Introduction to the ML-Bridge Project

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The ML-Bridge Project is an experiment in applying AI techniques to the game of duplicate contract bridge. This document explains the mission and status of the project. The project is in the proof-of-concept stage and research is on-going. The significance of this project is that it uses AI to make predictions about contracts, results and scores.

Initial experiments constrain the AI to neither having any understanding of the play of the hand nor any clues provided by bidding. This is opposed to par score calculation engines which have perfect double dummy knowledge of the play of the hand, or human players who obtain valuable information conveyed by bidding sequences. Keep in mind, the AI has been given some single dummy information and a final contract. The initial experiments ask the AI to:

1. Predict the maximum number of tricks which can be taken in the NS and EW directions for each suit. Accuracy is calculated by comparing the AI's predictions to double dummy results.
2. Predict par score and calculate accuracy by comparing predicted to actual par score.
3. Using the above predictions, calculate the AI's game percentage and ranking. Matchpoint information is obtained from The Common Game's (TCG) club hands and club's match point awards.

An important aspect of ML-Bridge is the creation of charts. The charts prove helpful in understanding the accuracy of predictions. Mistakes in predictions often become visible through examination of charts. The charts contain a wealth of valuable information for bridge enthusiasts, teachers and pros. The following charts are both simple and technical. Although they show simple relationships, such as HCP vs tricks taken, they are not so easy to comprehend unless you are experienced at reading charts. Patience is recommended.

Experimental results have been obtained by using TCG data from the year 2019. Predictions are made using unseen 2020 TCG data (validation set). It is safe to assume that using more years of data will result in more accurate predictions. About 5 times as much data is available from TCG.

ML-Bridge specific terminology appearing in charts:

1. “Par” means Par score as seen on hand records. Par score is derived from play engines which are guarenteed to be 100% accurate. This is a super-important measure frequently used by ML-Bridge.
2. “Pred” is an AI predicted value. It’s the contract (trick count) having the highest probability of making.
3. “Exp” is a value derived from “Pred” multiplied by the contract score. “Exp” is the maxiumum predicted score whereas “Pred” is the most likely making contract. Neither “Pred” nor “Exp” contracts may be the final contract due to higher competitive bids.
4. “Exp_Par” is the AI predicted “Par” score. It’s a super-important measure. It’s derived from “Pred”. Like “Par”, it’s the contract where neither side can improve upon by making a further bid. AKA, a Nash-equilibrium. “Par” is calculated by a hand playing engine with double dummy knowledge thus guarenteeing an accuracy of 100%. On the other hand, “Exp_Par” has absolutely no knowledge about play of the hand nor is it 100% accurate. “Exp_Par” is an AI prediction learned by seeing 100,000s of example hands.
5. “MP” is the matchpoint award.
6. “TCG” The Common Game – a website which provides data on contract scores, MPs and frequency of contracts, scores and results.
7. “Contract Type” can be either Pass, Partial, Game, SSlam, or GSlam.

AI Terminology:

1. “Prediction” a forecast enabled by learning from many examples.
2. “Ground Truth” is the actual, real-life, result. For example, Par score and double dummy trick calculations are considered “Ground Truth” as they are 100% accurate.
3. “Mean” is a synonym for “average”.
4. “Frequency” is how often something occurs usually presented as a count or percentage.
5. “Variance” difference between two numbers such as bidding level vs tricks taken.

Chart Notes:

1. Percentages are shown using the preferred mathematical scale of 0 to 1 which can be considered a rescaling of 0 to 100%.
2. Sometimes one should ignore outlier statistics. Yes, 8 HCP can take 13 tricks but that’s an exception which should be disregarded.

Index of Charts:

Chart 1: How often does a specific HCP holding take a specific number of tricks? Bottom row shows (HCP, Tricks Taken). For example, 20 HCP most often takes 9 tricks but occassionaly just 7 or even 13.

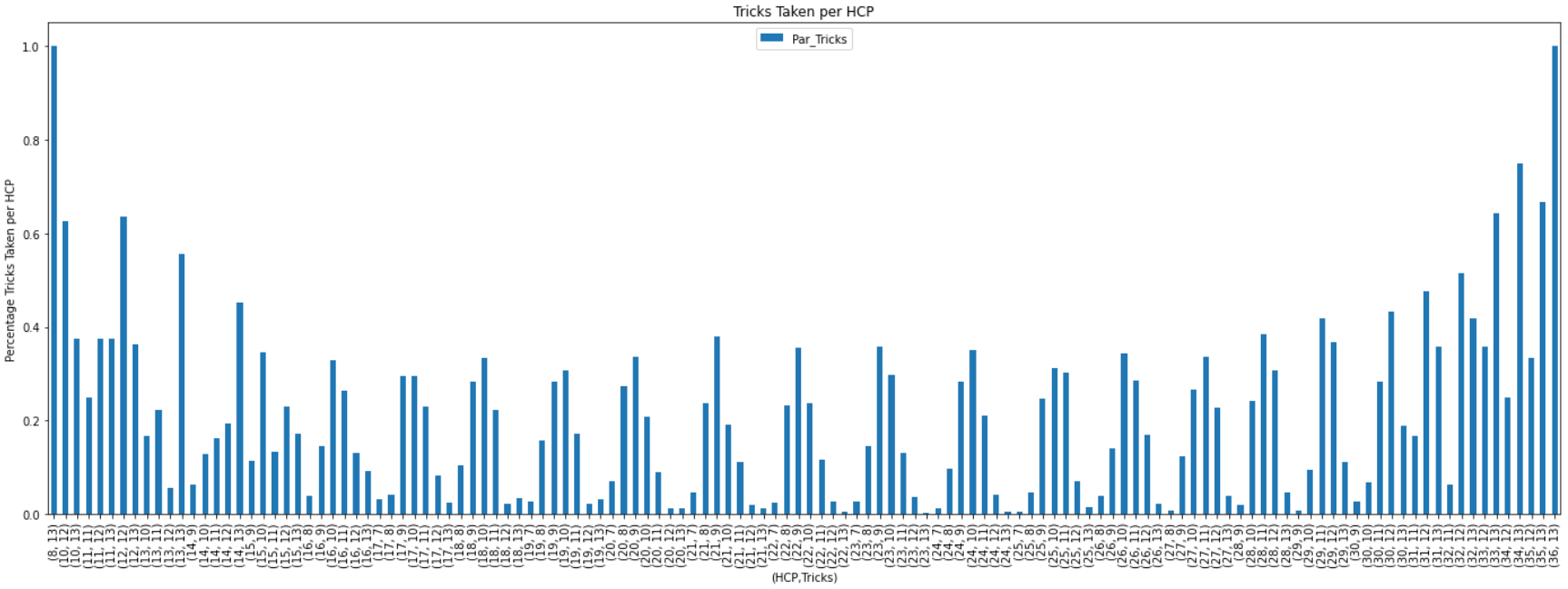


Chart 2: How often does a Par score take a specific number of tricks? Also shown is Pred (Predicted), Exp (Expected) and Exp_Par (Expected Par).

