PEREMPTORY CHALLENGES AND JURY SELECTION

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Peremptory Challenges Under Trial Uncertainty

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Abstract

In a 'struck jury' method of jury selection, the prosecution and defense execute peremptory challenges simultaneously on the entire pool of veniremen, and those that remain form the final jury. We establish that if the jurors' probabilities of conviction do not change over the the course of the trial, then the defense optimally challenges the veniremen with the highest expected probability of conviction, and the prosecution does the opposite. However, if probability of conviction possibly changes over the course of a trial, then the magnitude of jurors' shifts in probability becomes an important factor. We demonstrate that the prosecution prefers jurors who display larger changes in conviction probability caused by the evidence or the arguments offered in a trial, and the defense the opposite. Although we do not identify an optimal algorithm for jury selection, we do characterize an algorithm that performs better than fixed probability elimination.

1 Introduction

Millions of criminal and civil cases are tried before juries, and controversial jury verdicts can have major cultural reverberations. The outcome of a case can be strongly affected before it even begins with the selection of the jury, with poorly selected jurors potentially dooming an otherwise solid case. The prominence of trials and the juries on those trials has led to many attempts to model the process by which jurors are selected.

Anyone accused of criminal wrongdoing in the United States is entitled to a trial before a jury. A trial involves having the details of the alleged wrongdoing presented to a group of people who are affiliated with neither the case nor the court, called a jury. The prosecution presents and interprets evidence in a way that suggests that the person accused of wrongdoing, referred to as the defendant, is guilty of the wrongdoing, and the defense tries to show that the defendant is innocent. A judge is present to ensure that evidence is presented in a way consistent with existing rules, and after the prosecution and defense finish presenting and interpreting the evidence the jury must decide whether the defendant is guilty. In criminal trials in the United States, a jury must typically vote unanimously to acquit or convict a defendant. The prosecution and defense are generally given some influence over the composition of the jury. Rather than having each side bring forward candidates for the jury, they are instead given a randomly selected group of potential jurors, called veniremen, and allowed to execute a limited number peremptory challenges against some of these veniremen. In this way, both the prosecution and defense can remove veniremen that they consider unacceptable. There are many methods for executing peremptory challenges, although this paper considers only the struck jury method, where the prosecution and defense observe all of the veniremen and both sides use their peremptory challenges simultaneously. The veniremen who are not challenged are seated on the jury. Under this system the number of peremptory challenges is set so that the number of veniremen remaining after all challenges are executed is the targeted jury size.

In existing jury selection models, the prosecution and defense evaluate which veniremen to challenge by determining which veniremen are most likely to vote to prosecute the defendant. This is done by assigning a parameter to each venireman for his expected probability of convicting the defendant. Other papers characterize jurors with a fixed probability of conviction, which means as trials progress, evidence is presented, prosecution and defense attorneys examine and cross-examine witnesses, and experts testify, jurors' probabilities of finding the defendant guilty do not change. However, in reality they do. We demonstrate that the possible change in probability of conviction over the course of the trial affects optimal jury selection.

Since the probability of conviction for each venireman is fixed in all of these papers, and since the jury is selected before the trial, it is presumed that the probability given is the expectation over juror characteristics and possible trial outcomes. Existing papers take the overall jury's probability of conviction as the product of individual jurors' expected probability of conviction. In cases where jurors' probability of conviction is uncorrelated, this is a valid approach. For example, it may be plausible to assume that a juror's probability of conviction is independent of some of another jurors' characteristics, although this assumption may be weakened by the fact that jurors discuss the trial and vote as a group when deciding the verdict.

