Outwit, Outplay, Outlast:
A Game-Theoretic Analysis of "Survivor"

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ABSRACT

The CBS reality television hit "Survivor", is itself a carefully crafted game, defined by a set of strict rules. Sixteen players compete for a real individual pre-tax payoff of $1,000,000. Using majority rules, players successively vote each other out of the game until only one remains, who then claims the million-dollar prize. What has emerged after two seasons seems to be a game of complex timing in cooperation, defection, investment, and signaling strategies. Of all possible strategies, players most commonly form alliances with other players to get them to the end of the game.

I carefully examine the alliances of "Survivor" using game theory to show that creating alliances is a weakly dominant strategy. I also show that given any n players, a stable alliance must be of size at least INT[n/2] +1, and include players of consecutive ability to win the game. Finally, I analyze several real alliances used in different "Survivor" games to show how alliances have worked, or failed, their members in previous plays of "Survivor".

Introduction

"Survivor" is easily the most popular of the new "reality-TV" shows that have graced the networks for the last few years. This reality game show pits sixteen Americans against each other in a hostile environment, which so far has included a desert island, the Australian Outback, and Kenya. Forced to fend for themselves, these sixteen contestants must work together to survive the environment, while systematically voting one contestant out of the game every three days. In the end, only one person remains standing, which will claim the title "Survivor" as well as the million-dollar prize, and all of the fame that comes with having won this immensely popular game.

While being an extremely complex game, "Survivor" offers us an interesting look at the behavior of strategic agents in a dynamic setting where they compete for an eventual payoff. "Survivor" contestants must cooperate with each other, as well as vote strategically in order to maximize the probability that he or she will be the winner.

Understanding the outcome of each play of "Survivor" is a difficult task because so much can happen to influence the end. I propose to analyze "Survivor" using a game-theoretic approach. First, I will describe the play of the game as an introduction to my model. Second, as alliances are the most common stratagem used by players, I will model the alliance aspect of the game abstractly. My model will rest upon a series of assumptions about incentives and players that are supported by the available data and by intuition.

Once the game is modeled, I will compare my results and predictions with the games of "Survivor" that have already been played. Do the real players act according to their incentives as predicted by the model? Have the alliances we have seen in previous

plays of "Survivor" been as successful as the players hoped, and was it rational for those players to form the alliances they did?

I find that for any given round of the game, all players will prefer to be in an alliance of at least half the number of total players. A stable (defined later), successful alliance will always contain a majority of players in each round as the game progresses. I also show that if players can rank themselves in ability to win the game, we should only observe alliances between players of consecutive rank.

Overview of the Game

Selection of the Players:

Survivor contestants apply to participate in the game. In order to be eligible to participate, applicants must be at least 21 years old and in excellent physical and mental shape, not hold any public office around the time of the game, and be a U.S. citizen currently residing in the United States. The application itself includes a written portion involving questions designed to give the producers of Survivor an idea as to the character of the applicant. For example, "Describe your perfect day" and "Who is your hero and why?" are some of questions given. All applicants must also submit a three-minute video of themselves explaining who they are and why they would be the winner of the game, referred to as the "ultimate Survivor". Applicants are told to be creative in the video, as it shows the producers what you look like and what your personality is like.

Given the enormous popularity of the game, the application process is extremely competitive. After the game became a success with its first run in the summer of 2000, each successive play of the game has averaged around 50,000 applicants. From these 50,000 the producers of Survivor choose approximately 500 whom they wish to

interview. These potential contestants then undergo a series of interviews and psychological tests to determine both who could withstand the physical challenges of the environment and the mental challenges of the game, as well as who the producers think would be interesting to the viewers. After all, Survivor is a product that in the end must be marketed to the public.

The final candidates must submit to a comprehensive background check, after which the producers will select 16 final contestants and a few alternates, in case of last minute problems with one of the contestants. In previous plays of the game, the selected contestants include 8 women and 8 men, ranging in age from early twenties to early seventies. These contestants usually represent a broad spectrum of outdoors and athletic ability, as well as cultural and ethical backgrounds. They are chosen from all over the United States.

Contestants who make the final cut are called "survivors". They are the sixteen players of the game, among whom one shall claim the title "ultimate survivor".

Environmental Aspect of the Game:

The actual game of Survivor takes place far away from any civilization. The game's producers try to create a real sense of abandonment in the locations that they choose. The location of every game played so far bears this out. Survivor 1 took place on a desert island in the South China Sea. Survivor 2 took place in the middle of the Australian Outback. Survivor 3 was on a game reserve in Kenya, Africa. Survivor 4 returned to the islands, this time a small one near Tahiti.