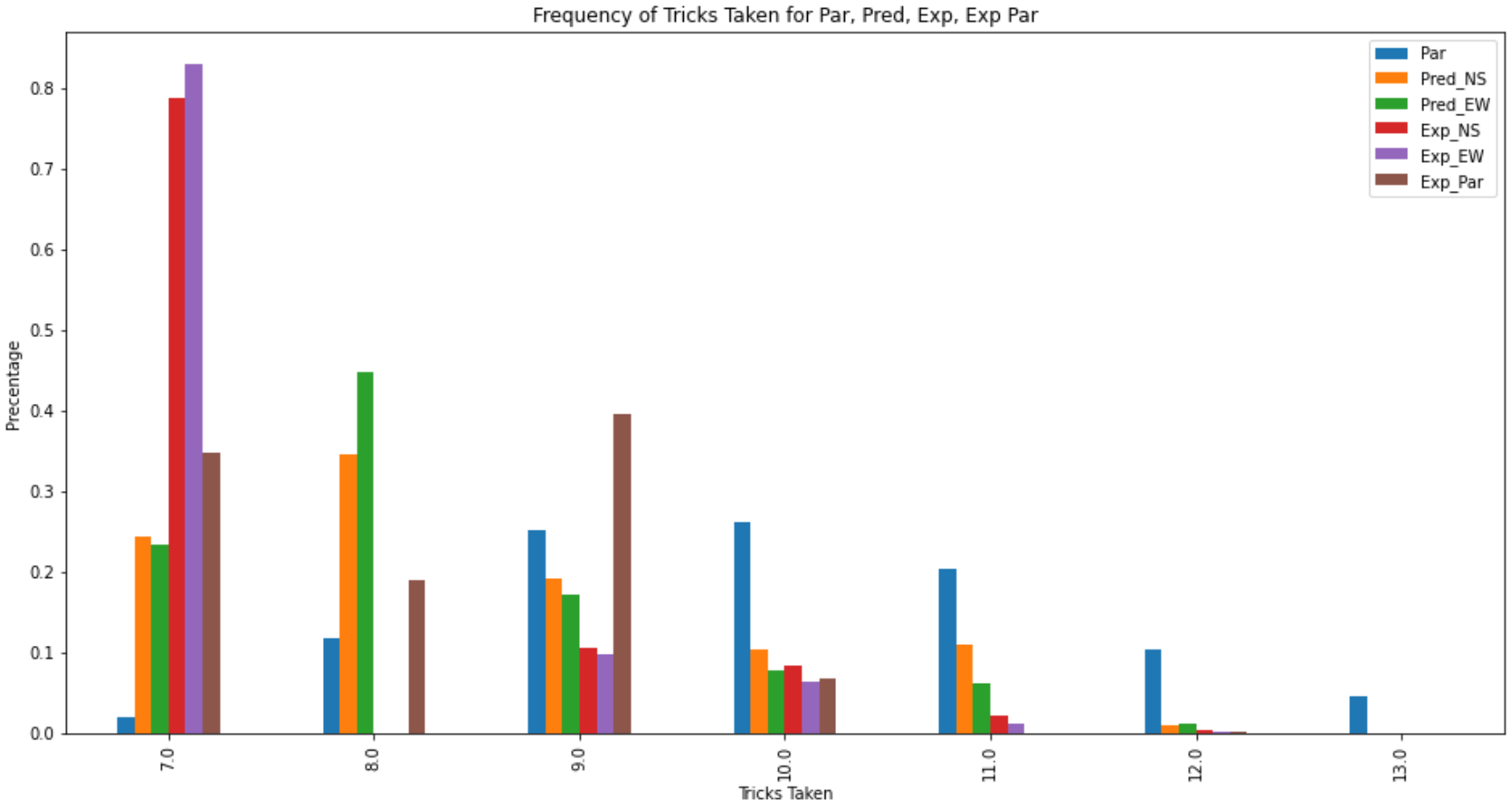


Chart 3: How well does Exp_Par (Expected Par) predict Par score? This chart shows the variance between what Exp_Par thought it could take and the actual number (Par) it really could take.

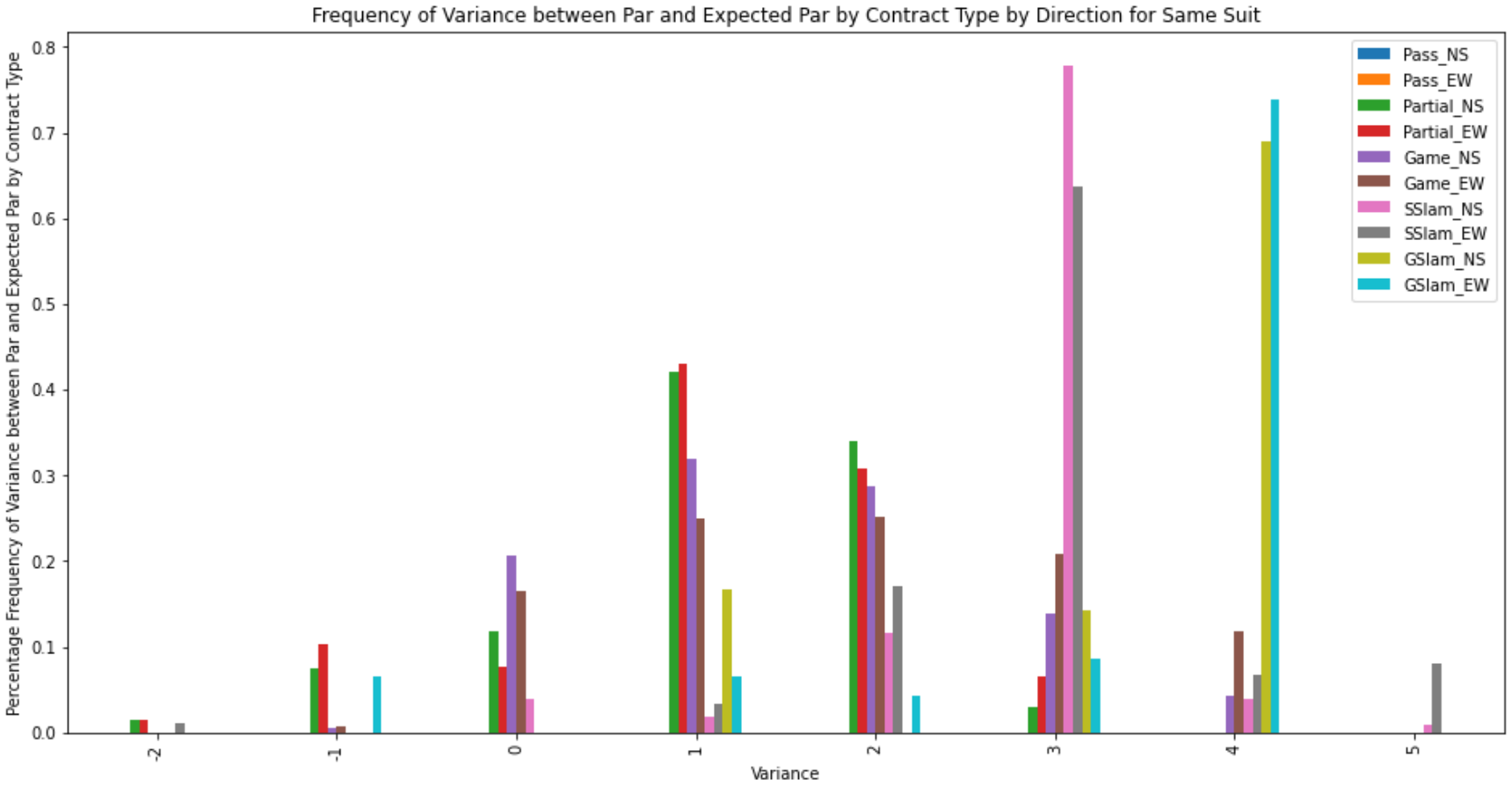


Chart 4: This chart compares actual number of tricks taken (Par) with Pred (Predicted), Exp (Expected), Exp_Par (Expected Par).

