UNIVERSITY OF CAMBRIDGE

Bayesian optimisation of approximateness in the trade-off between statistical and computational efficiency

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Introduction

- Since advent of computers, complex new statistical methods have been developed
- Many of these methods are slow or even intractable on current computers
- "Big data" is a trend that exacerbates this problem
- Experts make decisions about when to use approximations
- This should be automated

Introduction

- Runtime considerations not traditionally in the focus of statistical research
- Different perspectives on data:
  - **Statistics**: more data is better, allows higher confidence in results
  - **Computer science**: data is a workload to be completed

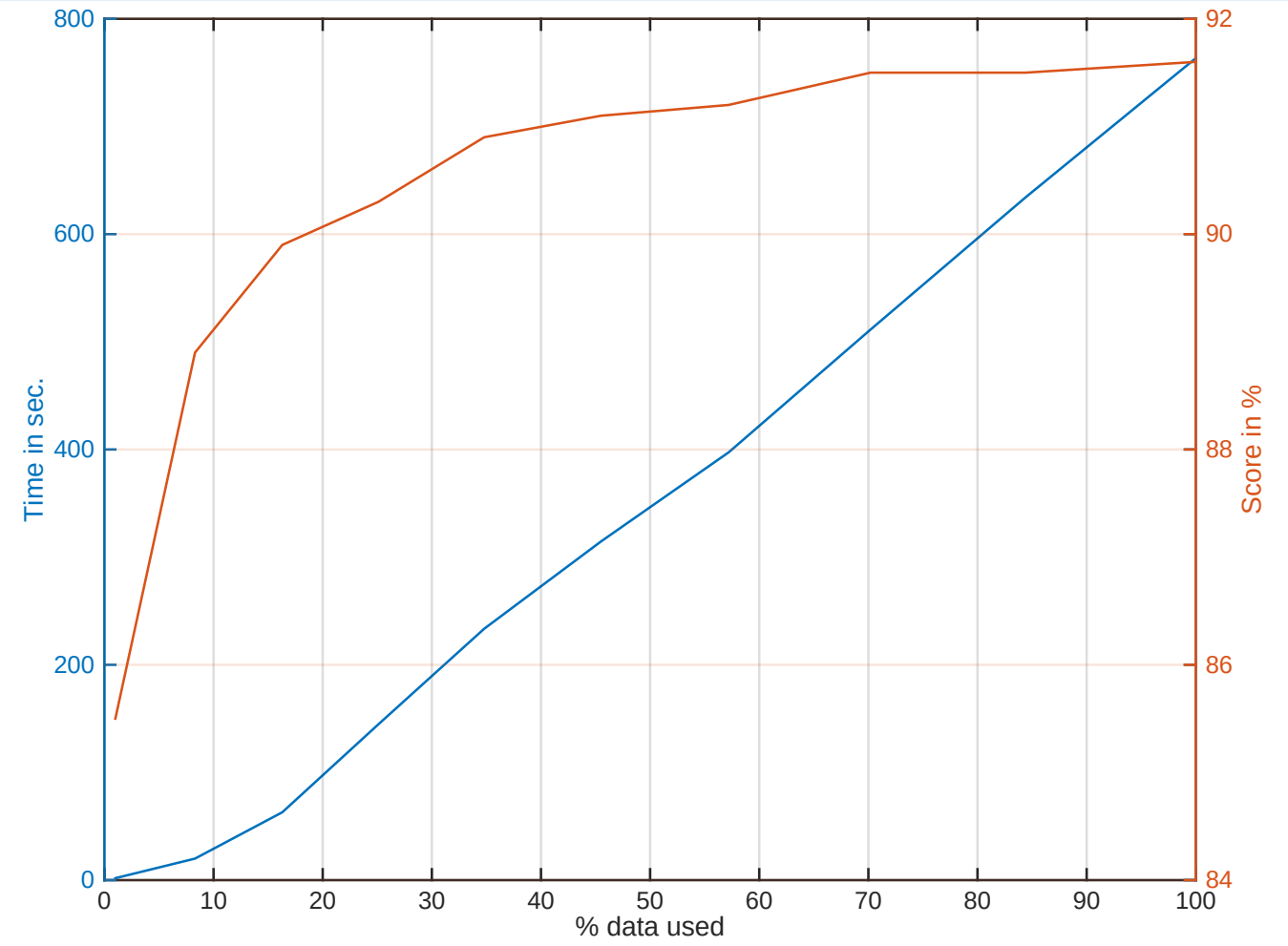
Introduction

- Many different possible goals when adding runtime considerations
- Anytime algorithm
- Contract algorithm
- Accuracy fixed
- ...