This game adheres well to its name. As these locations show, playing the game of Survivor is in part about surviving the harsh environments. Survivors are meant to

"survive" the area where they are placed, as much as they are expected to "survive" each other.

Survivors are allowed a limited amount of clothing (perhaps 2 or 3 changes of clothes), and one luxury item. This item must be something of personal value, but cannot be anything that could clearly be used as a survival tool, meaning for example, a pocketknife. Types of luxury items the survivors have brought include among other things: Bible, toothbrush, journal and pen, coloring book, deck of cards. Some survivors have been creative and brought luxury items that with a little imagination could be turned into a survival tool. For example, in Survivor: Australia, one survivor brought a large flag of Texas, which he and the others promptly converted into a tarp for their shelter.

Along with their personal and luxury items, the survivors are given a limited amount of supplies when they reach the area where the game will be conducted. In recent plays of the game, these supplies have included a few cooking pots, some small amount of medical supplies, and most importantly, a small amount of food and water.

It is important to note that survivors are expected to find their own water once the game begins. The amount they are allowed to start out with is minimal; if rationed well it will only last them a couple of days. It is their responsibility to find the water source closest to their camp, and to boil the water before drinking it so as not to get sick. The ability to make fire (not that easy, given they are not allowed to bring matches, flint, magnifying glasses, or any other such instrument) thus becomes the first priority of any group of survivors.

For food, survivors have usually been given either a large amount of rice or cornmeal, with maybe a few vegetable plants as well. This amount of food, if rationed

carefully, can last the survivors the entire game. If the government who controls the area where the game takes place permits it, survivors are free to forage for extra food. This includes searching for edible fruits and vegetables as well as hunting animals. Sometimes this is not an option, for example, the survivors in Survivor: Africa were not allowed to hurt any wildlife, due to the fact that it took place on the game reserve.

The producers of the game hold very strict to these food limitations. Survivors are not given extra food or water off-camera. Of course they cannot be allowed to starve to death. However, if survivors run out of food, even despite their best efforts, they are not given more food freely. In Survivor: Australia, when the contestants were running dangerously low on food due to poor rationing they were given choice: either continue to fish and forage in hopes of finding something, or trade in their tarps and shelter in return for a small but adequate amount of fishing wire and rice. In their dilemma, the survivors were willing to trade anything for more food.

When a survivor "loses" the game, i.e., he or she is voted out, they are removed from the environmental conditions of the game. However, no player returns home until the game has ended. This way, the producers keep the order in which the players were voted out as best a secret as possible.

Game Play

Opening Phase:

"Survivor", as stated earlier, consists of 16 contestants. These contestants, or survivors, are separated at the beginning of the game into two teams, referred to as "tribes". Each tribe consists of 4 men and 4 women. They are approximately separated evenly with respect to age as well. Each tribe typically has one male and one female in

their early twenties. One male/female pair is usually in their late twenties or early thirties. Another pair is in their late thirties or forties. The final male and female are usually in its fifties or sixties.[1]

The apparent goal of the show's producers in dividing the teams is to create two teams of approximate equal strength, so that at least at the beginning, no one tribe has a distinct advantage over the other. The survivors are not aware of who their fellow tribe-mates are until the game begins. They are not even allowed to converse with one another until they have been taken to the game site.[2]

Once they have reached the environment where the game will take place, the survivors are given whatever supplies the producers feel necessary to give them; then players are forced to carry these items, as well as their personal items to their individual tribal sites. This is the first strenuous requirement of the game, as the journey typically takes several hours. Several miles usually separate these sites from each other, so as to give each tribe a sufficiently large area to explore and to hunt in.

Outwit, Outplay, Outlast
Phase 1:

Once the players have reached their respective campsites, they begin the daily routine of survival: constructing shelter, hunting for food, gathering firewood. The real game of survivor however, is the game played between the players as they attempt to "Outwit, Outplay, Outlast", which is the slogan of Survivor.

Every episode of Survivor covers three days time, which I will refer to as the rounds of the game. In each round, the two competing tribes come together twice to

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[1] The oldest participant so far in Survivor has been the then 72 year-old Rudy Boesch
[2] This was not true on the first play of Survivor. Once players had boarded the boat that took them to the island, they were free to communicate. However, in all successive Survivors, the previously described rule has been in effect.

compete in a challenge. Challenges can be anything from obstacle races to puzzles and mazes. The tribes compete as teams against one another. Usually they involve intricate teamwork between the members of the tribe, so that if one tribe member falls short in the challenge, it usually hurts the entire tribe's performance.