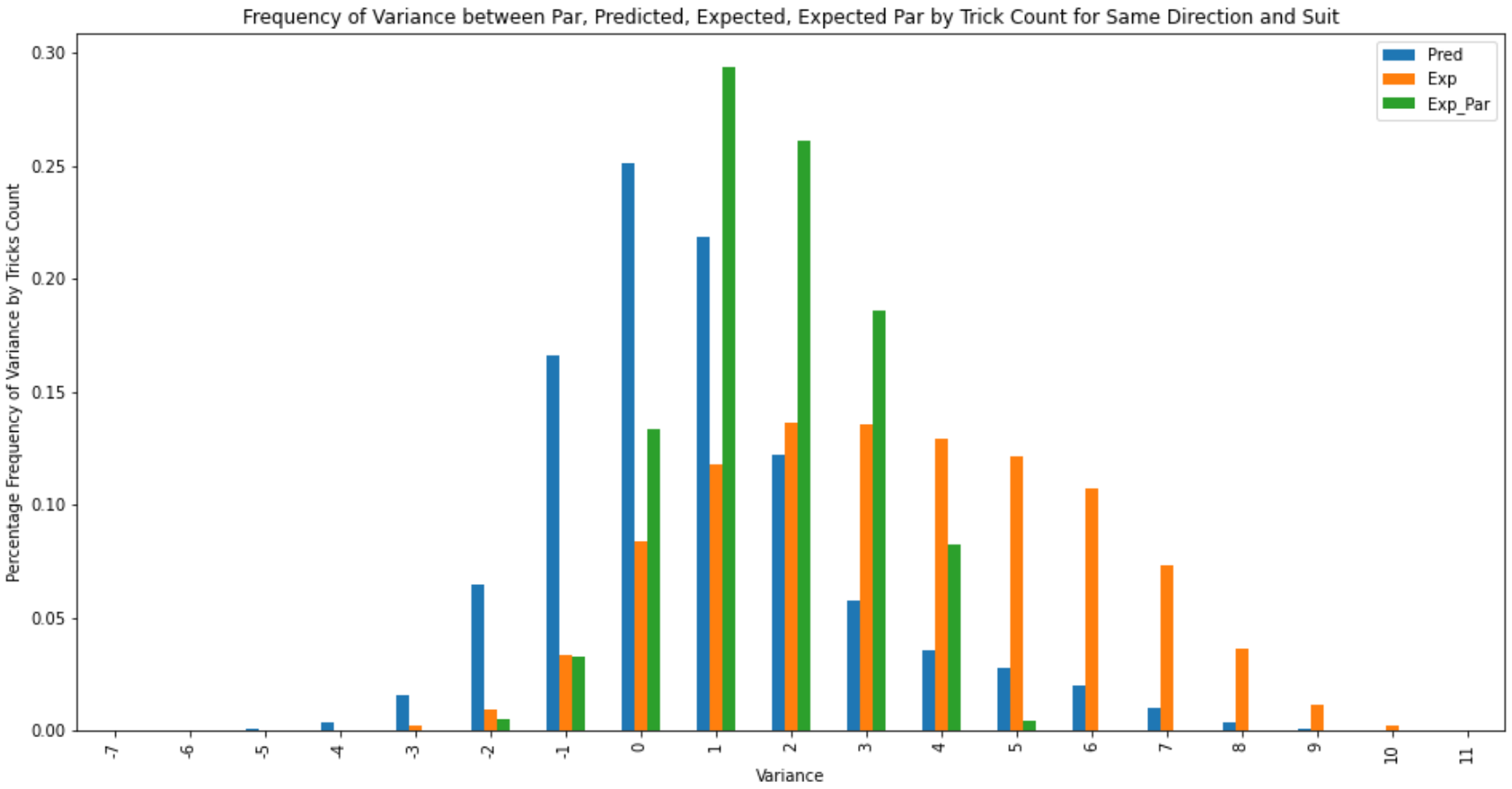


Chart 5: Frequency of MP (Match Points) awarded (299ers Game) by Contract Type (Pass, Partial, Game, SSlam, GSlam) for Par, Pred, Exp, Exp_Par. Scale shown is 0 to 1 instead of 0 to 100%.

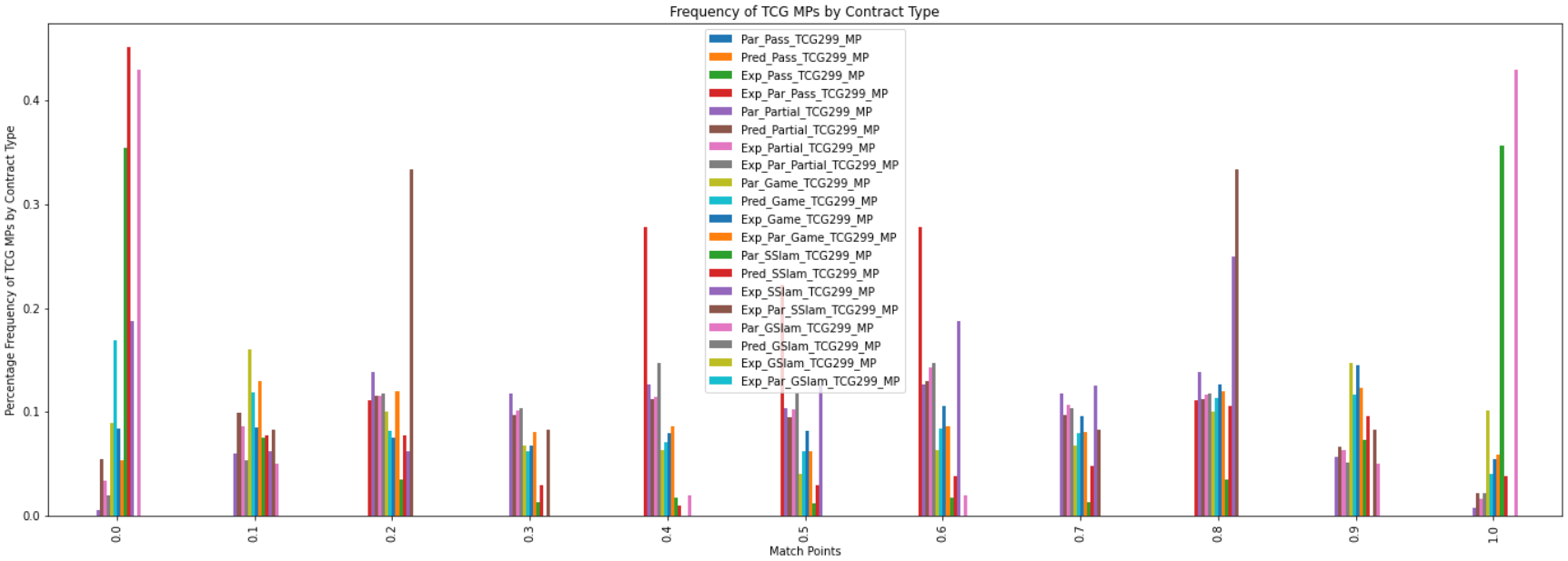


Chart 6: Frequency of MP (Match Points) awarded (open game) by Contract Type (Pass, Partial, Game, SSlam, GSlam) for Par, Pred, Exp, Exp_Par. Scale shown is 0 to 1 instead of 0 to 100%.

