Master's Thesis Extended Abstract

Population Tendency Based Poker Hand Analysis Tool For Android

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Topic description

The *poker boom*, or a sudden rise in popularity of poker games between the years of 2003 and 2006, can largely be attributed to a recreational player at the time, Chris Moneymaker winning the 2003 World Series of Poker Main Event. This, along with the advancements in online poker in general, made poker into a popular form of entertainment. Poker was no longer viewed as a shady underground card game, but as a skill based strategy game.

One variant of the game – *No Limit Texas Hold'em* (*NLHE*) – gained more popularity than others. Like many other variants of poker, NLHE remains unsolved due to its enormous game tree and the limitations of computing power. This complexity of the game, along with the strategical differences between cash games and various types of tournaments, keeps the poker scene highly competitive, forcing even the top professional NLHE players to constantly study the game, much like the players in professional chess scene. While there are several ways to study the game, one of the most effective ways is doing hand analyses. A *hand analysis* is the evaluation of betting actions taken by a player during a particular poker hand. In order to properly assess and quantify the value of actions, software that incorporate specific mathematical models for poker related calculations, called *solvers*, can be utilized.

By default, poker solvers output *GTO* (*Game Theory Optimal*) based strategic solutions. GTO, which assumes all involved players follow perfect Nash equilibrium [1], is a special subset of a *MES* (*Maximally Exploitative Strategy*), which constructs a counter-strategy with maximized *EV* (*Expected Value*) to an opponent's fixed strategy [2]. While mathematically sound and fairly accurate in high stakes games, GTO is generally less lucrative than specific MES approaches in low to midstakes games, where the average level of play is farther from optimal. Properly adjusting the input to convert a theoretical GTO output to a more realistic MES often requires

a relatively high level understanding of the game and player population tendencies, which makes solvers difficult to corretly use for most recreational players. Another downside to solvers is that they are heavy on computing requirements and therefore not useable on mobile devices, leaving the amount of tools available for on-the-go hand analysis in live play settings quite scarce. The general goal of this thesis is to address these problems and provide a possible solution.

Topicality and field overview

As popularity of poker is still growing [4], so is the amount of tools, materials and platforms for studying the game. The simplest way for a recreational player to get into poker strategy is by joining a coaching platform. Many such platforms, e.g., [5–8], offer video courses from experienced players and precalculated strategies for tournaments and cash games, along with a community for the students. While a good place to start, most of these platforms are not free to join and the depth their courses are able to go into is limited. Therefore, most of them encourage students to start using modern poker software to continue their studies after finishing the course.

There are many different software to choose from, most of which focus on hand analysis. A group of tools called equity calculators, e.g., [9], help calculate the equity of a hand or range (a set of hands) versus another hand or range. While equity calculation is an essential part of hand analysis, these tools are lacking in other important features, like postflop range analysis and strategic advice. Range analysis tools, e.g., [10, 11], on the other hand, are good at postflop range analysis, but have limited preflop features and lack strategic advice. Basic preflop Nash calculators, e.g., [12, 13], do provide strategic advice based on EV calculations, but are only limited to preflop scenarios. A huge leap forward from the latter, however, are solvers. Solvers are essentially preflop and postflop Nash calculators, which can formulate near-Nash equilibrium strategies for situations with arbitrary ranges and betsizes. Most commercial solvers, e.g., [14, 15], can calculate equity, EV, and full GTO and MES strategies with high accuracy. Although most solvers are limited to heads-up (two-player) situations, some can even solve for complex multi-way situations, e.g., [16]. What most of these software have in common, though, is that they have steep learning curves and they are relatively expensive. As mentioned earlier, most solvers can also be overwhelming for recreational players and their heavy hardware requirements make them nonviable on mobile devices. [3]