There are two types of challenges: Reward and Immunity. The Reward Challenge is always first, usually on the first of the three days. In a Reward Challenge, the tribes compete in some physical or mental challenge, of which the winning tribe receives a "reward". Rewards are typically some object that will increase the tribe's comfort, and make surviving the environment easier. Previous rewards have included: food, matches, blankets, fishing gear, and a filled water tank.

The Immunity Challenges are far more important in the long run than the Reward Challenges. The tribes meet to compete typically on day two or three. Immunity Challenges are much akin to Reward Challenges. They alternate between physical challenges such as races to mental challenges such as constructing S.O.S. signs (the easier one to spot from the air or sea wins the challenge). The tribe that wins the Immunity Challenge wins immunity from that round's vote. Meaning that the losing tribe is the tribe that has to go to Tribal Council (explained below) that round and vote one of its own members out of the game.

Phase 2:

When there are only 10 players total remaining in the game, the two tribes merge into one tribe, no matter how many challenges each tribe has won. This means that the tribes can merge in any proportion from even 5-5 to a lopsided 8-2. In this new single

tribe of 10 players, competition becomes individual vs. individual, rather than team-based. Play will continue this way until the end of the game.

For each challenge, only one player will emerge the winner. This time, the reward from the per round Reward Challenge is specifically the winner's, unless she chooses to share it with her fellow players in hopes of currying favor. Individual rewards tend to be more elaborate, including an entire day on a cruise ship, a snorkeling trip, a full-course meal, and even a car or truck. Sometimes the winner is allowed to pick one other player to share the reward with, which is an excellent method the producers use to reveal information on friendships and alliances to the other players.

Like the rewards, only one player can win immunity each round. From this point onward, every player, including the one with immunity, goes to Tribal Council and votes. The major difference is that for any given round, the player with immunity cannot receive any votes. Individual immunity becomes a guaranteed pass to the next round of the game. However, immunity goes up for grabs again every round, and the remaining players compete in a new Immunity Challenge.

Tribal Council:

At the end of every three days, the players gather to vote one of their own out of the game, in what is referred to as Tribal Council. At every Tribal Council the host, currently the poker-faced Jeff Probst, asks the players probing questions before the players actually cast their votes. These questions usually call to players' attention past mistakes certain players have made, or the current state of alliances and friendships.

Once he feels he has sufficiently stirred them up, Jeff Probst allows them to vote. Each player in turn walks a short distance to the voting booth, where they write down the

name of the person they are voting against on a strip of paper. They then take what time they want explaining to the camera, and the national audience, why they are casting their vote against that particular person. Having said their peace, they fold their vote so that subsequent players can't read it, and place it in a small box.

When all the players have cast their votes, Jeff Probst opens the vote box and begins to read the votes, revealing them one by one to the players. As soon as any one name has received a majority of votes, he declares the vote over, and does not read the, if any, remaining votes. Jeff Probst declares, "The Tribe has spoken." The player receiving the majority of votes has been "voted out" of the tribe, and is removed from the game. Probst asks the player to leave immediately, which he does, taking with him whatever personal belongings he brought to Tribal Council. After a few closing remarks, Probst dismisses the remaining players to return to their campsite for the evening.

If there is a tie-vote, then the two targets are asked to give a short statement saying why they feel they deserve to remain in the game. After hearing them out, the players all vote again, but this time they must vote for one of the two targets. If the result of the second vote is another tie, then the producers will add votes cast in previous tribal councils to the total. This way, votes in the past can come back to haunt a player.

All players receive some amount of cash reward depending on how long they remain in the game. The first player to be voted out is usually rewarded a few thousand dollars, and the second player receives a few thousand more. Cash rewards increase incrementally with the number of rounds players last. Third place wins $85,000, second place wins $100,000, and first place claims the grand sum of $1,000,000.

Endgame:

Starting when there are only 9 players remaining in the game, those players who are voted out join what is called the "jury". For example, when 5 players remain there are already 4 members of the jury. Jury members return for every Tribal Council after they are voted out to act as observers. They see how the rest of the game plays out. No communication is permitted between jury members and players.

The game continues normally until only 3 are left. At that point the players participate in one final Immunity Challenge. The winner of that challenge is the only voter in that round (because the other two votes cancel out). She decides which of the other 2 players she wants to go head to head with in the final round. The player she votes out becomes the seventh and final member of the jury.

It is the jury that will decide how the game ends. The final two players spend one more day back at camp, and then return to the final Tribal Council that night. In this Tribal Council, the final 2 are made to answer for how they conducted themselves throughout the game.