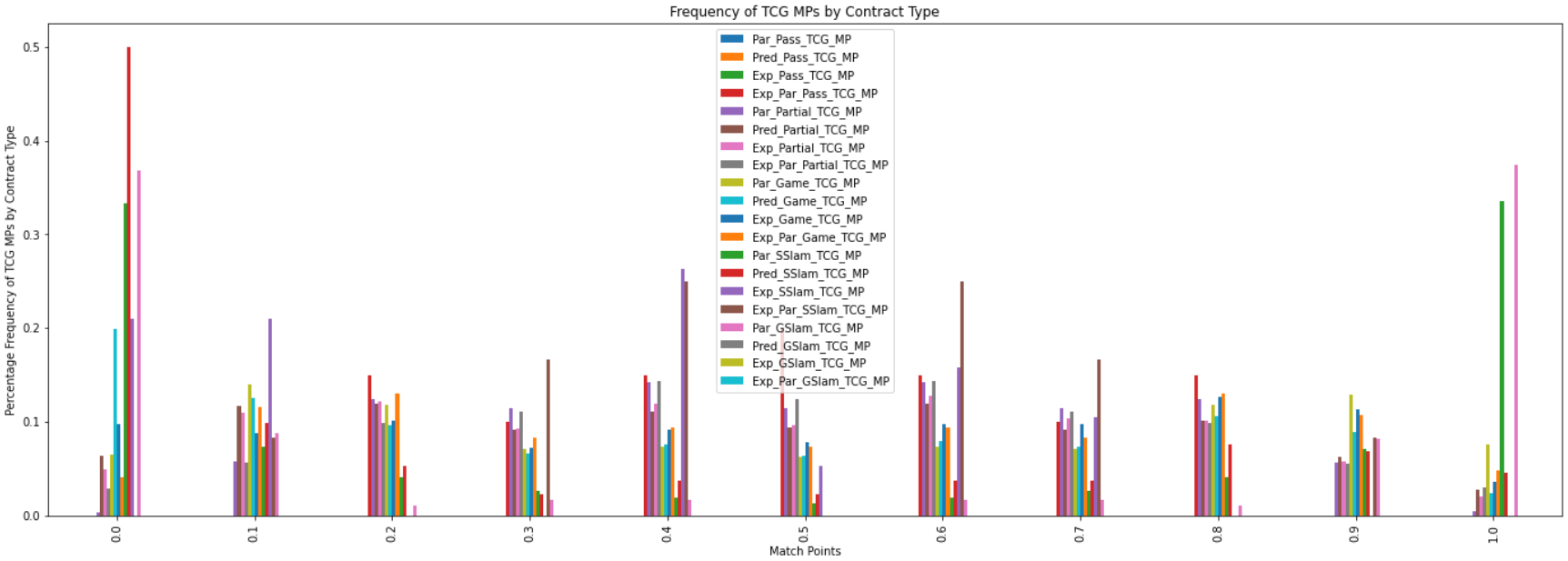


Chart 7: Frequency of MP (Match Points) awarded for Par, Pred, Exp, Exp_Par.

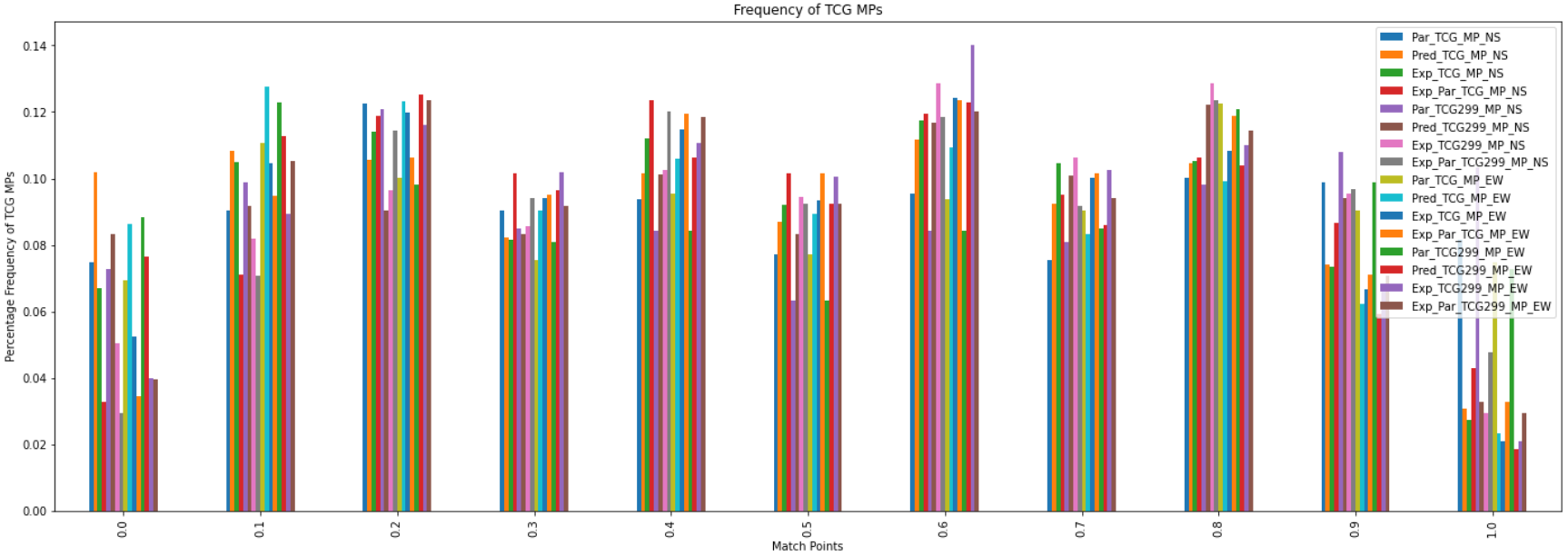


Chart 8: How often is the Par score contract a sacrifice? A Par score is considered a sacrifice if the contract results in a set. Contract types are (Partial, Game, SSlam, GSlam)? Also shown is Exp_Par (Expected Par).

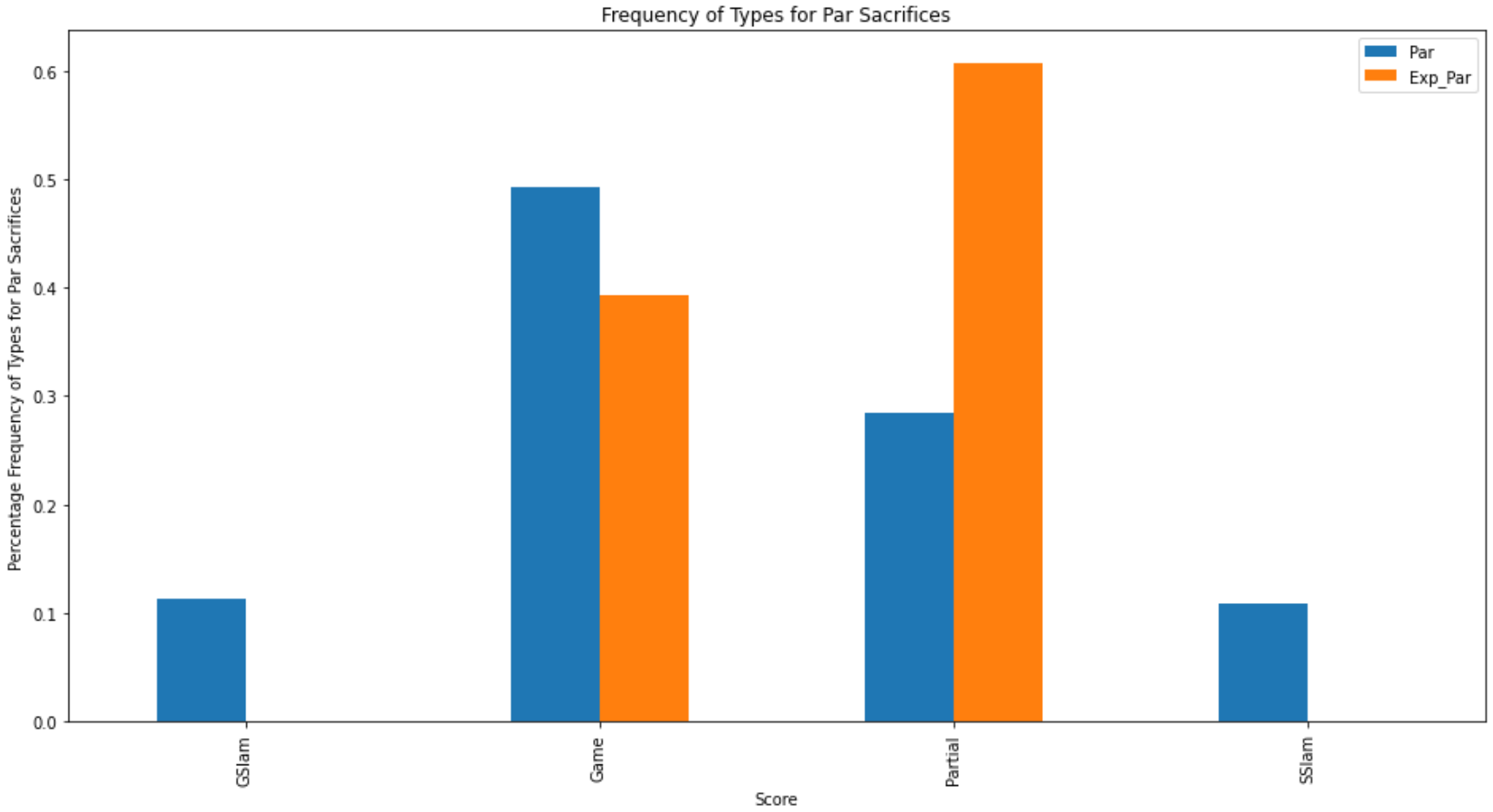


Chart 9: What is the frequency of scores for Par sacrifices? Also shown is Exp_Par (Expected Par). Some Exp_Par sacrifices actually made (oops). FYI, all Par sacrifices are doubled.