This paper focuses on the expected probability of conviction over possible trial outcomes. Many factors come into play during a trial, such as witnesses being more convincing than anticipated or recanting, and objections being sustained or overruled. If these events are not known in advance, the outcome of the trial could be a random variable, with some outcomes making the prosecution's case more persuasive, and others doing the same for the defense. Trial outcomes that benefit the prosecution will increase a juror's expected probability of conviction, and outcomes that benefit the defense will likely decrease expected probability of conviction. All jurors observe the same trial, and if trial outcomes vary, and jurors' probability of conviction changes with trial outcome, this will cause jurors' probability of conviction to display positive covariance. In this case the probability of conviction will be the product of each juror's expected probability of conviction, plus a positive covariance term. Veniremen that experience greater changes in opinion due to trial outcomes will form larger covariance terms, which leads to a higher expected probability of conviction, the desired result for the prosecution. This result indicates that prosecution and defense should consider a venireman's probability of conviction and 'persuadability', or how much trial outcomes may shift a venireman's probability of conviction, when deciding peremptory challenges. There is anecdotal evidence that this is indeed the case. Marcia Clark, one of the prosecutors in the OJ Simpson case, faced a pool of veniremen that was viewed as unsympathetic toward the prosecution's case. In the recent documentary *OJ Simpson: Made in America*, Clark says that before the trial she thought that "(the case) will be an uphill battle, but (the jury) will listen." This seems to indicate that the prosecution chose to prioritize more persuadable jurors when jurors with a high probability of conviction were not available.

2 Related Literature

Roth et al. (1977) consider jury selection when the prosecution and defense have separate expectations about each venireman's probability of conviction. They use these differences in expectation to construct an optimal algorithm for the strike-and-replace algorithm, where a third party randomly selects a venireman, and a venireman is added to the jury if neither the prosecution nor the defense elect to challenge him. Roth et al. (1977) find that under the strike-and-replace procedure it is advantageous to be the first party to challenge. Ford (2009) models the effect of changing parameter specifications on the results of the struck jury algorithm, where the prosecution and defense simultaneously execute all of their peremptory challenges on the entire pool of veniremen. Ford demonstrates that the probability of a jury voting to convict increases with respect to the number of peremptory challenges, and also finds that the standard deviation of jury conviction probabilities decreases as peremptory challenges increase.

In an environment where each venireman's probability of conviction does not change over the course of a trial, Flanagan (2015) demonstrates that strike-and-replace and struck jury procedures for jury selection increase the bias of juries relative to randomly selecting jurors without challenges. Flanagan also demonstrates that there is not a challenge procedure that decisively eliminates this problem. Furthermore, for a fixed jury size, the prosecution benefits as the number of veniremen and peremptory challenges increases in both the struck jury and strike-and-replace cases. Roth et al. (1977), Ford (2009), and Flanagan (2015) each fail to account for the possibility that a juror's probability of conviction changes over the course of the trial.

Stevenson (2011) examines the role of uncertainty throughout the jury system, and argues in general that uncertain jury outcomes may be more fair than consistent ones when the overall population holds biases. Although he does not model the jury selection process, his paper specifically suggests that many jury selection procedures mistakenly assume that jurors with relatively extreme beliefs are also relatively tenacious in those beliefs. Although the model introduced below is not explicitly related to this paper, they may be complementary in forming intuition.

3 The Model

Let V be the set of m veniremen, with individual veniremen denoted by i for $i \in 1, 2, ..., m$. Let prosecution, P, and defense, D, each have positive k_p and k_d peremptory challenges, respectively. P and D use these challenges to form a jury J, consisting of $n = m - k_p - k_d$ jurors. The n jurors that go unchallenged form the jury $J \subset V$. After the jury is formed, the trial takes place.