Each player opens with a statement. It can be as long as they want. Jeff Probst asks the players to tell the jury why they believe that they made it to the final 2, and why they deserve to be the 'Ultimate Survivor'.[3] Typically players are not apologetic in these speeches for being in the final 2, but they are also quite humble. After hearing these testimonies, one by one each member of the jury asks a question which the players must respond to. Questions have ranged from the mundane "what will you do with the money

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[3] For example, Colby Donaldson's statement to the Jury in "Survivor: Australian Outback":
"Well, I guess we're supposed to make a spiel here about why we deserve the million dollars, or why I deserve it over Tina, and I don't. I don't know that I do. You've gotta be a jack of all trades, but not necessarily a master at any, and that's an old saying that goes way back. I don't think I was necessarily the best at anything, and I don't think I've beat Tina in strategy or any elements of the game, but I feel like I did 'em all pretty good, and that's why I'm here."

if you win?" to the more loaded "which member of the jury do you believe does NOT deserve the million dollars?"

These questions are meant to give the jury members a better idea as to which remaining player they want to be the winner. Sometimes a jury member already knows whom she wants to win, and uses the question to stab at the other player in front of the other jury members, in hopes of swinging their opinion. Others have nothing to say, and use their question as their own personal closing statement to the game.

Once all questions have been asked, the two players are allowed to make a short closing statement to the jury, maybe to answer any stabs taken at them, or make a last ditch effort at currying favor.[4] One by one, the jury members approach the voting booth, and write down the name of the player they think deserves to win. Unlike before when players vote against each other, this time they are voting for someone. Having all cast their votes, the host reads the votes to the players and jury simultaneously. The player with the most votes claims the title "The Ultimate Survivor" and the grand prize of $1,000,000.

The Model

Modeling a game as complex as "Survivor" is impossible, because there exist and infinite number of strategies that both players and nature can take throughout the multi-round game. In this model, I will isolate a particular type of strategy, the alliance strategy. Forming alliances appears to be the most common strategy among players to

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[4] For example, Richard Hatch's closing statement to the Jury in "Survivor":
I imagine it's probably a pretty difficult decision for some people, and I just want to say that I appreciate your making it. I wouldn't change anything that I did, and I hope you respect that that was what I felt I needed to do to play the game. Thanks."

date. I will show why forming alliances is a weakly dominant strategy, and I will try to

reach some conclusions about the nature and the stability of these alliances.

Let N be the set of players. N = {1, 2, …, n}

Let R be the set of rounds that mark the duration of the game. R = {1, 2, …, r}[5]

Definition: An **alliance** is an agreement between two or more players. Players in an

alliance will not vote against any member of the alliance in the next Tribal Council (TC).

Alliances last for at least one round, meaning through the next TC, at which time players

can decide to continue the alliance, or defect to a new one.

Definition: **Endgame** is the final round where only two players remain, and the jury,

comprised of the seven previously voted out players, votes on which of the two players

they think deserves the million-dollar prize.

Definition: Define $\theta_j \in [0,1] \ \forall \ j \in N$, as j's belief that he will **not** be voted out in this

round's TC.

A1:   Assume that in each round, U^r_j is the incremental utility payoff to player j from

advancing up from round r. Let $U^r_j = 0$ for each period that player j is voted out.

A2:   Assume that players are not risk-loving.

Let A(j) denote the set of players that form the alliance that j belongs to. By the

definition of alliance, A(j) is not the empty set as long as j is a member of an alliance.

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[5] Obviously, n is a function of r, and n is strictly decreasing in r. However, this is not a factor in my
analysis, so I treat n as the number of players in any given round r.

Lemma 1:   Forming an alliance is a weakly dominant strategy

      Proof: This result follows almost immediately from the definition of alliances. Note that players' utility is increasing with the number of rounds they remain in the game. This comes from the fact that the longer a player remains in the game, the larger amount of money they win. Therefore rational players will choose strategies that they believe will increase their time in the game.

      From **A2**, players will treat each successive round they participate in as if it is the first round. At each round's TC, players have an expected utility representation $EU_j = \theta_j(U^r_j)$. From our definition of alliances, θ_j is a function of the size of the alliance to which player j belongs. The more players are in an alliance with player j, the fewer votes are available to be cast against player j, so θ_j is weakly increasing in the size of j's alliance. Therefore, each player's expected utility is also weakly increasing in the size of his or her alliances.   **Q.E.D.**

      A stable alliance is one in which the members of the alliance have no incentive to leave the alliance with any subset of players and create another alliance with anyone else. An alliance must be stable for at least one round to be considered a viable alliance.

Proposition: If an alliance is stable then it must be of size at least INT[n/2]+1.

