

# An Argument Game

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## 1 LMNOP

This game<sup>3</sup> was designed to investigate protocols and strategies for resource-bounded disputation. The rules presented here correspond very closely to the problem of controlling search in an actual program.

The computer program on which the game is based is LMNOP (see Loui-Norman-Stiefvater-Merrill-Olson-Costello [92]). It is a LISP system designed to produce arguments and counterarguments from a set of statutory rules (defeasible rules) and a corpus of precedents (analogical sources), and applied to legal and quasi-legal reasoning. LMNOP was co-designed by a researcher in AI knowledge representation and by a trained computer scientist who was an editor of *Washington University Law Review* at the time (now a practicing litigator).

LMNOP is based on the idea of a non-demonstrative or defeasible rule: i.e., a rule that admits exceptions. It adopts a representational convention that supposes there is an implicit preference of more specific rules over less specific rules. In fact, it automatically adjudicates between competing arguments when one argument meets the broader criterion of being more specific than another. The convention is based on an idea originally presented by David Poole [85], and is embedded in a system of determining which arguments are ultimately warranted, which originally appeared in the literatures of epistemology and ethics, by Pollock [87] (see also references to that author's earlier work in the paper; the system dates to 1965). This system evolves from work by the first author since 1987; the full statement of the theory is in [92]. Prakken [92] is one example of the idea's application to the legal domain. LMNOP also draws heavily on the model of legal reasoning and analogical reasoning put forward by Edwina Rissland and Kevin Ashley [89, 90]. Similarities to their legal case-based reasoning program, HYPO, are no accident; LMNOP seeks to improve on HYPO. A description of LMNOP is forthcoming (Loui-Norman [93]).

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The card game evolved from initial investigations by Andrew Merrill, Jon Olson, Jeff Norman, and the first author. The initial objective was to discover a good way to control LMNOP's computation.

Several protocols were invented, and many protocols are suitable as the basis for an enjoyable game that has logical merit. This is the game that is currently most popular. The rules for scoring are tentative. Simplified, less technical versions of the rules with successively more advanced variants of the game are planned.

The game was first publicly shown at the International Conference on Knowledge Representation and Reasoning, Boston, 1992.

Three sample plays of the game are included at the end of this paper. The reader is recommended to consult the examples before reading the rules.

The sample plays rely on a different layout of the cards which allows a compressed depiction of the game's state. The required transformation should be obvious (in the examples, cases are constructed during play by flipping; in the rules, cases are constructed in advance, then revealed). The second example also experiments with the idea of a burden-shift card, which has not yet been integrated into the bidding and scoring.

## **WFF 'N PROOF**

Thirty years ago, a brilliant young law professor in Palo Alto named Layman Allen paved the way for games of this kind. His WFF 'N PROOF was at once an educationally valuable instructional device, a notable contribution to legal reasoning, and a popular hit. We hope that this game, with its inevitable variants, leads to educational and cultural benefits of a similar kind.

## 2 Rules

### 2.1 Rules Defining Components

- there are two players, designated in advance to be *red* and *black*, respectively.
- four decks of cards (with jokers) are required.
- cards are distinguished only by *color* and *value*, not by suit; a card's opposite is a card of same value and opposing color.
- a joker initially has no value nor color and we refer to it as a joker that takes on a value and color.

### 2.2 Rules for Scoring

- both players begin with 0 *points*.
- score is recorded in two parts: *below the line* (for contracts met) and *above the line* (for over-score and opposing player's unmet contracts).
- a *game* can be won by a player with 100 points or more below the line.
- a game can be won by a player with 1000 points or more above the line.
- a met contract at the level  $k$  is worth points depending on the difficulty,  $d$ , of the contract and the number of remaining resources,  $r$ , if any:
  - below the line,  $5d - k$
  - above the line,  $rd$note that the point value is independent of  $k$ ; point values are doubled if the contract was doubled, quadrupled if the contract was redoubled.
- an unmet contract of difficulty  $d$  and level  $k$  is worth  $5(5d + k)$  points above the line to the defending player, doubled if the contract was doubled, quadrupled if the contract was redoubled.
- errors in play are worth 500 points above the line to the opposing side.

### 2.3 Rules for Dealing

- either player can be designated initial dealer.
- deal alternates between players.

- cards are placed with faces down in a *pool* and mixed.
- first, draw three cards as *evidence* in succession from the pool, where:
  - if a joker is drawn, it is returned to the pool.
  - if a value is drawn that is already evidence, it is returned to the pool (regardless of color).
- evidence cards are placed in the evidence area.
- next, draw *cases*, each as follows, and according to the following schedule:
  - to draw a case of size  $n$ , draw  $n$  cards face down from the pool, then draw a single card face up from the pool; if this card's value is the same as any of the evidence cards' values, then return it to the pool (face down) and draw again (repeatedly, if necessary).
  - construct 10 cases of size 10 and 10 cases of size 2.
- cases are stacked neatly in the case area.
- the set of visible cards among the cases are the *decisions*.
- a case is said to be for its decision; when cards face down are later displayed, these are said to be displayed *facts of the case*; a case with any displayed facts is *opened*; a case with all cards displayed is *exhausted*.