The outcomes of many events affecting a trial are unknown when peremptory challenges take place. One example might involve a star witness for the prosecution. The prosecution may expect this witness to testify at the trial with probability 1/2, and to recant otherwise, but the prosecution does not know which of these events will happen until the trial occurs. Since the jury is selected before the trial, P and D must execute their peremptory challenges while ignorant about which outcomes actually occur during the trial. In other words, both P and D know what they expect to happen in the trial on average, but they do not know which events actually happen in advance. Because the outcomes of these events are unknown when selection takes place, the model assumes that P and D consider the trial itself to be a random variable. For simplicity's sake, trial outcomes are modeled as a Bernoulli random variable. Although the rest of this paper's analysis is done on Bernoulli trial outcomes, the general result comes from the covariance between other variables that depend on the random trial outcome. Let T denote the trial outcome, with $T = 1$ corresponding to events favoring P, and $T = 0$ corresponding to events favoring D. To relate this to the star witness example above, $T = 1$ if the witness chooses to testify, and $T = 0$ if the witness recants. The probability of T is the probability that the witness chooses to testify. The analysis is conducted assuming $P(T = 1) = P(T = 0) = 1/2$. This means that events over the course of the trial have an equal chance of favoring the prosecution or defense overall.

Uncertainty about the outcome of a trial affects peremptory challenges by affecting veniremen's probabilities of voting for conviction. At $T = 1$, the trial favors P, meaning that the presented case for the defendant's guilt is strong relative to the evidence, and opposite when $T = 0$. For each venireman i, let $\pi_{i1} = P(convict|T = 1)$ and $\pi_{i0} = P(convict|T = 0)$. These correspond to the probability that the venireman will vote to convict the defendant after observing a trial favoring either P, when $(T = 1)$ or D, when $(T = 0)$. Since a trial favoring P corresponds to a stronger signal of the defendant's guilt than one favoring D, we impose the inequality $\pi_{i1} \geq \pi_{i0}$. From these values it is possible to derive an equation for π_i, which is the expected probability of venireman i voting for conviction, not conditional on trial outcomes. This is derived by taking

$$\pi_i = P(convict|T = 1) * P(T = 1) + P(convict|T = 0) * P(T = 0).$$

$$= (1/2)(\pi_{i1} + \pi_{i0}).$$

From the above definition, we derive the 'persuadability' of a venireman as how much each venireman's expected probability of conviction conditional on each T deviates from his or her overall expected probability of conviction. This value is equivalent to the standard deviation of π_i, and since $P(T = 1) = 1/2$, it is calculated by

$$\delta_i = \pi_{i1} - \pi_i = \pi_i - \pi_{i0}.$$

It is important to note that π_{i1} and π_{i0} are bounded by $0 \leq \pi_{i0} \leq \pi_{i1} \leq 1$. This implies that values for expected conviction probability and persuadability are bounded by

$$\begin{cases} \delta_i \leq \pi_i & \text{if } \pi_i \leq 1/2; \\ \delta_i \leq (1 - \pi_i) & \text{if } \pi_i > 1/2. \end{cases}$$

Further, we characterize each venireman i by the outcome vector

$$v_i = \begin{pmatrix} \pi_{i1} \\ \pi_{i0} \end{pmatrix}.$$

The prosecution's objective is to attain the maximum expected probability of conviction for the jury, and the defense's objective is the opposite. Therefore, to find the utility resulting from each party's actions the expected probability of conviction for the resulting jury must be derived.

Let ρ_J be the expected probability that jury J votes unanimously to convict the defendant. For example, in a one-man jury, $J = i$, the resulting probability of conviction is simply π_i, the expected probability of conviction for venireman i. For each jury, let $\rho_{J1} = E(J|T = 1)$ and $\rho_{J0} = E(J|T = 0)$, or the jury's expected probability of conviction given a good trial for P and a good trial for D, respectively. For a jury consisting of n members, the expected probability of conviction is

$$\rho_J = E(J|T = 1) + E(J|T = 0)$$

$$= 1/2 * (\prod_{l=1} \pi_{l1} + \prod_{l=1} \pi_{l0}).$$

For notational simplicity, let $\rho_J = E(J)$, the expected probability of conviction for jury J, and let

$\gamma_J = \rho_{J1} - \rho_J = \rho_J - \rho_{J0}$, the variance in the expected probability of conviction for J resulting from uncertainty in trial outcomes. These values are the whole jury equivalent to π_i and δ_i, respectively. Jury J can be represented by the outcome vector

$$v_J = \begin{pmatrix} \rho_{J1} \\ \rho_{J0} \end{pmatrix}.$$

Using these formulas, we are able to derive the expected probability of conviction when an additional juror is added to the jury, forming jury $J \cup i$.