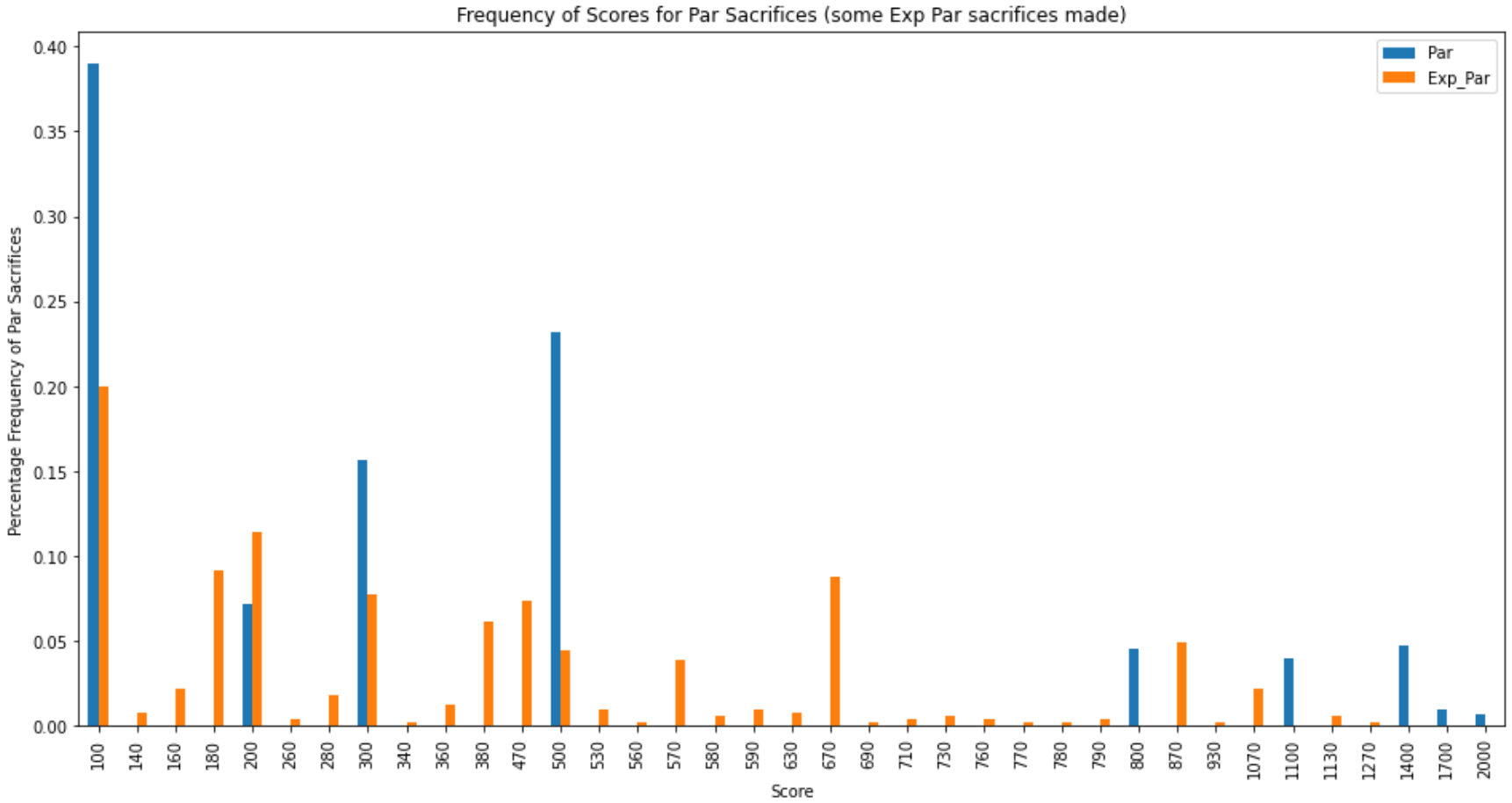


Chart 10: What is the frequency of contract types (Pass, Partial, Game, SSlam, GSlam) for Par scores? Also shown are Pred, Exp and Exp_Par.

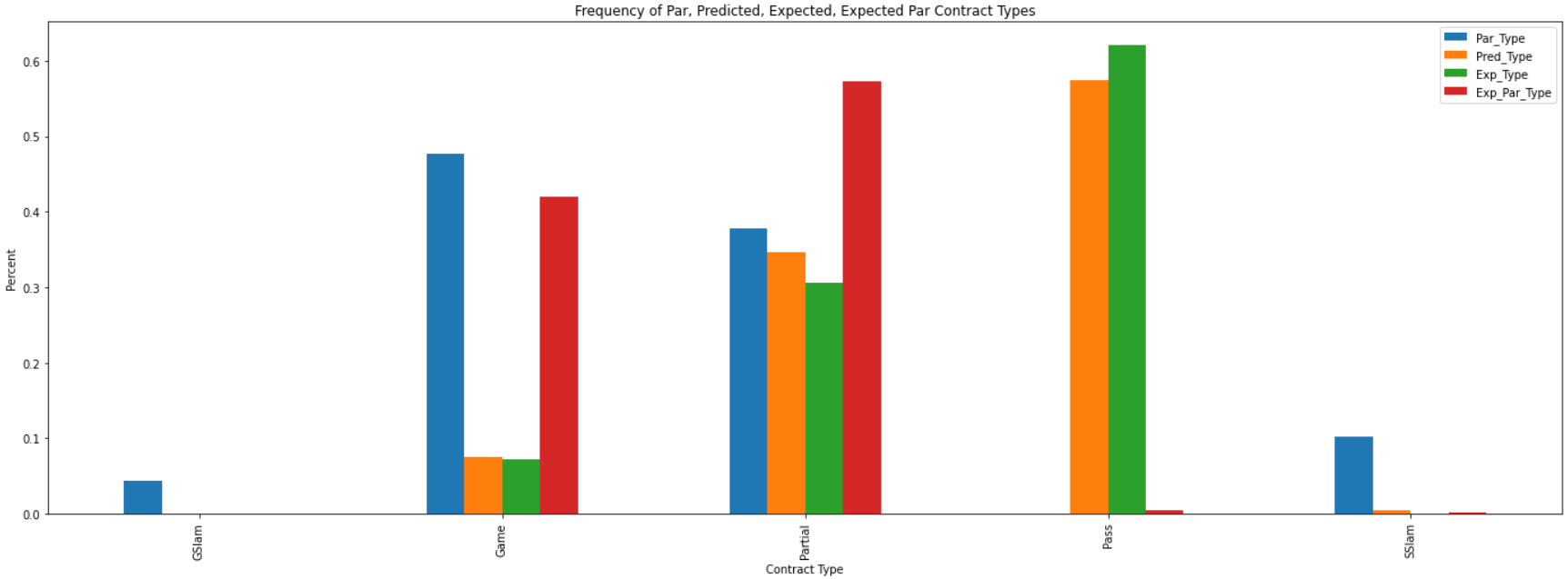


Chart 11: This is not a visual acuity eye exam. It's a chart showing the frequency of scores for Par, Pred, Exp and Exp_Par.