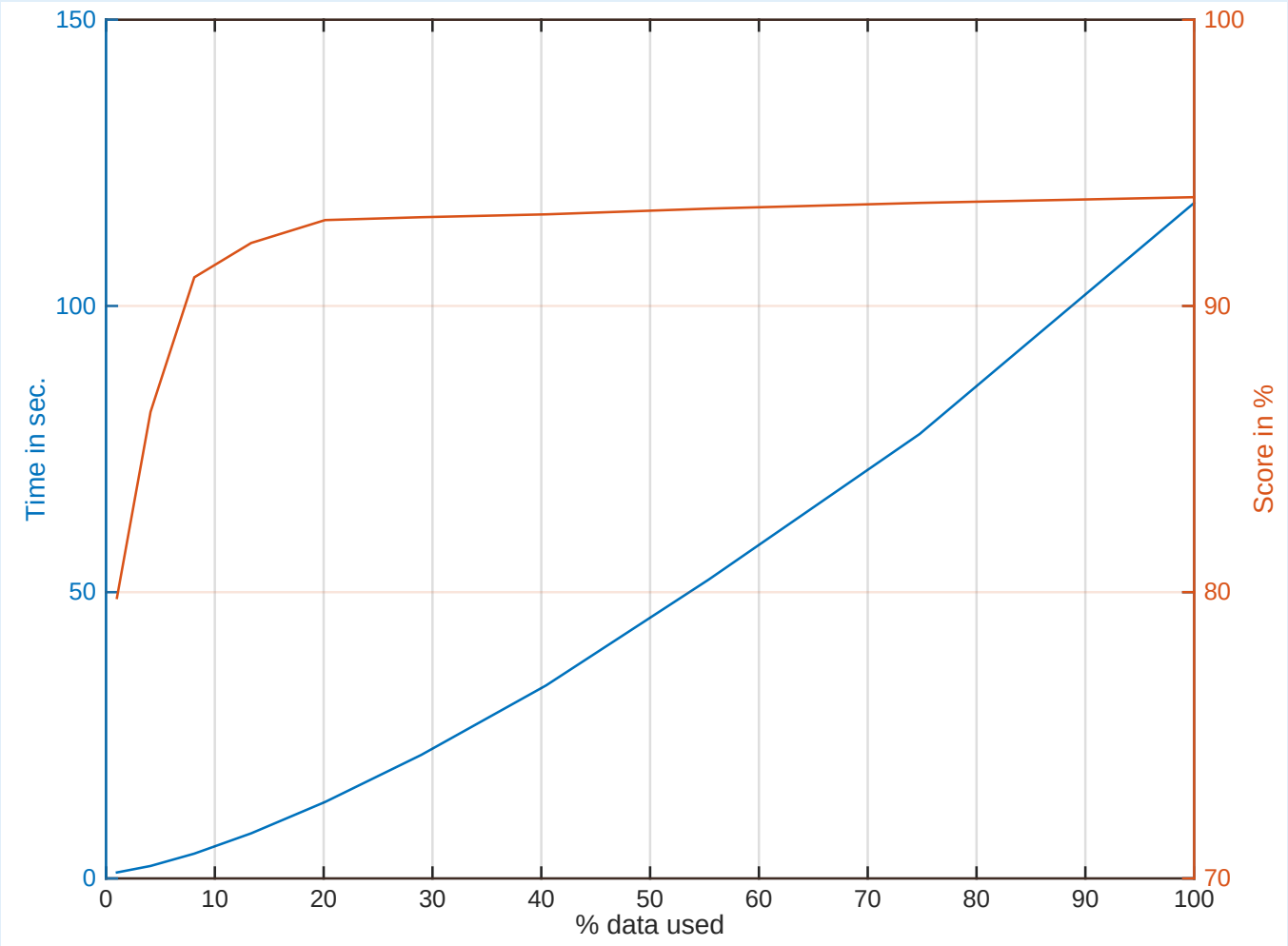
Approximation parameters

- Approximation parameters to learning algorithm control degree of approximateness
- Functions from approximation parameters to runtime and predictive accuracy
- Model of these functions