$$E(J \cup i) = .5 * (\pi_{i1} * \rho_{i1} + \pi_{i0} * \rho_{i0})$$
$$= 1/2 * \begin{pmatrix} \pi_{i1} \\ \pi_{i0} \end{pmatrix} \cdot \begin{pmatrix} \rho_{J1} \\ \rho_{J0} \end{pmatrix}.$$

The final definition needed to evaluate this problem is an equation for the utility of the prosecution and defense. P's objective is for the case to result in a conviction, and D hopes for acquittal. To maintain tractability, we assume that P and D cannot negotiate a settlement, and a split jury decision has 0 utility for both sides. Consistent with these constraints, P has utility $U_P = E(J)$ and D has utility $U_D = -E(J)$. This characterizes the jury selection process as a strictly competitive game, since any increase in one party's utility results in an proportionate decrease in the other's. This fact is needed to characterize the equilibrium outcome. Both sides' utility is a function of the final jury J, although neither directly selects it. Instead, P selects a set $C_P \subset V$ of cardinality k_p that is prevented from joining the final jury J, and D does the same for set C_D. Since the selection game is strictly competitive, the Nash equilibrium peremptory challenge selection is characterized by the minimax solution. Therefore, the equilibrium jury has the property

$$J^* = (V/C_P^*)/C_D^*.$$

where $C_P^* = C_{Pl}$ and $C_D^* = C_{Dz}$ for l and z characterizing

$$\max_{l \in L} \min_{z \in Z} E((V/C_{Pl})/C_{Dz})$$

where L indexes subsets of V with magnitude k_p, and Z indexes subsets of V/C_P^* with magnitude k_d. In the case where $\delta = 0$ for all veniremen, this process reduces to ranking the veniremen from highest π_i to lowest, and eliminating the k_d highest ranked ones, and the k_p lowest. This is the struck jury algorithm evaluated in the existing jury selection literature.

4 Results

Lemma 1. *P's utility from adding venireman i to jury J is $U_P(J \cup i) = \pi_i * \rho_J + \delta_i * \gamma_J$*

Proof of Lemma 1 By definition, $U_P(J \cup i) = E(J \cup i)$

$$= .5 * (\pi_{i1} * \rho_{J1} + \pi_{i0} * \rho_{J0})$$

$$= .5 * ((\pi_i + \delta_i) * (\rho_J + \gamma_J) + (\pi_i - \delta_i) * (\rho_J - \gamma_J))$$

$$= \pi_i * \rho_J + \delta_i * \gamma_J.$$

□

This lemma reframes the expected probability of conviction calculation by presenting it as a function of the venireman and jury's expected probability of conviction and persuadability. The proof presented above is straightforward when trial outcomes are modeled as a Bernoulli random variable, but the result can be generalized by noting that it is a special case of the formula for the product of random variables, i.e.

$$E(XY) = E(X)E(Y) + Cov(X, Y).$$

Note that the correlation between ρ_J and π_i is 1, since they both deviate as a result of variation in the same variable, T. P's marginal utility of adding a venireman to the jury, as expressed in Lemma 1, allows the contribution from a venireman's decisiveness to be calculated when the rest of the jury is taken as given, providing algebraic simplicity when evaluating marginal jurors.