Therefore, poker learning tools for mobile devices are mostly either equity calculators or strategy lookup applications. Some of the more advanced equity calculators, e.g., [17], even have postflop range analysis features. Most of them are feasible on mobile devices, because their calculations rely on simple Monte Carlo simulations. Unfortunately, all the input ranges are expected from the user, which may prove to be too difficult for most recreational players, and the calculation results are given as raw equities, which alone are not enough for strategic advice. On the other hand, most strategy lookup applications do present precalculated strategic advice. While some of these apps present only limited preflop strategies and quizzes, e.g., [18], others are able to do this even for most postflop heads-up situations, e.g., [19–21]. These precalculated strategies, however, are noneditable and are rigidly based on GTO, not taking population tendencies into account. Although a small group of apps do provide non-GTO strategies, they rely on commercial artificial intelligence to formulate strategies by playing a large number of hands against itself, e.g., [22]. The formulated core strategy is solely based on what the software at hand believes is good when playing against itself, however, and is not directly verifiable, cannot guarantee unexploitability nor adjust for population tendencies. This strategy is also subject to change over time, making it hard to learn from it. [3]

Problem statement and goals

Thus, most poker hand analysis tools for mobile devices are not easy to use or helpful for all recreational players. The better part of them either require complicated user input or provide rigid strategic advice without taking low to midstakes population tendencies into account. The goal of the thesis at hand is to provide a solution to this problem in the form of a mobile application that is easy and beneficial for players of all skill levels to use, basing its strategic advice on realistic population tendencies. Furthermore, this thesis also aims to research and achieve the following subgoals:

- Research how to categorize community card run-outs and game trees for data analysis.
- Determine how to discretize and present population tendencies.
- Research poker strategy related calculation algorithms, identify the necessary ones for hand analysis and optimize them for mobile devices, if possible.
- Realize a poker hand analysis method that requires minimal user input, but allows the user to alter it in detail.
- Determine how to formulate the output of a hand analysis with minimal calculations.

Methodology and work structure

The thesis can be divided into two main subtasks: developing the mobile application and statistically analyzing population tendencies.

Mobile application

The development of the mobile application will broadly be based on design science research methods [23] and the structure of the work will encompass the following:

- Identify a demand for the application via a survey in a poker community.
- Study the features and UI of other poker hand analysis applications.
- Determine which poker strategy related calculation algorithms to use.
- Define the *MVP* (*Minimum Viable Product*) of the application based on the former.
- Model the application in UML taking well established design patterns [24] into account.
- Develop and evaluate the application in iterations using Agile methods.

The application will be developed for Android, as it is the leading mobile OS on the global market [25]. Developing a separate application for iOS or learning a cross-platform technology unfamiliar for the author will be disregarded as extending beyond the scope of this thesis. This part of the project will be realized in Kotlin, which has become the standard for Android native application development.

Population tendency analysis

The results of the analysis will be integrated into the hand analysis method of the mobile application. This part of the project will be realized in Python, as it has many libraries and data visualization options suitable for data analysis. It will encompass the following:

- Determine a realistic scope for the statistical analysis (gametypes, stakes).
- Collect a bulk of poker hand history data, e.g., from [26].
- Parse the data to a more compact format for analysis.
- Categorize community card run-outs via texture.
- Simplify and categorize game trees.
- Filter hand history data by every possible category combination of the former two.
- Discretize population tendencies and study them in each filtered group.
- Integrate the results into the mobile application.

Evaluation of results

The evaluation of the mobile application will generally be based on *FEDS* (*Framework for Evaluation in Design Science*) [27]. Namely, once the MVP of the application has been developed, it will be released to a group of test users for feedback. The test users in this case will be the poker players that agreed to be a part of the test group in the initial survey, which was used to determine a demand for the application. Their feedback will be used to potentially add features and make changes or corrections in the features of the application in the next iteration of development. The hand analysis method of the application will be evaluated separately by consulting a group of well established poker players to give feedback on the validity of its results. The number of iterations needed for the project at hand is yet to be determined.

References

[1] D. M. Kreps, "Nash equilibrium," in *Game Theory*, J. Eatwell, M. Milgate, and P. Newman, Eds., 1st ed. London, UK: Palgrave Macmillan, 1989, pp. 167–168.

[2] M. Acevedo, "The elements of game theory," in *Modern Poker Theory: Building an Unbeatable Strategy Based on GTO Principles*. Brighton and Hove, UK: D&B Publishing, 2019, pp. 69–110.

[3] M. Acevedo, "Modern poker software," in *Modern Poker Theory: Building an Unbeatable Strategy Based on GTO Principles*. Brighton and Hove, UK: D&B Publishing, 2019, pp. 111–121.

