Know when to fold 'em: Researchers solve heads-up limit hold 'em poker

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University of Alberta researcher Michael Bowling and his team have solved heads-up limit Texas hold'em poker. Credit: John Ulan, University of Alberta

For over a half-century, games have been test beds for new ideas in Artificial Intelligence (AI) and the resulting successes have marked significant milestones - Deep Blue defeated Kasparov in chess and Watson defeated Jennings and Rutter on Jeopardy! However, defeating top human players is not the same as actually solving a game, and for the

first time researchers in the Computer Poker Research Group at the Faculty of Science, University of Alberta in Canada, have essentially solved heads-up limit hold'em poker.

"Poker has been a challenge problem for artificial intelligence going back over 40 years, and until now, heads-up limit Texas hold'em poker was unsolved," says Bowling, lead author and professor in the Faculty of Science whose findings were published January 9 in *Science*.

Poker is a family of games that exhibit imperfect information, where players do not have full knowledge of past events. The most popular variant of poker today is Texas hold'em. When it is played with just two-players (heads-up) and with fixed bet-sizes and number of raises (limit), it is called heads-up limit hold'em. While smaller than checkers, the imperfect information nature of heads-up limit hold'em makes it a far more challenging game for computers to play or solve.

"We define a game to be essentially solved if a lifetime of play is unable to statistically differentiate it from being solved at 95% confidence," explains Bowling. "Imagine someone playing 200 hands of poker an hour for 12 hours a day without missing a day for 70 years. Furthermore imagine them employing the worst-case, maximally exploitive, opponent strategy, and never making a mistake."

While many perfect information games (where all players are informed of everything that has occurred in the game prior to making a decision) have been solved, e.g., Connect Four, no nontrivial imperfect information game played competitively by humans has previously been solved. These games are more challenging, with theory, computational algorithms, and instances of solved games lagging behind results in the perfect information setting. And, while perfect information may be a common property of parlour games, it is far less common in real-world decision making settings.

"The breakthroughs behind this result are general algorithmic advances that make game-theoretic reasoning in large-scale models of any sort more tractable," says Bowling.

And, while seemingly playful, game theory has always been envisioned to have serious implications, including a surge in game-theoretic applications involving security, such as systems being deployed for airport checkpoints, air marshall scheduling, and coast guard patrolling. With real-life decision-making settings almost always involving uncertainty and missing information, algorithmic advances, such as those needed to solve poker, are needed to drive future applications.

You can query the program's strategy or play against it yourself online at: http://poker.srv.ualberta.ca.

More information: "Heads-up limit hold'em poker is solved," www.sciencemag.org/lookup/doi/ … 1126/science.1259433

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