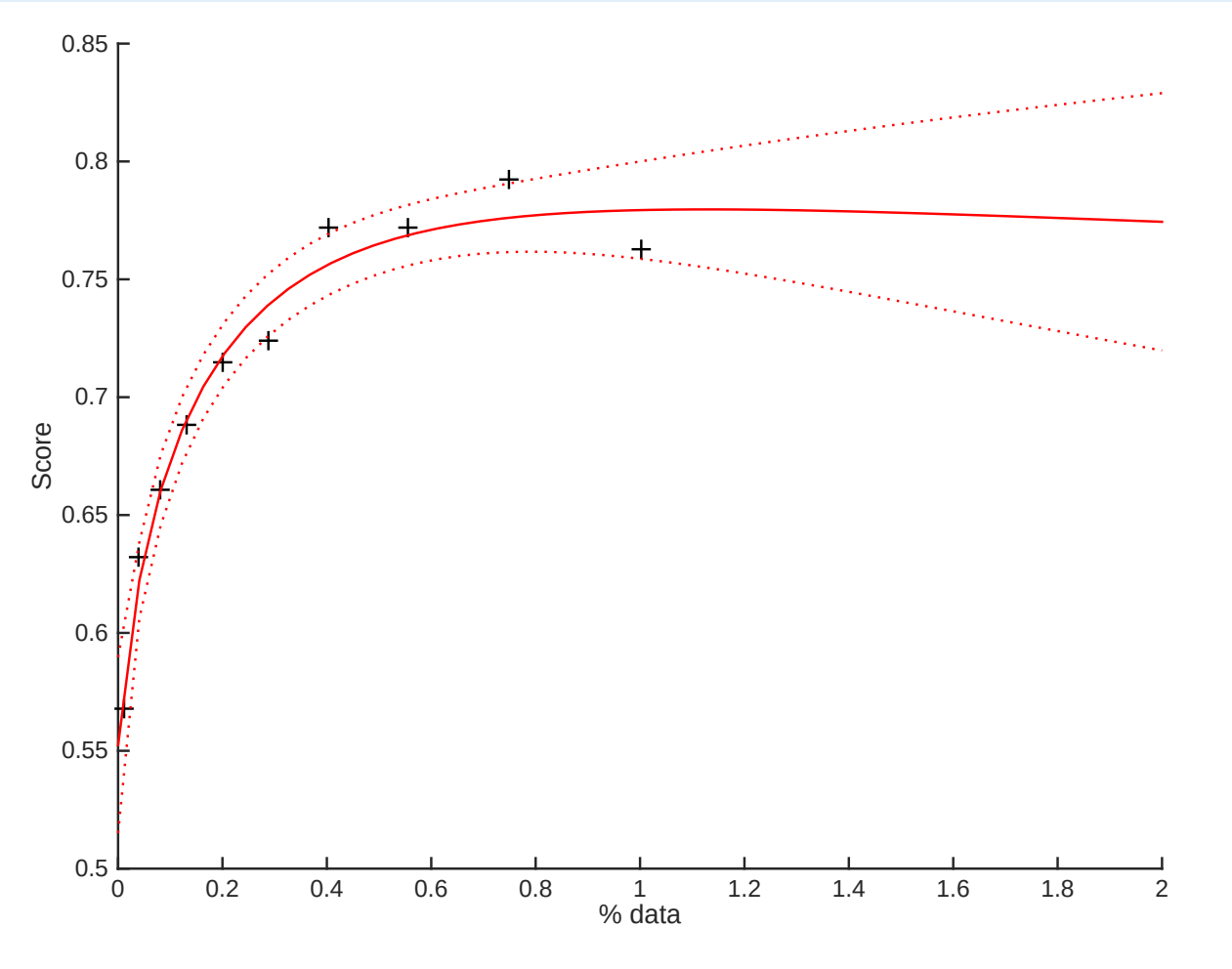
Logistic regression/MNIST



Random forest/Synthetic data



Modelling performance

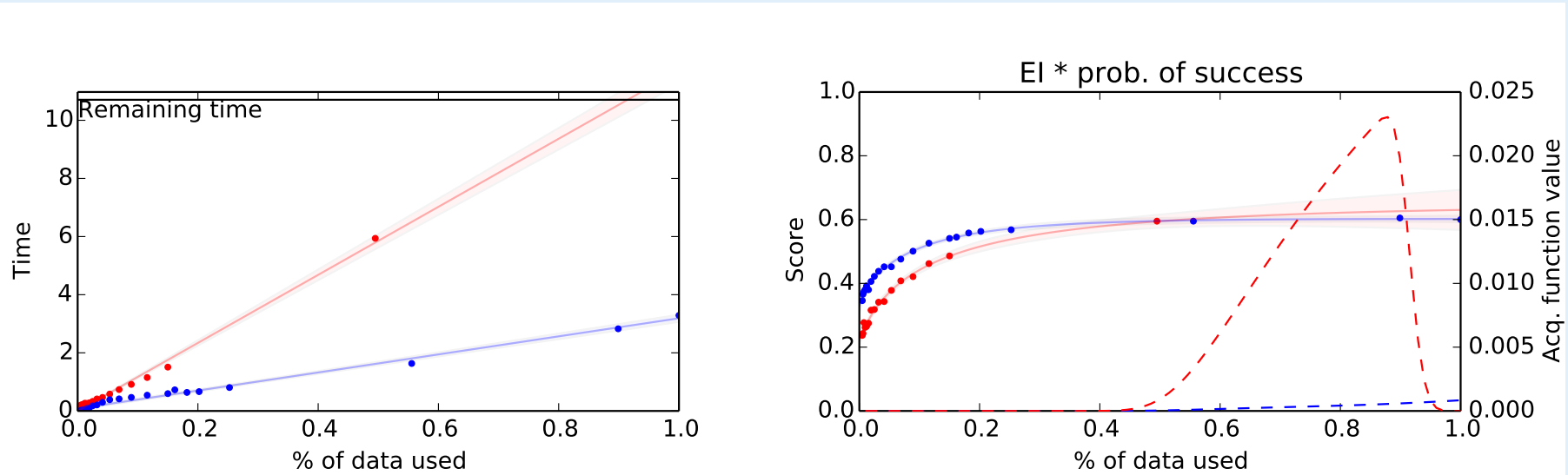


Optimisation

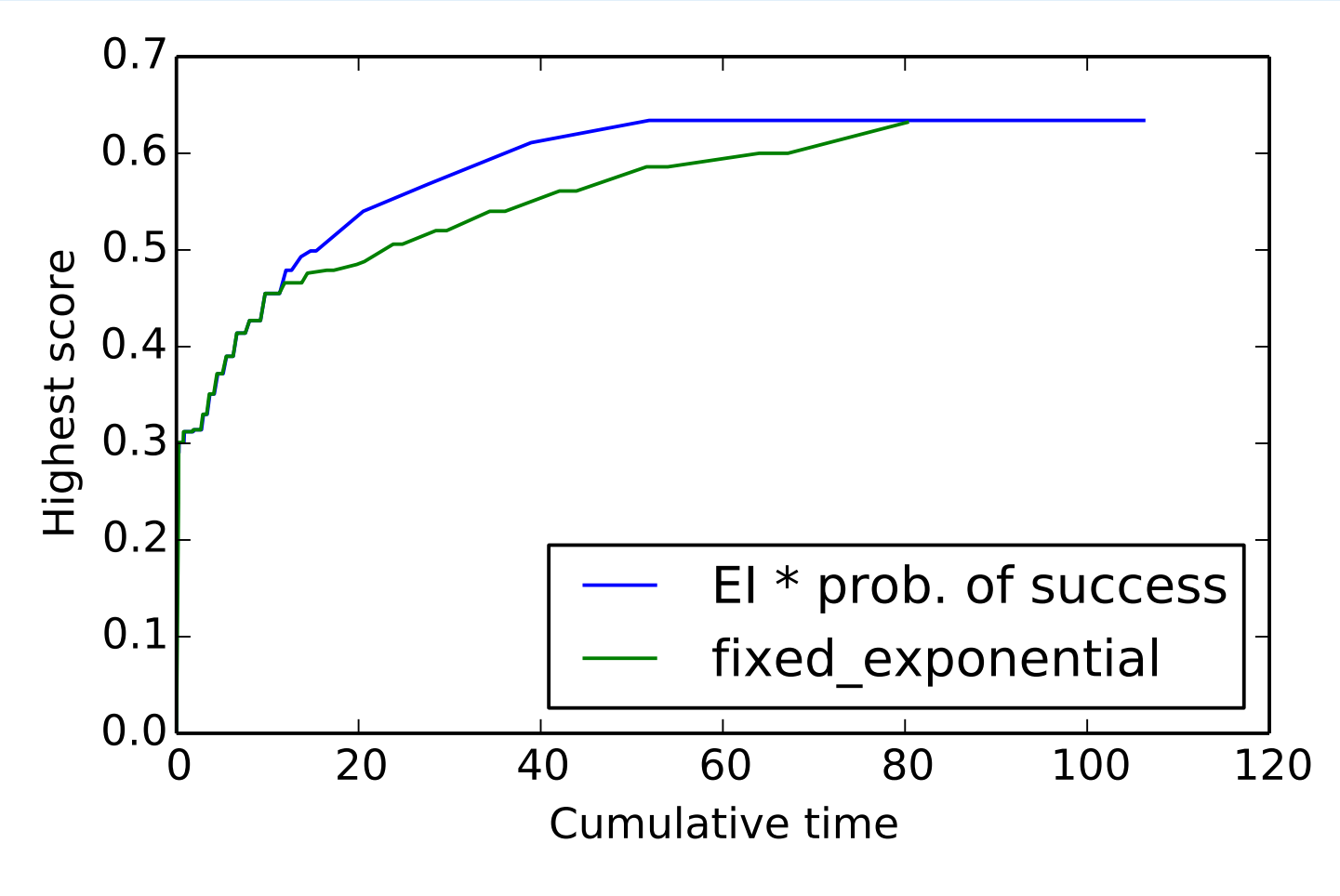
- Finding approximateness trade-off is an optimisation problem
- Function potentially very costly to evaluate
- Natural candidate: Bayesian optimisation
  - Efficient in number of evaluations
  - Making decisions comparatively costly
- Expected improvement: balancing exploration & exploitation
- Modified to take runtime into account leading to a set of heuristics