      Proof: Assume that there are n players in this TC. Since it only takes a majority vote to be kicked out of the game, if player j is in an alliance of any size greater than INT[n/2]+1, he cannot be voted out of the game in that round. When $|Aj| \geq INT[n/2]+1$,

$\theta_j = 1 \; \forall \; i \in A_j$. So in any given round of n players, an alliance of size at least INT[n/2]+1

guarantees all members of that alliance a pass to the next round of the game.

Any size alliance less than INT[n/2]+1 does not guarantee its members passage to

the next round of the game. Each player will still have some $\theta < 1$ in his expected utility.

Assuming that all players are not risk loving, any player will prefer to be in an

INT[n/2]+1 size alliance than not be in one. If the size of any A_j is less than this stable

size, then both the current alliance members of any alliance and any non-alliance player

will experience a positive expected utility gain in this round if the non-alliance player

joins the alliance. This gain in expected utility continues as long as $|A_j| <$ INT[n/2]+1

$\forall j \in N.$ **Q.E.D.**

In any alliance of size 4 or greater, the alliance will eventually have to turn on

itself, and start voting out its own members.[6] By using backward induction from the

endgame and with a few more assumptions, we can make stronger predictions about these

alliances.

A4:   Consider any four players: i, j, k, h. Assume without loss that these players are

ranked in their likelihood of winning the game if they are in the last round. Namely,

player h is more universally liked and respected than players i, j, or k, and would more

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[6] The proof of this statement comes from the structure of the game. When only 3 players remain, they hold one final Immunity Challenge. The winner of this challenge then gets to pick which of the other 2 players she wants to go up against for the million-dollar prize. In effect, she is the only one who casts a vote in that round. Any alliance between the non-voting players is pointless because it can't affect the vote. An alliance between the voter and a non-voter could potentially exist. However, if the voter is rational and wants to maximize the chance that she will win the game in the final round, she will vote out the player she believes would be harder to beat. So technically, if 3 players are in an alliance that makes it to the end, there is no need for sub-alliances within that alliance. At any previous stage however, all players vote, and potentially alliances can still influence the outcome.

likely win against any of them in endgame. Player k will more likely win in endgame against players i or j, but will more likely lose in endgame to player h, and so on. Denote this relationship by i<j<k<h.

A5: Assume there exists a probability distribution between players that represents their individual beliefs about the probability of winning in the endgame when up against a particular player. Let P_{ij} denote the probability that player i wins the endgame against player j.

A6: Assume that the ranking in A4 and the probability distributions in A5 are common knowledge to all players.

These assumptions give us the results that $P_{ij} = 1 - P_{ji}$, and P_{ij} is decreasing in j for all i.

Definition: A **consecutive alliance** is an alliance between consecutively ranked players. Example: An alliance of players i, j, and k is a consecutive alliance. An alliance of players i, j, and h is not.

Given A4 and Theorem 1, we know that a 3-member alliance is the optimal size alliance when there are four remaining players. Let A_{ijk} denote an alliance between players i, j, and k, and let $V_i(A_{ijk})$ denote the "value" of that alliance to player i. To cast the final player out before the endgame, players compete in one final Immunity Challenge, the winner of which picks which of the other two he wants to vote out. Assume that all members of the alliance make it to the final three. Assume that they all consider themselves to have an equal chance at winning the final immunity challenge, meaning each player wins with probability 1/3.

Lemma 2:   Any stable alliance is also a consecutive alliance.

      Proof: Take A4 as given. By my proposition, the stable size of an alliance must be 3 players. To each member of the alliance, the value of a given alliance is given by a probability distribution over the players, representing the likelihood of that member of the alliance making it to the final two. Imagine that the alliance {i, j, h} is proposed. Players i and j will both prefer to leave this alliance and join the alliance {i, j, k} because they both have a better chance at winning the game against k than against h. Obviously, player k will prefer to be in an alliance than not, making {i, j, k} a possible alliance over {i, j, h}. Now imagine that the alliance {i, k, h} is proposed. Both i and k would rather be in an alliance with j rather than h, moving again to the alliance {i, j, k}. The same analysis follows if alliance {j, k, h} is proposed. Player h is not able to hold onto an alliance, because the other two will always prefer to join an alliance with a lower ability player. **Q.E.D.**

Case Studies

The Tagi Alliance

"I think with, an alliance that we establish here, we can do very very well."
    –Richard Hatch, to teammates before merge.
"My advice to anyone that does this game is form an alliance."
     – Rudy Boesch's final words.

      The first "Survivor" immediately showed the effectiveness of forming an alliance. The infamous "Tagi Alliance" of Richard Hatch, Rudy Boesch, Kelly Wiglesworth, and Susan Hawk is still the most memorable, if perhaps not the most powerful alliance to

date. Although it was not a smooth ride, the Tagi Alliance took all four of its members to the final four, and carried Richard Hatch to the $1,000,000 prize.

