**Line of Argumentation**

Potential argumentation snippets for the paper

Fourier transformations of, for example, rectangular movements, result in a large number of Fourier components, and therefore a problem to which a rectangular trajectory would yield a good solution requires a complex Fourier transformation. Complexity, here, simply is the number of Fourier components. Complexity in terms of requiring a comparably large number of parameters, can be disadvantageous because, on the one hand, high-parametrized prediction algorithms tend to over-fit the data, and, on the other hand, the computational resources to estimate the weights of such components are comparably large given the limited computational power which a capacity-limited system like the human mind provides. Therefore, Fourier transformations unlikely yield plausible models of how cognition approaches QuantumMinds. Since approaching the problem by using Fourier transformations – although a general solution – is complex it may, if only limited training data is available, yield solutions inferior to more simple algorithms. For example, simulations by Gigerenzer et al showed that following a one-reason decision strategy by relying on memory retrieval of the city name and ignoring other information about a city will, when trained on a small sample, data predict which of two cities is larger more accurately than a more complex classification tree or a linear regression (Gigerenzer, Todd, & ABC Research Group, 1999). This does not hold for large numbers of training data.

Little training data in a smooth optimization landscape is comparable to much data in a high-dimensional non-smooth optimization landscape, where even absolutely speaking high numbers of data points from the landscape will not reveal the complete problem.

**Wording**

Cognitive-science specific wording and terms and concepts.

* Behavior under “uncertainty” vs. “risk” (Knight, 1921). Risk refers to a situation in which probabilities and outcomes are known. Known refers to whether the human actor has the information subjectively available. Uncertainty, on the other hand, refers to situations in which the outcomes or probabilities are unknown.   
  Starting to play a quantum games is – from a player perspective – behavior under uncertainty.
* “Ecological rationality” refers to decisions (e.g., Goldstein & Gigerenzer, 2002). Refers to a match between a decision algorithm that is not globally optimal and a particular environmental, statistical structure, in which the globally suboptimal algorithm capitalizes on the particularities of the environment and exceeds globally optimal algorithms in performance. Globally optimal refers to algorithms for which it is possible to prove that they yield a good solution to a problem as measured by some goodness criterion, for example, accurate weather predictions.  
  The visual system capitalizes on the visual gaming environment, which enables ecological rational decisions.
* “Bias variance decomposition” (Geman, Bienenstock, & Doursat, 1992) is the splitting of the prediction error variance of a model into a bias component plus a variance component plus random error. Random error refers to irreducible error due to aspects the prediction algorithm does not capture. The variance component is the scatter of multiple predictions derived from subsets of training data around their expectation, whereas the bias component is the distance of the expectation of multiple predictions derived from different subsets of training data from the true value.  
  One reason why humans outperform machines when only little training data is available, is that with little data the variance component of the squared error of a complex machine’s prediction is large. A simpler human algorithm has a lower variance component of the squared error, but more bias. With little data, the variance is worse than the bias; this commonly flips with more data which favors the more complex algorithm.
* “Lexicographic strategy” (e.g., Luce, 1956) is a decision strategy that uses input information in a particular order and can potentially decide after less than all information is processed. It belongs to the cognitive algorithms that allow for choice behavior that which systematically ignores information.

**(Future) Questions**

* Can humans achieve a better (or good solution quicker) by receiving instructions during learning, where the instructions contain learning rules based on our path analysis of learning by successful players as opposed to non-successful players?   
    
  > To move beyond mere correlation and test if the path dimensions we found are *causally* responsible for player success
* How are different motor production systems (finger vs. mouse movement) related to performance or performance increase?

References

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