Corollary 1. *P's utility $U_P(J \cup v_i)$ from adding venireman i is increasing in persuadability δ_i.*

Proof of Corollary 1 This follows from Lemma 1, since venireman i's persuadability, δ_i is multiplied by the persuadability of the other jurors, γ_J in P's utility function. Since the persuadability of the other jurors is non-negative, the corollary follows. □

Corollary 1 implies that if veniremen i and j have equivalent expected probability, but i is more persuadable than j (i.e. $\pi_i = \pi_j$ and $\delta_i > \delta j$), P prefers i and D prefers j. It also follows that the persuadability of a juror only affects utility in the presence of other persuadable jurors. In the case of a one-man jury, the expected probability of conviction $E(i) = \pi_i$ for all levels of persuadability. When a juror with any level of persuadability is added to a jury with zero persuadability, then the expected probability of conviction is

$$E(J \cup i) = \pi_i * \rho_J + \delta_i * 0 = \pi_i * \rho_J.$$

This is simply equivalent to the product of the jury and the added venireman's expected probability of conviction, with no contribution from the added juror's decisiveness. The covariance interpretation also helps to make sense of Lemma 1, since covariance will be greater in terms with greater variance, all else equal. Another consequence of Lemma 1 is that veniremen and juries can be described using parameter vectors

$$S_i = \begin{pmatrix} \pi_i \\ \delta_i \end{pmatrix}$$

and

$$S_J = \begin{pmatrix} \rho_J \\ \gamma_J \end{pmatrix}.$$

Because of the linear form of the expected utility of adding an additional juror, it is possible to derive linear indifference curves for each juror within a jury. Before deriving this form, further notation must be defined. For J, a jury of n veniremen, and venireman i on jury J, let J_{-i} be the jury consisting of the other $n-1$ veniremen.

Lemma 2. If $U_P(J) = U_D(J) = c$, then there exists an indifference curve with respect to each venireman $i \in J$ for both P and D along

$$\delta k = (c/\gamma_{-i}) - (\rho_{-i}/\gamma_{-i}) * \pi_k$$

.

Proof of Lemma 2 By Lemma 1, we have

$$\pi_i * \rho_{-i} + \delta_i * \gamma_{-i} = c.$$

This equation is linear in π_i and δi. Rearranging the terms gives a line

$$\delta k = (c/\gamma_{-i}) - (\rho_{-i}/\gamma_{-i}) * \pi_k,$$

the indifference curve of persuadability with respect to expected probability of conviction. □

Veniremen falling below this indifference curve would lower the jury's expected probability of conviction if they replaced i, and those above the curve would increase the expected probability of conviction.

When constructing this indifference curve, it is important to be mindful of the inequality

$$\begin{cases} \delta_i \leq \pi_i & \text{if } \pi_i \leq 1/2; \\ \delta_i \leq (1-\pi_i) & \text{if } \pi_i > 1/2. \end{cases}$$

Previous models of juror selection did not account for persuadability, so they effectively set the persuadability/variance parameter on conviction probability to 0. In this case there exists an optimal algorithm for selecting jurors to challenge, described in Ford (2009). It will be labeled the Probability-Only algorithm.

The Probability-Only Algorithm Sort the veniremen in descending order with respect to their expected probability of conviction π_i. D then executes peremptory challenges on the k_d highest ranked veniremen, and P executes challenges on the k_p lowest ranked.

It is trivial to show that the jury produced by the Probability-Only algorithm is the Nash equilibrium jury in the case when persuadability is 0 for all veniremen. The following example demonstrates that this algorithm becomes sub-optimal when veniremen have non-zero persuadability.

Example 1 Let P and D have 1 peremptory challenge each, and let them form a 2-man jury J by eliminating 1 venireman each from the 4-man panel V. The veniremen have the following parameter vectors

Under Probability-Only challenges P will eliminate S_1 and D will eliminate S_4, since $\pi_1 < \pi_2 \leq \pi_3 < \pi_4$. Then $\rho_J = E(S_2 \cup S_3) = \pi_2 * \pi_3 + \delta_2 * \delta_3 = .25$. But if P instead eliminates v_2, the resulting jury will have the expected conviction rate $E(S_1 \cup S_3) = \pi_1 * \pi_3 + \delta_1 * \delta_3 = .225 + .09 = .315$, and D will not change his challenge.

