event analyst to evaluate the decisions and strategies that the players have chosen in order to achieve a reasonable and acceptable result. The system also shows the impact of players' decisions on each other, and the impact of the results from one period on the results of subsequent periods.

In this study, we used a dynamic system of strategic games to investigate the interaction between the Soviet Union and the US from the end of the Second World War until October 28, 1962, that is, up to the end of the Cuban Missile Crisis. A dynamic system of games is a combination of dynamic and static

g_1

	$_1C$	$_1D$
$_1C$	2,2	1,4
$_1D$	4,1	3,3

$_1D_1$ $_1D_2$

g_2

	$_2C$	$_2D$
$_2C$	1,4	2,3
$_2D$	4,2	3,1

g_3

	$_3C$	$_3D$
$_3C$	1,3	3,4
$_3D$	4,1	2,2

$_2D_1$ $_2C_2$ $(_3C,_3D)_1$ $_3D_2$

g_4

	$_4C$	$_4D$
$_4C$	3,3	2,4
$_4D$	4,2	1,1

g_5

	$_5C$	$_5D$
$_5C$	4,4	1,3
$_5D$	3,1	2,2

g_6

	$_6C$	$_6D$
$_6C$	4,4	1,3
$_6D$	3,1	2,2

g_7

	$_7C$	$_7D$
$_7C$	3,3	2,4
$_7D$	4,2	1,1

$(_5C,_5C)'_{1,2}$ $(_6C,_6C)'_{1,2}$

$(_4C,_4C)_{1,2}$ $(_7C,_7C)_{1,2}$

$(_6C,_6C)_{1,2}$ $(_5C,_5C)_{1,2}$

g_8

	$_8C$	$_8D$
$_8C$	4,4	1,1
$_8D$	2,2	3,3

g_9

	$_9C$	$_9D$
$_9C$	4,4	1,3
$_9D$	3,1	1,1

$(_8C,_8C)_{1,2}$ $(_9C,_9C)_{1,2}$

g_{10}

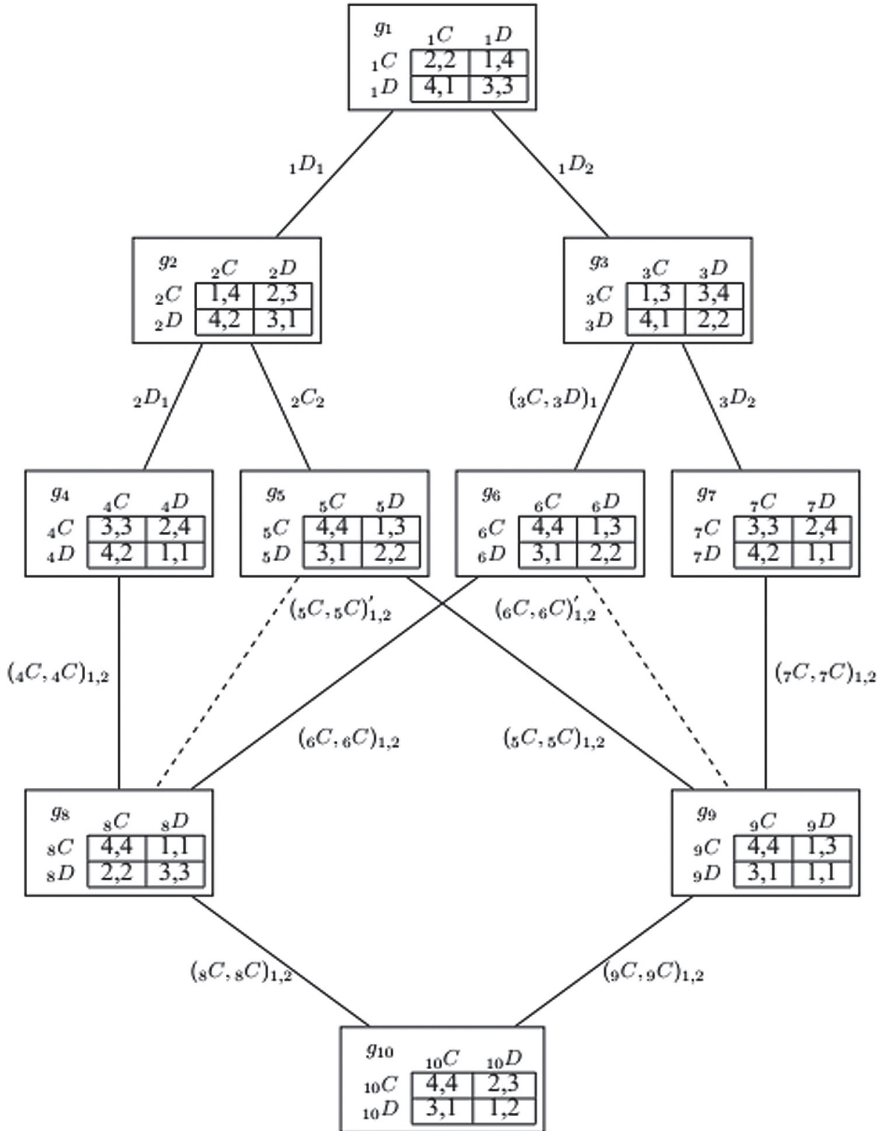|	$_{10}C$	$_{10}D$
$_{10}C$	4,4	2,3
$_{10}D$	3,1	1,2

Figure 1   Dynamic system of games between the Soviet Union and the US.

interactive situations that are moving forward. In our case we divided the full time interval into five periods, and in each period we reviewed static games with complete information. Each country, based on its forces and capabilities, sought to achieve its goals and objectives in Cuba. The result of the dynamic game was

that the countries reached a compromise, as in fact occurred in history. Looking at the strategies adopted in each period, we can see what sorts of strategies have the potential to achieve such a compromise. Thinking about other cases of conflict beyond the case we examined, this study shows how a dynamic system of strategic games can provide a frame for analysing what sorts of cooperative behaviours among players can potentially yield an exit from the conflict.

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