Optimizing Saving Decisions in Counter-Strike 2

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Counter-Strike 2

5-on-5, round-based first-person shooter

- First to 13 rounds wins the match
- Terrorist Side (Offensive) looks to plant and defend a bomb
- Counter-Terrorist (Defensive) seek to defend the site / defuse the bomb
- If you survive a round, weapons / utilities are carried over to the next round

Ability to use powerful weapons depends on the economy

- Money depends on what happens during previous rounds (e.g. winning or losing the round, getting kills)
- Being able to properly manage your economy is important to winning the game

Data

Matches are saved by the game via "demo" files

- Demo files can be parsed via the awpy package to produce full tracking and event data
- We use all demo files(259 matchups, 500+ matches) from tournaments during the later-half of the 2025 year
- Demo files are available to be downloaded on HLTV.org, web-scraping to automatically download

Saving

The idea of intentionally giving up a round to "save" powerful weapons for use in future rounds

- Useful for situations when the round is likely lost, but still holding on to these weapons
- Recently, in the professional scene, saving has been used substantially more liberally (e.g. in 5v3 situations)

We look to build a win-probability framework to determine whether this the decision is optimal

Win Probability Models

Building Markov-Chain win-probability model for each round

- Given the score, economic situations of each team, what is the probability that team x wins?

With these win-probabilities, we build an in-round MDP for saving

- The MDP will look to reach certain terminating state
  - e.g. Terrorist Side won, Counter-Terrorists hold on to \$5000 worth of inventory
  - These terminating states will then be used to calculate the state for our Markov-Chain to derive a win-probability
- State - number of players left, value of current inventories, whether bomb has been planted, time left
- Action - whether to save or continue to go for it
- Value - the win-probabilities from potential ending Markov Chain states

From here, we can determine if / when it would be optimal to save