Robots in Theory and Practice, II

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To make decisions, bridge robots largely depend on one of two techniques: double-dummy simulation (the machine generates deals that match the known conditions and determines what would work most often on a double-dummy basis) and limited single-dummy algorithms (modeled on how a human player might approach a problem). The single-dummy approach offers wide scope for development; for example, it allows for planning the playa number of tricks ahead, beneficial in such areas as the play of a suit combination. The developers of two of the most successful programs, Hans Kuijf (Jack) and Yves Costel (Wbridge5), report that their robots use different algorithms in the play. The more cards that remain to be played, the more time is required by these methods, so play-time constraints limit effectiveness. These developers remark that planning an entire deal at trick one is far from possible in current robot play, as time constraints limit the depth of an analysis. The double-dummy and single dummy approaches have strengths and weaknesses. Consider this deal from the 2015 Robot Championship (held in parallel with, and using some of the same deals played in, events at the 2015 Summer Nationals):

North
♠ 4 2
♥ 9 4
♦ Q 6 4
♣ Q J 10 6 5 2

South
♠ K J 6 3
♥ A K J
♦ A J 5
♣ A 9 3

South	**West**	**North**	**E ast**
2 NT	Pass	3 NT	(All Pass)

At three tables of the Grand National Teams semifinals and eight robot tables, the bidding went as shown, and the opening lead was the three of diamonds. All the human declarers, Jack, and Wbridge5 won trick one with the *ace,* rather than the jack, aiming to preserve a diamond entry to dummy's long clubs. All those declarers led the club three at trick two, but, as Kit Woolsey pointed out, for different reasons. The humans hoped to induce a defender with king-third of clubs, particularly East, to win the trick (although, at this level of play, that was unlikely). The robot declarers had a technical reason: Using double-dummy simulation, at the trick-two decision for South, the robots assumed that the winning play would be made at trick three(a finesse against East's tripleton king) if East ducked trick two. (However, both human and robot declarers, after winning with dummy's club queen at trick two and seeing East play a low club on the jack at trick three, would not finesse, because that would put the contract in jeopardy if West held king-low of clubs (while there would be almost the same chance to make the contract whether or not declarer lost a trick to the king of clubs, because being able to use the diamond queen as an entry is the critical concern).In that deal, double-dummy simulation sufficed, but sometimes it is inadequate, as demonstrated by this deal from the final of the computer event between Jack and Wbridge5:

South dealer
East-West vulnerable

North
♠ K Q J 9 7
♥ Q 4 2
♦ A 8
♣ K 9 3

South
♠ A
♥ K 7 5 3
♦ K 7
♣ A Q 10 8 7 6

The robot Souths reached six clubs after East had doubled a diamond bid; each West led the three of diamonds to declarer's king. Jack played the club queen, saw East show out took the marked club finesse, and, with spades lying favorably, had 13 tricks.Wbridge5 led a low club to dummy's king and could not shed losing hearts fast enough: down one. The difference stemmed from the algorithms in use. At the start of the play, Wbridge5 uses a double-dummy simulation. In such an analysis, either a high or a low club from the South hand leads to the same result (as a known layout is assumed), so Wbridge5 was equally likely to start with a high club from either hand. However, having led a low club from hand, a new double dummy analysis to determine dummy's play to that trick resulted in the play of the king. For slams, Wbridge5 switches to a single-dummy algorithm

starting at trick three (one trick too late for this deal); it switches at trick four for a game, trick five for a part-score. At trick one, Jack uses a single-dummy algorithm limited by sample size and look-ahead depth. Because of these limitations, Jack's approach might be inferior on deals where a double-dummy simulation would fare well. Given that most critical decisions are made at trick one or trick two, one suspects that Jack's approach may have the advantage. Correctly analyzing the possibilities of an opponent's hand based on the bidding is advantageous for both humans and robots. Good inferences enable a robot to obtain a more-effective sampling of possible deals, but if the assumed constraints are even slightly wrong, rigidly applying them may end in a losing decision, as here:

East dealer
Both sides vulnerable

North
♠ 8 6
♥ A Q 8 5 3
♦ Q J 4 3 2
♣ 2

West
♠ Q 10 4
♥ K 6 2
♦ 10
♣ A K 10 8 7 6

E ast
♠ K J 9 3 2
♥ 10 7 4
♦ 9
♣ J 9 5 3

South
♠ A 7 5
♥ J 9
♦ A K 8 7 6 5
♣ Q 4

South	**West**	**North**	**E ast**
——	——	——	Pass
1 ♦	3 ♣	3 ♥	4 ♣
Double	Pass	5 ♦	(All Pass)

In the Wagar Teams final, one North-South made five diamonds, the other made three notrump by South after the club-ace lead followed by a low club. When Micro Bridge was North-South, the bidding went as shown. West led the club ace and then the spade four to the king and ace. The robot declarer constrained the West hand to an upper limit of 11 high-card points, learned that that hand included the club ace king and the spade queen, thus decided to play East for the king of hearts after East had discarded two hearts, even though that discarding would have been irrational. Inflexibility to overcome the presumed point-count range led to the robot's downfall. At the other table, Jack reached five diamonds after a two club overcall and, after the same opening lead and continuation, later took the heart finesse for a 12-imp pickup. In that deal, a robot placed an upper limit on a preemptive overcall. In the next deal (from the final of the computer event), a robot placed a lower limit on an opening bid:

East dealer
North-South vulnerable

North
♠ A 9 7 3
♥ 5
♦ A 6 4
♣ 10 8 5 3 2

West
♠ K Q 10 8 6 4
♥ 10 8 6
♦ 9 7 3
♣ J

East
♠ J 5
♥ K J 9 7 4
♦ 2
♣ K Q 9 7 6

South
♠ 2
♥ A Q 3 2
♦ K Q J 10 8 5
♣ A 4

South	**West**	**North**	**East**
——	——	——	1 ♥
Double	2 ♥	3 ♠	Pass
5 ♦	Pass	6 ♦	(All Pass)

Wbridge5 arrived at slam, but where a human would take the club-jack opening lead and crossruff the majors, the robot ducked at trick one(!), took the diamond shift in hand, led a spade to the ace, took the "marked" heart finesse, ruffed a heart, ruffed a spade, and tried to cash the club ace: down two, after a ruff and a trump continuation. Why? Analyzing the generated samples and placing king-fifth of hearts with opener, a robot expects 12 tricks whether it wins or ducks the first trick. Deciding how to reenter the South hand at trick six, the lower-limit 11-HCP strength constraint on the East hand ensures that it will hold at least one more spade (the king or queen), so the club ace is safe. Notice that when plays seems equally good to a robot, it will make one at random, which will occasionally look weird—in an ending, a robot might choose a proven double squeeze over cashing out in high cards.

A comparison of four segments of late-round major national events with the same deals played by robots is posted at www.computerbridge.com, along with the complete records of the 2015 robot championship, the 19-year history of the event, and many articles on robot play.