The Tagi Alliance was the brainchild of Richard Hatch. When it came time to merge in the first "Survivor" the two tribes, Pagong and Tagi were exactly even 5 to 5. The remaining survivors were as follows:

Pagong	Tagi
Gretchen	Richard
Greg	Kelly
Jenna	Rudy
Gervase	Susan
Colleen	Sean

Just before the merge, Richard spoke with Kelly, Rudy, and Susan about forming an alliance to always vote for the same person until they had eliminated everyone else. They all agreed. This was the first alliance ever formed on "Survivor". None of the Pagong tribe members thought to form an alliance going into the merge. If they had, they would have maintained supremacy and control of the game with an alliance of 5 as compared to Richard's alliance of 4.

At the first Tribal Council after the merge, the Tagi Alliance targeted Gretchen as its first victim. Gretchen Cordy, 38 year-old from Tennessee was the oldest remaining member of Pagong, and the un-proclaimed leader of Pagong as well. Votes went to nearly everyone in that Council. Because of their decision to vote together, Gretchen easily received the most votes out of anyone.

In hindsight, it makes sense that Gretchen would be the alliance's first victim. She was the one person that Pagong could have most easily rallied behind. After her departure, and with all successive Tribal Councils, the Tagi alliance secured its position. The next target was 24 year-old Greg Buis. He received 2 votes in addition to the four

from the alliance; making it six out of nine votes cast against him that Council. One of those votes was from fellow Pagong member Jenna, showing that even then the surviving Pagong failed to realize the need to take collective action against Tagi.

Richard's alliance was not problem-proof however. In the round following Greg's dismissal, Kelly began to show signs of defection. If Tagi retained control until the final four, then there would be more Pagong members on the jury than Tagi. If Kelly could distance herself from the alliance, which the Pagong members already disliked, and still managed to make it to the final 2, she stood a good chance at winning the majority of votes in the final Tribal Council. At the same time Colleen, Jenna, and Gervase tried to form their own alliance, called the "Ketchup Alliance", in order to wrestle control from Tagi. It almost worked. In a tense Tribal Council, the Tagi alliance targeted Jenna with 3 votes while Kelly defected to vote against Sean. The Ketchup alliance targeted Richard with their 3 votes. It was only the swing vote of Sean, himself not officially an alliance member, against Jenna that tipped the scales against the Ketchup alliance. Jenna was voted out.

In the next two tribal councils, Gervase and Colleen were both voted out by the Tagi alliance. They tried to swing the votes against Sean in order to stay longer, however with so few players left, the Tagi alliance was in too strong a position to be challenged. Kelly occasionally continued to defect to vote against Sean, a move that the Tagi alliance did not forgive. They tried several times to vote Kelly out of the tribe once there were only 6 total remaining players, however from that moment on Kelly consecutively won every single individual Immunity Challenge, making it impossible for her to receive any votes.

Richard's alliance did succeed in taking all four of its members to the final four. By this time, they realized that they would have to target each other, and had formed small sub-alliances. Kelly allied herself with Susan, while Richard sided with Rudy. This resulted in a tie-vote that was broken however, when Kelly switched to vote against Susan, alienating her and sending her to the jury. Again she won the final Immunity Challenge, and cast the last vote against Rudy, effectively choosing to go up against Richard in the final round.

In hindsight, this final vote was a rational choice. Richard appeared to be nearly universally despised by the jury for being manipulative and deceiving, whereas the gruff, coarse Rudy was considered more likeable. In the final Tribal Council, Richard made no apologies for being deceiving or for forming an alliance (a move that some felt was unfair). He only claimed that he did what he felt was necessary to win the game. In the end, his alliance and his argument worked. Richard won the final vote four votes to three. Greg, Sean, Rudy, and Susan all cast their jury votes for Richard, while Gervase, Colleen, and Jenna cast theirs for Kelly.

The Ogakor Alliance

"What it boils down to is, did I come here for forty-two days to starve, to live in the type of environment I've lived in, to make those types of sacrifices to give somebody like Elisabeth a million dollars? Or did I come here to play this game and me deserve the million dollars? --Tina Wesson

"Survivor: the Australian Outback" brought the popular game show to the TV screen for the second time. Most contestants had been avid fans of the first show, and had seen how successful Richard Hatch's alliance had been for him. Not surprisingly, the 16 players of this new show began hatching alliance strategies almost from the outset.