This example demonstrates that the Probability-Only algorithm is suboptimal when persuadability becomes a factor in veniremen. There does exist an algorithm that produces a more optimal response than the Probability-Only algorithm when the opponent plays the Probability-Only algorithm.

The Marginal Juror Algorithm Execute the Probability-Only algorithm, and let $c_\pi = \rho_{J\pi}$, the expected conviction rate of that algorithm's jury. P selects h_{max}, the venireman P challenged with the highest π, and j_{min}, the juror with the lowest π. Let $J_- = J_\pi / j_{min}$. If $\delta_{h_{max}} > (c_\pi/\gamma_{J_-}) - (\rho_{J_-}/\gamma_{J_-}) * \pi_{h_{max}}$, P challenges j_{min} rather than h_{max}. Otherwise, leave the challenges unchanged. The algorithm is comparable for D.

Theorem 1. For either P or D, the Marginal Juror Algorithm performs at least as well as the Probability-Only algorithm when played against the Probability-Only algorithm.

The following proof is for P, the corresponding one for D is similar.

Proof of Theorem 1 There are two cases

[Case 1] If $\delta_{h_{max}} > (c_\pi/\gamma_{J_-}) - (\rho_{J_-}/\gamma_{J_-}) * \pi_{h_{max}}$, then h_{max} lies above the indifference curve for j_{min} relative to J_-. Therefore $E(h_{max} \cup J_-) = U_P(h_{max} \cup J_-) = U_P(J_{MJA}) > U_P(J_\pi)$.

[Case 2] If $\delta_{h_{max}} \leq (c_\pi/\gamma_{J_-}) - (\rho_{J_-}/\gamma_{J_-}) * \pi_{h_{max}}$, then h_{max} lies on or below the indifference curve for j_{min} relative to J_-, and challenges are left unchanged. Then $U_P(J_{MJA}) = U_P(J_\pi)$, since $J_{MJA} = J_\pi$.

Therefore, $U_P(J_{MJA}) \geq U_P(J_\pi)$. □

Theorem 1 demonstrates that the addition of the persuadability parameter affects the choice of peremptory challenges for P and D, which changes the composition of the final jury. Although the marginal juror algorithm is not optimal, it shows that modeling jury selection with uncertainty about the outcome of the trial changes the way that P and D optimally evaluate veniremen, since it provides an improved response to the π-only algorithm.

5 Conclusion

Trials are used to resolve millions of criminal and civil cases, and understanding the process of selecting jurors to hear those trials is a worthwhile endeavor. To the best of our knowledge this paper is the first to examine the role of the trial as part of the optimal jury selection process. Under reasonable assumptions that the outcome of events that occur during a trial are unknown when the jury is selected, and that individual jurors' probability of convicting the defendant shift in response to these events, juries will be expected to convict defendants at a higher rate than the product of individual jurors' expected probabilities of conviction. This is because all jurors observe the same trial, introducing positive covariance in their probabilities of conviction.

This paper opens numerous doors for further theoretical, empirical, and experimental research. The problem of finding an optimal non-enumerative algorithm for juror selection with uncertain trials remains open, as well as characterizing the problem under strike-and-replace peremptory challenges, rather than struck jury ones. There are other possible sources of correlation between juror conviction probabilities that could be modeled. One possible target is the persuasiveness of a juror, since this may cause other jurors to adopt the persuasive juror's verdict during deliberations. Empirical and experimental paths rely critically on identifying observable characteristics that serve as proxies for a venireman's 'persuadability'. If these characteristics can be identified, existing databases of juror characteristics and jury verdicts used by lawyers when making peremptory challenge decisions provide a starting point for empirical research. If the distribution of trial outcomes is assumed to not differ, it may be possible to test whether more persuadable juries do have a higher conviction rate than less persuadable ones. It may be possible to use experiments to test whether prosecutors and defense attorneys control for persuadability, by comparing which members of a mock panel of veniremen an experienced prosecutor and defense attorney choose to challenge, versus the members a control group without legal experience chooses to challenge.

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