[4] "Online Gambling Market Size, Share & Trends Analysis Report By Type (Sports Betting, Casinos, Poker, Bingo), By Device (Desktop, Mobile), By Region (North America, Europe, APAC, Latin America, MEA), And Segment Forecasts, 2022 – 2030," Grand View Res., San Francisco, CA, USA, Tech. Rep. GVR-3-68038-474-1, May 2022.

[5] Raise Your Edge. [Online]. Available: https://raiseyouredge.com/ Accessed: Nov. 4th, 2022

[6] BBZ Poker. [Online]. Available: https://bbzpoker.com/ Accessed: Nov. 4th, 2022

[7] Upswing Poker. [Online]. Available: https://upswingpoker.com/ Accessed: Nov. 4th, 2022

[8] Run It Once. [Online]. Available: https://runitonce.com/ Accessed: Nov. 4th, 2022

[9] *Power-Equilab*. (1.12.4.0). [Online]. Available: http://power-equilab.com/ Accessed: Nov. 4th, 2022

[10] *Poker Ranger*. (2.3.1). [Online]. Available: https://pokerranger.com/ Accessed: Nov. 4th, 2022

[11] *Flopzilla*. (1.8.6). StoxEV B.V. [Online]. Available: https://flopzilla.com/ Accessed: Nov. 4th, 2022

[12] *Holdem Resources Calculator*. (2.0). HoldemResources GmbH. [Online]. Available: https://holdemresources.net/ Accessed: Nov. 4th, 2022

[13] *ICMIZER*. (3.14.3). ICMIZER Limited. [Online]. Available: https://icmizer.com/ Accessed: Nov. 4th, 2022

[14] *PioSOLVER*. (2.0). [Online]. Available: https://piosolver.com/ Accessed: Nov. 4th, 2022

[15] *GTO+*. (1.4.4). StoxEV B.V. [Online]. Available: https://gtoplus.com/ Accessed: Nov. 4th, 2022

[16] *MonkerSolver*. (2.1.9). Monkerware. [Online]. Available: https://monkerware.com/ Accessed: Nov. 4th, 2022

[17] *PokerCruncher*. (15.2.1). PokerCruncher, LLC. [Online]. Available: https://pokercruncher.com/ Accessed: Nov. 4th, 2022

[18] *SnapShove*. (2.1.33). Silver Software Applications Limited. [Online]. Available: https://play.google.com/store/apps/details?id=com.maxsilver.snapshove Accessed: Nov. 4th, 2022

[19] *Poker Solver+*. (1.7.0). Crafty Wheel Studios Pty Ltd. [Online]. Available: https://play.google.com/store/apps/details?id=com.craftywheel.poker.training.solverplus Accessed: Nov. 4th, 2022

[20] *Postflop+ GTO Poker Trainer*. (4.5.4). Crafty Wheel Studios Pty Ltd. [Online]. Available: https://play.google.com/store/apps/details?id=com.craftywheel.postflopplus Accessed: Nov. 4th, 2022

[21] GTO Wizard. [Online]. Available: https://gtowizard.com/ Accessed: Nov. 4th, 2022

[22] *PokerSnowie*. (1.2.0). Snowie Games Ltd. [Online]. Available: https://pokersnowie.com/ Accessed: Nov. 4th, 2022

[23] A. R. Hevner, S. T. March, J. Park and S. Ram. "Design Science in Information Systems Research," *MIS Quarterly*, vol. 28, no. 1, pp. 75-105, 2004, doi: 10.2307/25148625.

[24] Refactoring Guru, *Design patterns*. [Online]. Available: https://refactoring.guru/design-patterns Accessed: Nov. 4th, 2022

[25] Statcounter Global Stats, *Mobile Operating System Market Share Worldwide*. [Online]. Available: https://gs.statcounter.com/os-market-share/mobile/worldwide/#monthly-202208-202209-map Accessed: Nov. 4th, 2022

[26] HH Smithy. [Online]. Available: https://www.hhsmithy.com/ Accessed: Nov. 4th, 2022

[27] J. Venable, J. Pries-Heje and R. Baskerville. "FEDS: a framework for evaluation in design science research," *European journal of information systems*, vol. 25, no. 1, pp. 77–89, 2016, doi: 10.1057/ejis.2014.36.