Jerri Manthey, a 30 year-old member of the Ogakor tribe formed a large alliance of five players around herself while walking to their camp's location. For a short time she easily controlled the outcomes of Tribal Council because she controlled the majority of the votes. However, her sometimes-abrasive mannerisms managed to alienate two members of her own alliance: Colby Donaldson and Tina Wesson. With 6 players remaining in the Ogakor tribe before the merge, these two secretly teamed up with the one player still outside Jerri's alliance, Keith Famie. In the next Tribal Council this new alliance of Colby, Tina, and Keith managed to oust one of Jerri's alliance members, and in effect, wrest control of the tribe away from her.

When Ogakor and its competing tribe Kucha merged with 10 total players remaining in the game, they each had 5 players. Having been witnesses to Pagong's tragic end in the first "Survivor", both teams recognized the need to go into the merge as alliances. This need is obvious. If Ogakor went into the merge split into two alliances, while Kucha went in as one big alliance, Kucha would gain control of the next phase of the game. In the first Tribal Council after the merge, the Ogakor alliance targeted Kucha member Jeff Varner, while the Kucha alliance targeted Colby. This resulted in a 5-5-tie vote. This time it was votes cast in previous Tribal Councils that broke the tie. Jeff had one vote against him so far, whereas Colby had received none. That one vote was enough to make a difference; Jeff was voted out, and the Ogakor alliance gained a 5 to 4 majority in the merged tribe.

The remaining tribe members were as follows, 7 of who would form the jury:

Ogakor	Kucha
Tina	Elisabeth
Colby	Roger
Keith	Nick

Amber   Alicia
Jerri

From this moment on, the Tina-Colby-Keith alliance maintained perfect control of the game. The next Tribal Council they voted Alicia off, giving Ogakor a 5-3 advantage. This gave them the option of voting one of their own off while still maintaining a majority in the tribe. Having looked for a chance to get rid of Jerri, the player they loved to hate, they joined temporarily with the remaining Kucha members without informing either Jerri or Amber to oust Jerri at the following Tribal Council.

At this point Amber, who was the last member of Jerri's old alliance could have realized that there was a sub-alliance within Ogakor working against them. If she would have joined the remaining 3 Kucha members: Elisabeth, Roger, and Nick, she would have had a 4-3 majority against Tina, Colby, and Keith, and been able to turn the tables on them, and perhaps survive longer than she did. Whatever her reasons, she remained true to her original Ogakor tribe. After next voting out Nick, she became the next target of the Ogakor sub-alliance, still leaving Tina, Colby, and Keith with a 3-2 advantage over Elisabeth and Roger.

The alliance that Tina, Colby, and Keith formed even before the merge managed to take all three of them to the final 3. There, Colby won the final Immunity Challenge and decided to vote out Keith, leaving Tina to challenge him in the final vote. Whether this move was rational has been a matter of some debate. Arguably, Tina was much more highly favored by the jury than Keith. If Colby had chosen instead to go to the jury with Keith instead of Tina, there is little doubt that he would have won a majority of the final vote.

Whatever his reasons being, Colby and Tina were the final two survivors in "Survivor: The Australian Outback". Tina won the $1,000,000 prize and the title of "ultimate survivor" by a close vote of 4 to 3. Alicia, Elisabeth, Jerri, and Keith each cast their votes for Tina, while Roger, Amber, and Nick cast theirs for Colby.

The Ogakor alliance of Tina, Colby, and Keith was arguably more successful than the Tagi alliance. First, it was a smaller alliance of three rather than four players that managed to get all its members as far as possible. Second, there was no defection by any member of the alliance throughout the game. Never at any time were Colby, Tina, or Keith in any danger of being voted out, as they always managed to hold a majority in the tribe. Third, they were generally respected by the jury at the end of the game for the way that they manipulated events to get themselves there. By the time Richard's alliance reached the end, he was almost universally despised for his tactics, whereas Tina who arguably masterminded her alliance was genuinely well liked.

The Dark Horse Alliance

"Its just funny to see that we turned around at the last second to beat them at their own game by all voting together is hilarious. I just laughed my head off."
        --Neleh Dennis, round 9 "Survivor: Marquesas"

"Survivor: Marquesas" has witnessed some of the most strategic alliance moves, and biggest upsets yet seen in the popular game show. The game again began with two separate tribes: Maraamu and Rotu. However, this game differed in the first phase in one major aspect: the Rotu tribe won nearly every Immunity and Reward Challenge. They won so much, that when it came time to merge; Rotu had a 7 to 3 advantage over Maraamu. Clearly, this put Rotu tribe members in a distinct advantage over the Maraamu

members. They could have easily voted the remaining 3 Maraamu out before turning in on themselves.