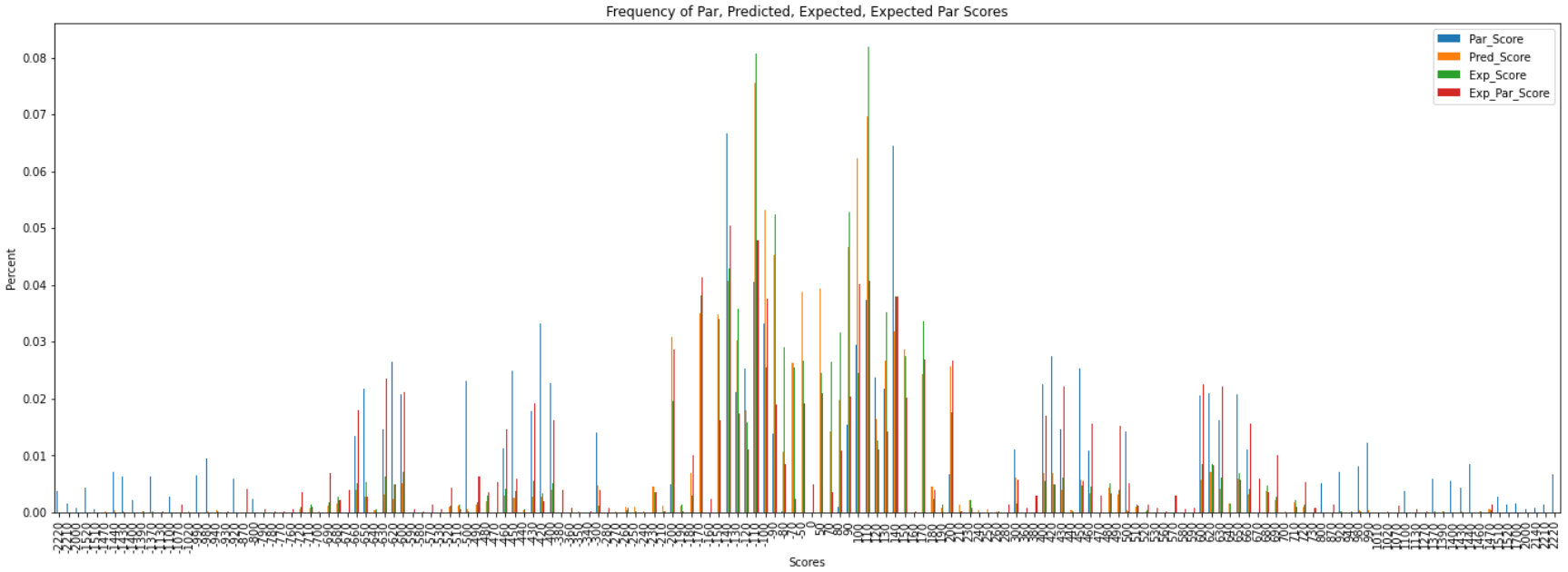


Chart 12: Frequency of MP (Match Points) for Par, Pred, Exp, Exp_Par broken out by direction (EW) and suit.

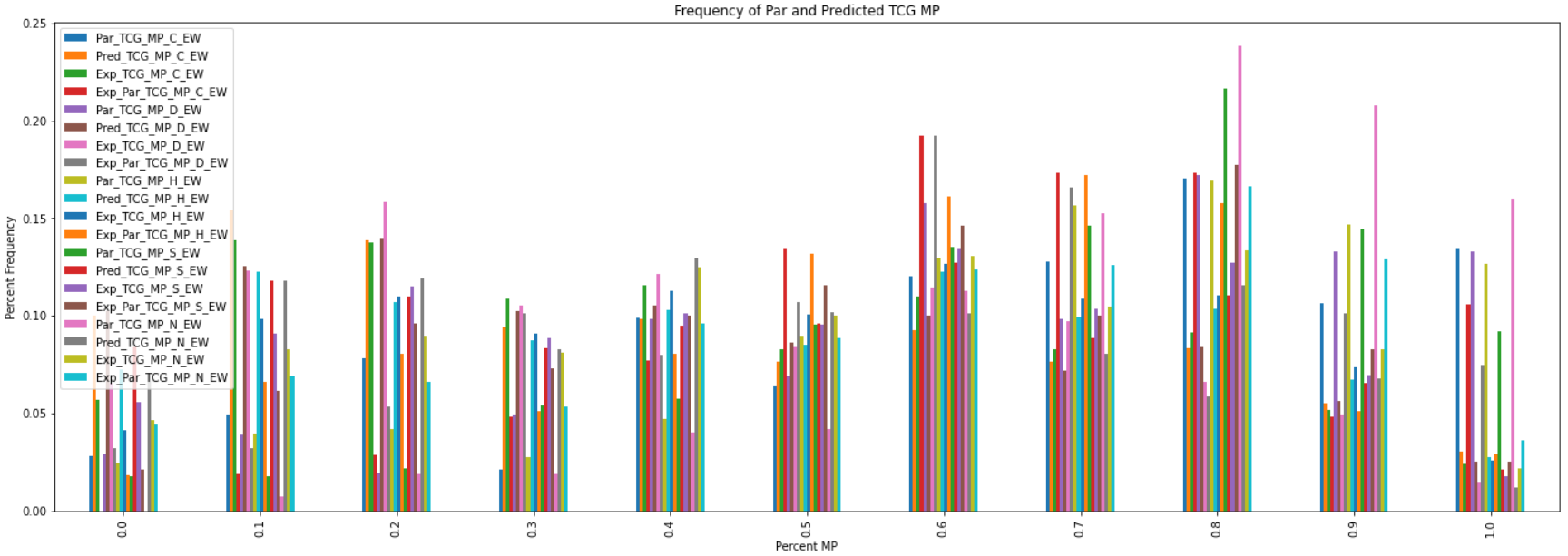


Chart 13: Frequency of MP (Match Points) for Par, Pred, Exp, Exp_Par broken out by direction (NS) and suit.

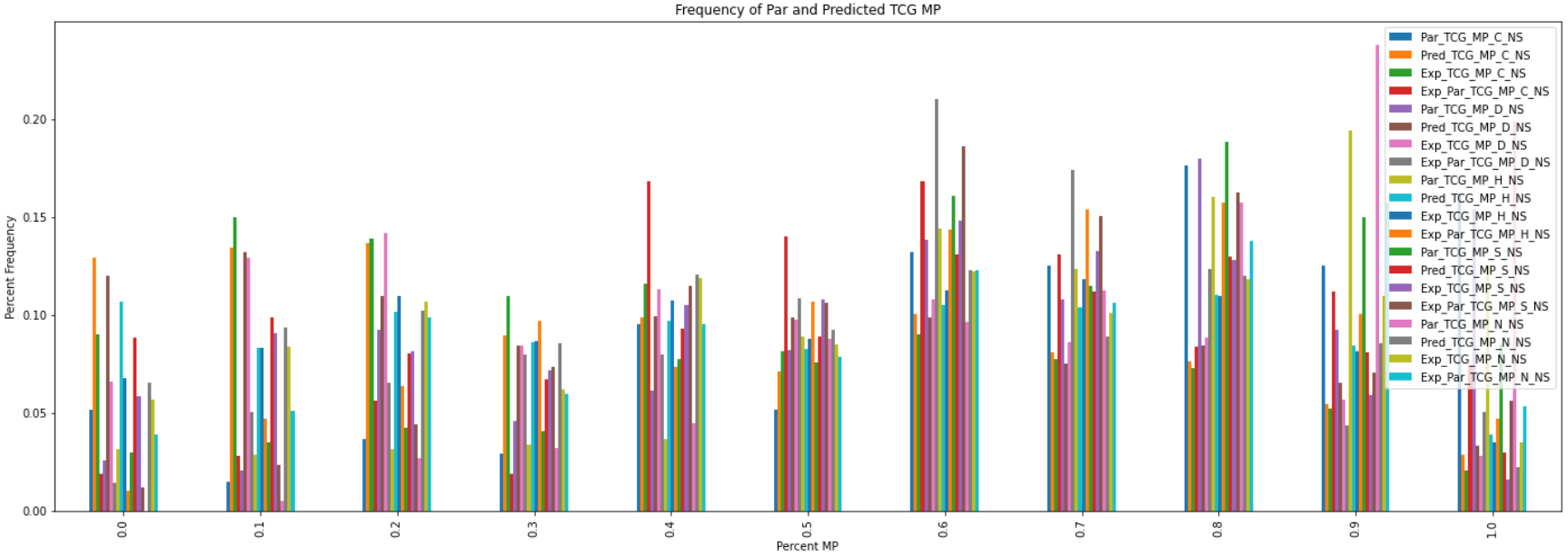


Chart 14: Frequency of MP (Match Points) for Par, Pred, Exp, Exp_Par broken out by direction (NS).