Anytime heuristic

- Expected improvement · probability of finishing in time

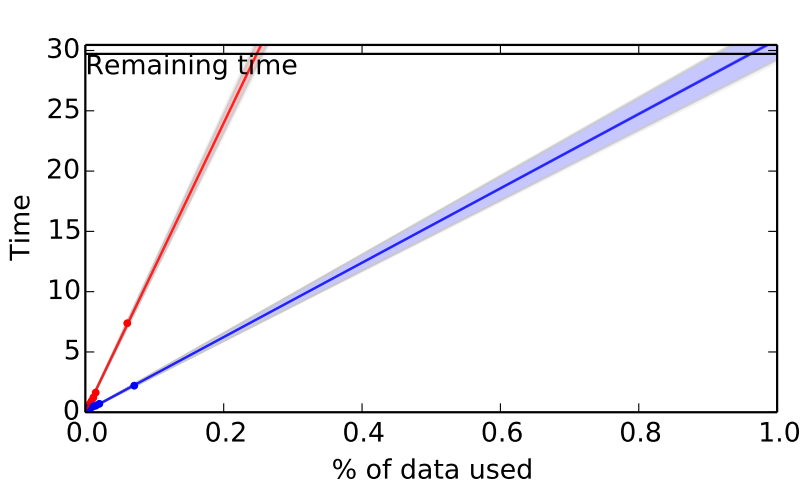


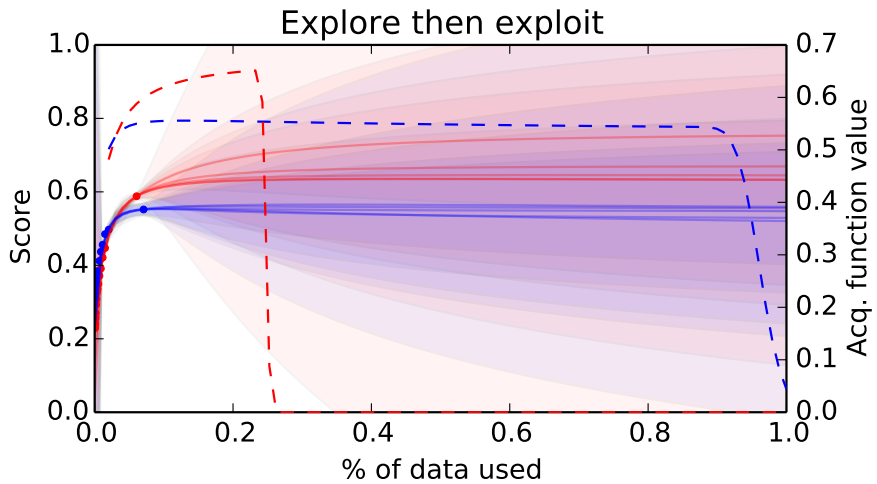
Anytime heuristic



Contract heuristic

- One time budget to explore, one to exploit





Conclusion

- Approximation parameters to learning algorithms
- Modelling algorithm performance with Gaussian processes
- Bayesian optimisation of approximation function
- Heuristics for anytime/contract style algorithms

Questions?