There was one major flaw to this plan. Rotu member John Carroll had formed a sub-alliance within Rotu with 3 other tribe members: Robert DeCanio, Tammy Leitner, and Zoe Zanidakis. With this alliance, John planned on voting out the three Maraamu first, followed by the three Rotu members not of his alliance: Kathy Vavrick-O'Brian, Neleh Dennis, and Paschal English. It appeared to be a flawless strategy, because he convinced Neleh and Paschal in the meantime that they were a part of a bigger Rotu alliance, and that he had no sub-alliance that didn't include them.

In the first Tribal Council after the merge, nearly all Rotu members did vote together as planned and cast one of the Maraamu out of the game. This left only two Maraamu: Sean Rector and Vecepia Towery. By this time Kathy knew that she would be a target as soon as John had ousted Sean and Vecepia, so she tried to build a counter-alliance against John. Neleh and Paschal were at first reluctant to join Kathy's alliance, as ties to their old Rotu were still strong, and they felt they needed to be honest to their old team members and not vote against them.

All things changed at the next Immunity Challenge. The producers had cleverly created a challenge that would reveal to all players any hidden information about alliances. Each player had 3 bunches of coconuts suspended in the air, each by a separate rope. Jeff Probst asked multiple-choice and true/false questions based on survival skills. For each question, every player that had answered correctly got a chance to cut down one of the ropes of another player. When all three of a given player's ropes had been cut down, that player was out of the challenge.

Unwisely, John and his alliance together worked on cutting down everyone else's ropes before going against each other. Sean was the first to fall, followed by Vecepia, Kathy, Paschal, and Neleh. The ousted survivors began to fear that they were being eliminated in a pre-determined order that would be reflected in Tribal Councils. Because of this, Neleh and Paschal rethought their alliance with John. While John's plan was to vote Sean out that night at Tribal Council, Neleh complained to Paschal, "I have been nothing but nice to those guys and I would be lying to myself and to my heart if I went up there tonight and voted for Sean. We have been here for too long and worked too hard, and I am not going to go out like that."

In the end, Neleh and Paschal joined with Kathy, Sean, and Vecepia to vote John out that very night, turning his alliance on its head. In turn, they have subsequently voted out the other members of John's old alliance: Zoe, Tammy, and Robert. At the time of this paper, the outcome of "Survivor: Marquesas" is unknown. However, the alliance created by these five players undoubtedly turned the game in their favor, and each of them has already made it further than they would have had they not made that move. It shows that defection can change the course of the game, and smart, rational players can topple alliances in power, if they move at the right time.

Comparative Analysis

Does the model hold up in the data? These case studies show that forming alliances tends to be a successful strategy. The players who have made it the farthest in the game have always been members of some alliance. If an alliance has ever been unsuccessful in carrying its members to the end, it has been because another alliance was created to usurp it.

The data also shows that the most successful alliances have been those of size at least INT[n/2] + 1. The Ogakor alliance was successful, even though it really only had 3 members, because two other players were under the false impression that they too were part of the alliance. Thus the Ogakor alliance was able to act as a 5 player alliance with 9 players left, then as a 4 player alliance with 7 remaining, and finally a 3 player alliance in a 5 player game.

The Dark Horse alliance shows how an alliance of less than INT[n/2] + 1 was not a rational, successful strategy. John had formed an alliance of only 4 players when there were still 9 players left. Two other players believed they were a part of this alliance, effectively giving him the power of an alliance of 6. However, the Immunity Challenge that round revealed to those two players that they were in fact not a part of his core alliance. This gave them the incentive to join with the other three players to form the Dark Horse alliance of 5, which gave them the stable majority.

Conclusion

I have shown that in the game of "Survivor" forming an alliance is a weakly dominant strategy. Players appear to understand this, as alliances have played the major role in determining the outcome of the game, even since the first "Survivor". I have also shown that given n players, a stable alliance must be one of at least size INT[n/2] +1, and it must be an alliance of players with consecutive ability to win the game.

Modeling how players interact in such a game can be a useful tool for understanding rational and irrational behavior. Why did some players make moves that obviously hurt their chances of winning $1,000,000? Perhaps abstracts like friendship,

honor, and trust play a stronger role than pure rationality. Further research could attempt to gain insight on these concepts through "Survivor".

Obviously, modeling a game as complex as Survivor requires setting up a complex framework of definitions and assumptions. Some may disagree with either my assumptions or my approach. Further research can test the applicability of this type of game to real world. For example, perhaps it is in the interest of weaker firms within an industry to "ally" themselves against the more powerful firms in their business strategies, just as the weaker players do on "Survivor".

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