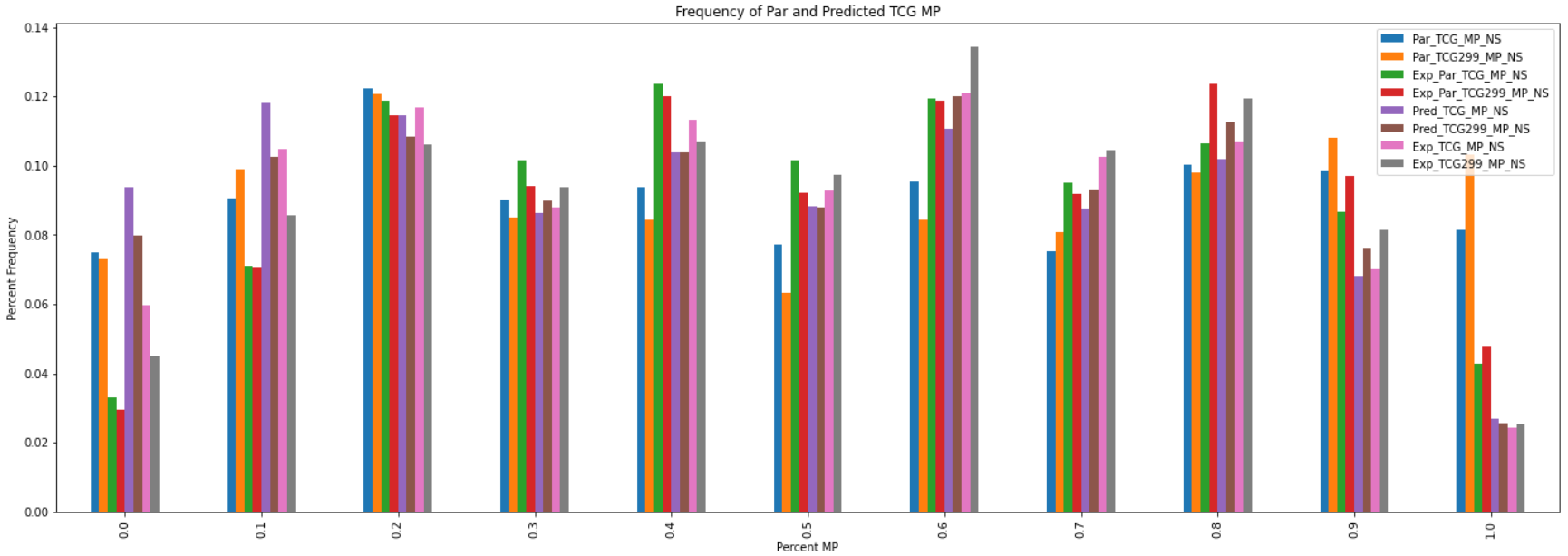


Chart 15: How does the mean (average) MP (Match Point) compare between suits for Par, Pred, Exp, Exp_Par?

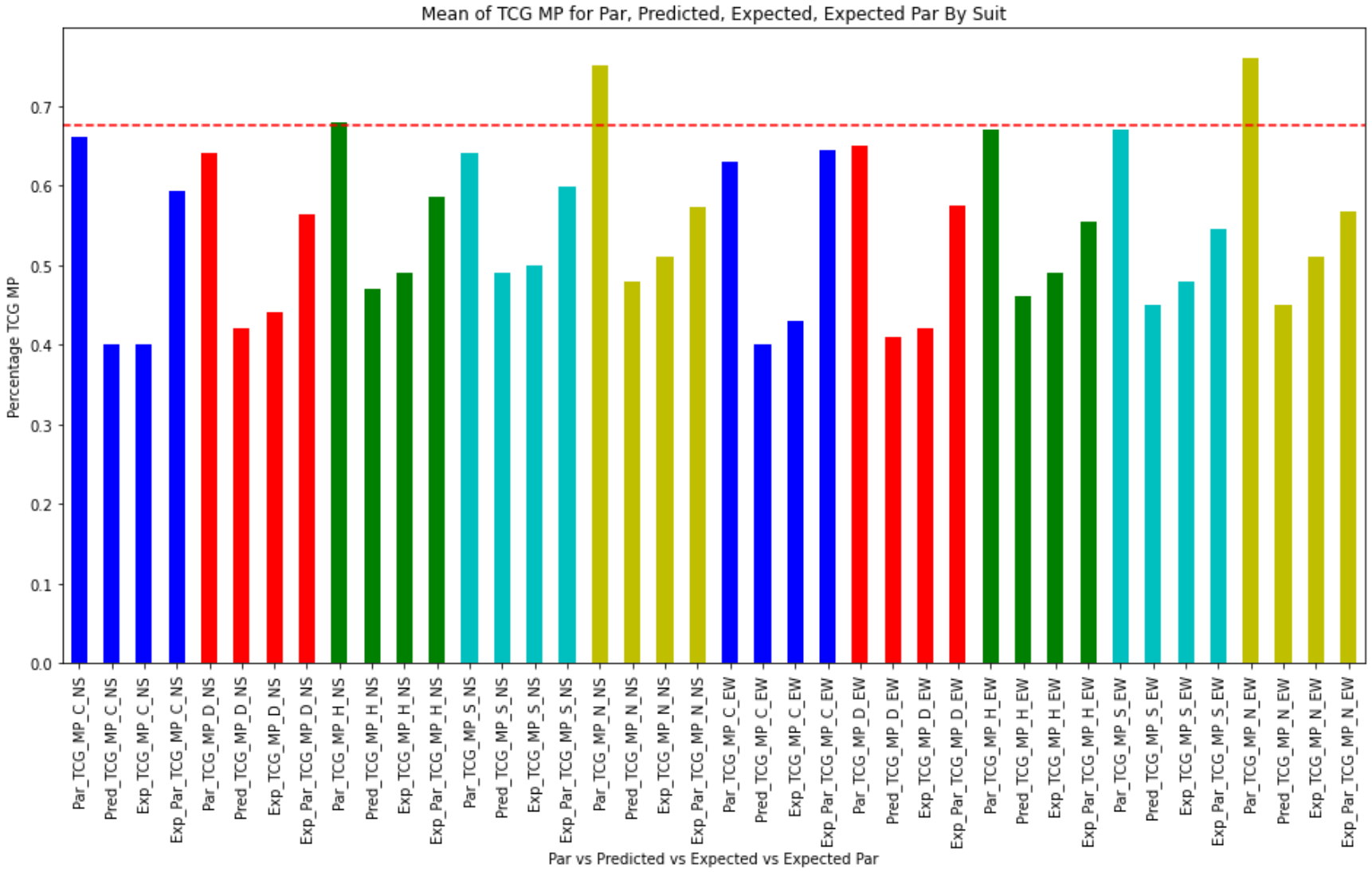


Chart 16: How does the mean (average) compare for MP (open game and 299ers) for Par, Pred, Exp, Exp_Par)?