## 2.4 Rules for Bidding

- dealer opens bidding.
- bidding strictly alternates between players.
- bidding closes with two consecutive *passes*.
- a successful bid is the last bid, if any, before bidding closes.
- the successful bidder is called the *declarer* for this deal.
- the other player is the *defender* for this deal.
- a bidder may pass, or if there is already a bid, may *improve* a bid (including his own bid), *double*, or *redouble*.

- bids have three parts: *difficulty*, *level*, and *claim*.
- bids are lexicographically ordered first by increasing degree of difficulty, then by decreasing level; improvements of bids must follow this ordering.
- the claim must have a color and value: the color must be the same as the bidder, and the value must be such that there exists at least one red decision and one black decision for this value.
- level must be between 1 and 30.
- difficulty is any combination of the available handicaps.
- degree of difficulty is determined by adding the following: (the recommended phrases' lengths correspond to their contributions to degree)
  - *burden to reinstate with defeat*: 5
  - *no defeasible specificity chains*: 4
  - *no playable resources*: 3
  - *unordered evidence*: 2
- two subsequent passes ends the bidding.

## 2.5 Rules for Play

- declarer initiates play, after which play strictly alternates.
- the level of the contract,  $k$ , determines the initial declarer's *resources*;  $k$  cards are drawn from the pool (face down) to indicate the level of this resource.
- play terminates if it is a player's turn to play and that player cannot make a *sufficient response*; thus, the other player wins.
- play terminates if it is the declarer's turn to play and declarer has exhausted declarer's resources; thus, defender wins.
- to end a player's turn, the player must be able to *engage in dialogue* that establishes sufficiency (sometimes sufficiency is obvious, so dialogue is unneeded; sometimes, dialogue is required to resolve ambiguities of commitment).

- declarer opens by showing that the claim is *admissible*.
- a card is admissible (or *live*) for a player if
  - it is an evidence card; or
  - it is a card for which there is no opened case for the opposite card and for which there are no challenges;
  - a tree of potential argument can be cited for the card which is undefeated for the player.
- a *tree of potential argument* for a card (henceforth, an *argument*) is a collection of cases that can be organized into a tree by:
  - taking the card to be root,
  - taking the unique case for the card to define the children of the root by using any (including possibly all) of its admissible facts as children of the root;
  - checking that no card and its opposite both appear;
  - checking that the leaves of this tree are each admissible.
- an argument is *undefeated* for the player if the opposite of a card in the tree cannot be cited to have potential argument for the opposing player where the argument cited has appropriate strength.
- *appropriate strength* is determined in part by *specificity* and in part by *burden*.
- an argument has appropriate strength against its counterargument if:
  - the argument in question is for the defender, and this argument for the defender is not less specific than the argument for the declarer; or
  - there is no burden-to-reinstate-with-defeat and the argument in question is for the declarer and this argument for the declarer is not less specific than the argument for the defender (note that this situation is symmetric);
  - there is burden-to-reinstate-with-defeat and the argument in question is for the declarer and this argument for the declarer is more specific than the argument for the defender.

- an argument for a card is *activated* by a set of cards if the set of cards contains a cut-set (not including the root) of the argument.
- an argument is more specific than another if:
  - there is a set of cards that can be cited that activates the lesser argument, but does not activate the greater argument.
  - if there is ordered evidence, then the set of cards is first augmented by any evidence cards less than the highest evidence card in the set (if any), before checking for activation.
  - if there are defeasible specificity chains, then the set of cards is augmented by any card that is a decision of a displayed case for which a fact of the case is already in the (possibly already augmented) set.
- declarer may flip cards to display facts of cases during his turn, as long as he has resources; each flip of card consumes one card of resources; this rule is altered under challenges.
- defender may flip cards to display facts of cases during his turn; each flip of card contributes one card to declarer's resources; this rule is altered under challenges.
- if there are playable resources, declarer may choose to play a resource card at any time during his turn, to add to the facts of any exhausted case, as a displayed card, consuming his resources.
- a sufficient response for the declarer consists of either:
  - being able to cite an undefeated argument for the claim of the contract; or
  - challenging a challengeable card used in one of the opponent's counterarguments.
- a sufficient response for the defender consists of either:
  - being able to cite an undefeated counterargument to the declarer's argument for the claim of the contract; or
  - challenging a challengeable card used in one of the opponent's counterarguments.

- at any time, either player can engage in *clarification dialogue*, to determine which arguments are held against him; clarification dialogue begins with declarer stating his argument for the claim of the contract, and defender stating his response, and so forth.
- a *challengeable card* is any leaf in an opponent's held argument that is not evidence.
- the *first response* to a challenge is the first case investigated in order to find a case that would support the challenged card.
- any resources consumed while flipping from the first response to a challenge are not transferred to the other side if the challenge is met by producing an admissible card among the facts of the first response.
- flipping in response to a challenge must stop as soon as a sufficient response can be made.

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