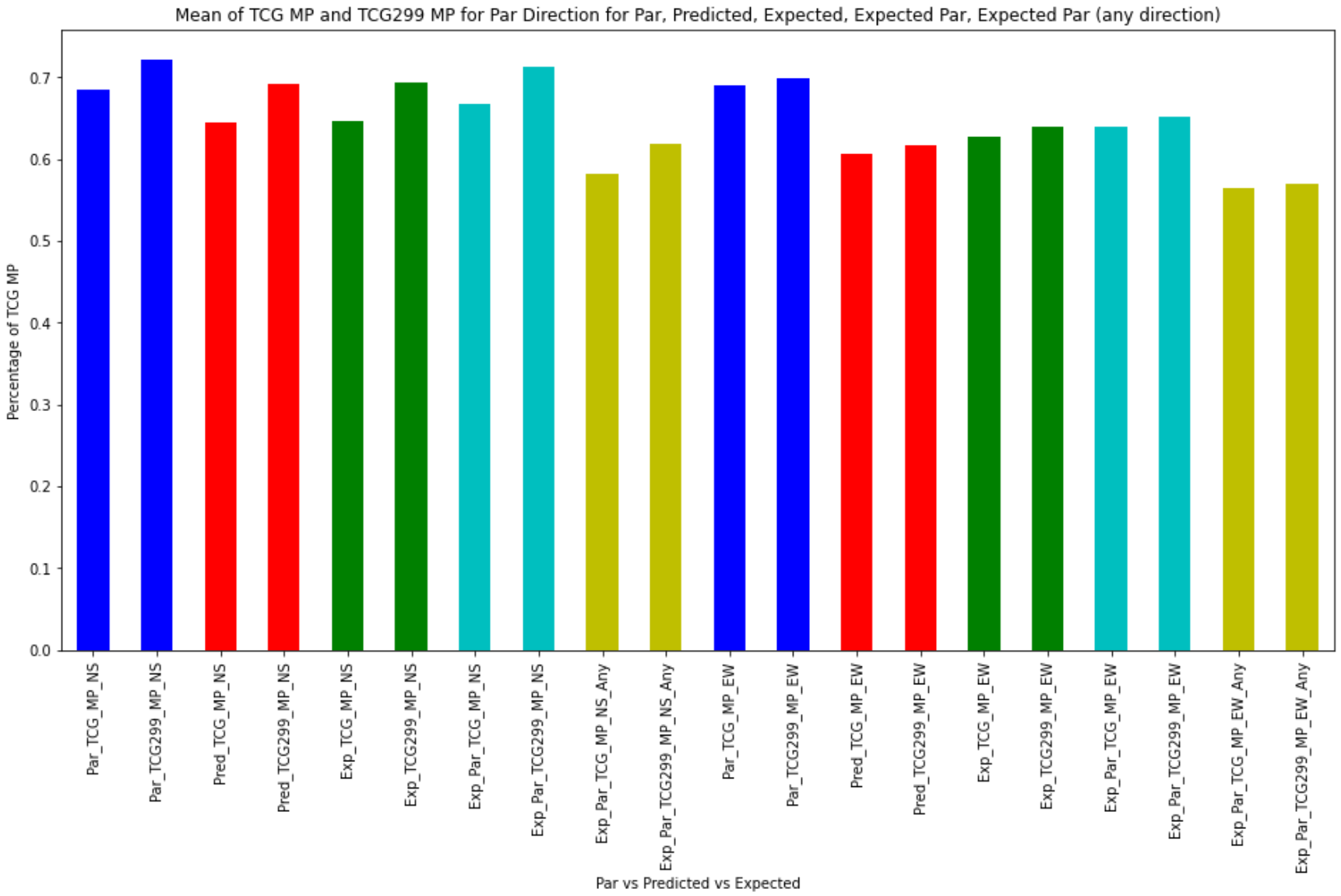
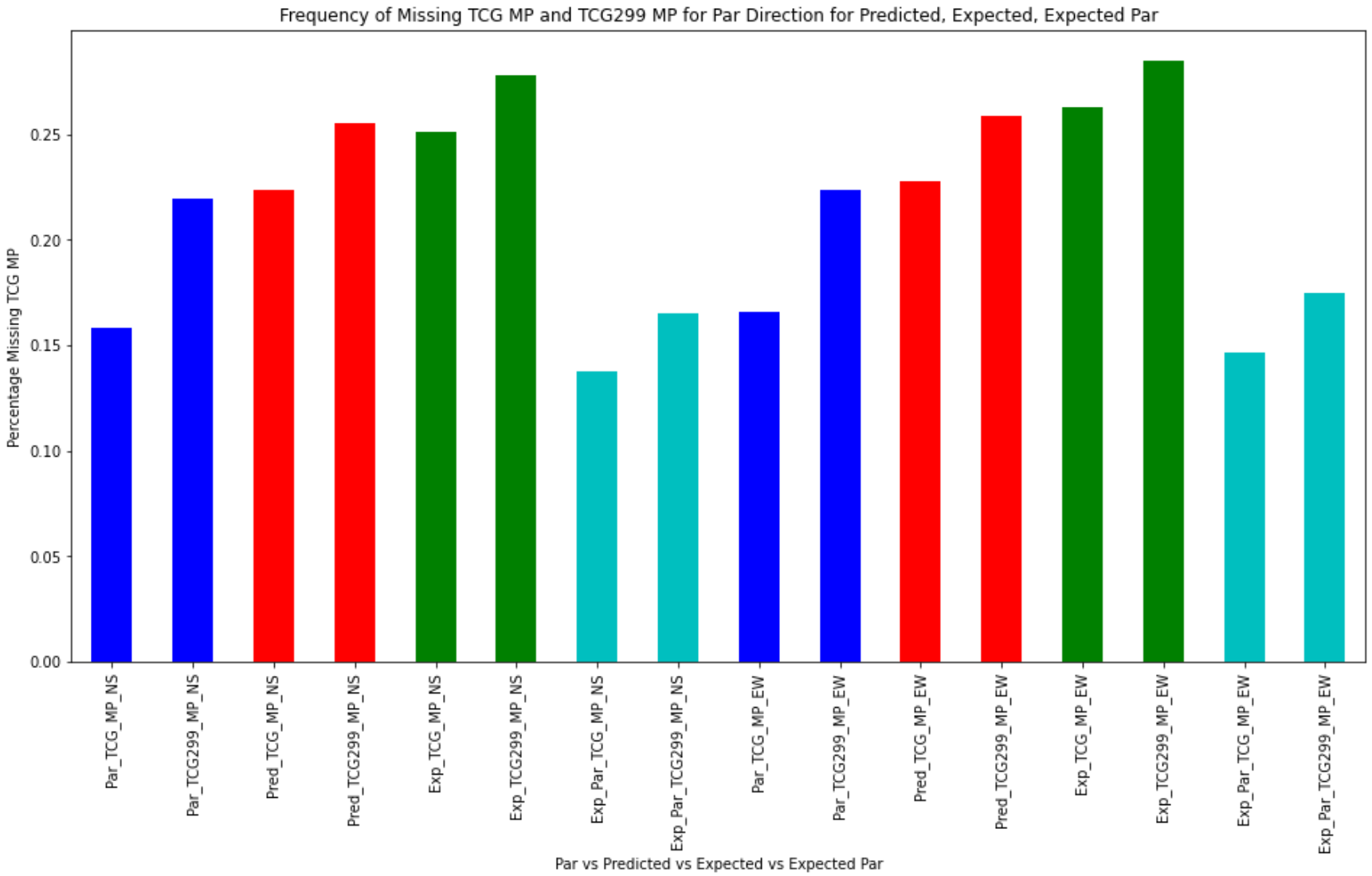


Chart 17: How often is a Par score so unique that TCG (The Common Game) hasn't recorded any other instance? Also compared with Pred, Exp, Exp_Par.



Chat 18: This is a bubble chart. It's a different type of chart than we have previously seen. It shows the relationship between HCP (oops, legend is missing from bottom row), tricks taken and the frequency of occurrence. Hence it shows three dimensions of data instead of the usual two. This chart conveys crucial information when designing a bidding system.