

Group 1 (Take 2)

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Not sure about being a Good Guy)

Exploration vs. Exploitation

Tradeoffs Between Search and Evaluation

Exploiting Special Properties

Scalable algorithms and High-Dimensional Problems

Agenda

Setting Research Priorities

Barriers to Practice

Next Steps?

Disclaimer: We agreed to disagree!

Problem Class Differentiation

- Effort required to obtain function values
- Dimensionality
- Continuous, Integer, Categorical Inputs
- Noise
 - Concavity of the value of information
- Online vs. offline optimization
- Estimation costs
 - Setup costs? Switchover costs?
- Problem structure
- White box / Black box models

Setting Research Priorities (1)

Balancing search (exploration/exploitation) with estimation/approximation.

- How much computational effort should be devoted to refining function estimates at a point?
- How to use that information to choose what to search next?
- Balancing point and function estimation / approximation.

Setting Research Priorities (2)

Computational Resource Allocation

- Exploration / Exploitation Tradeoff
- Estimation \Leftrightarrow Approximation \Leftrightarrow Search
- Is there an estimation problem or an approximation problem, even with deterministic objective functions?
- Estimation \Rightarrow Dealing with exogenous noise
- Approximation \Rightarrow Dealing with numerical error or biases

Key Point: Knowing what to do and when to do it.

Setting Research Priorities (3)

Approximating Functions and Machine Learning

– Properties

- Asymptotic unbiasedness
- Rates of convergence
- Approximate whole surfaces vs sets of points?

– Parametric vs non-parametric statistics

– Algorithm comparison

- Robustness vs Problem-Specific Effectiveness

– High-dimensional problems

- What does high-dimensional mean?

Setting Research Priorities (4)

Theory Building

- Rates of convergence
- Finite-time performance and stopping criteria
- Algorithms without tunable parameters
- How to tune tunable parameters using prior problem structure
- Surrogate function design and optimization
- Using function approximation to guide opt. vs estimating entire response surface

Setting Research Priorities (5)

Learning with gray box functions

- Incorporate prior information about the structure of the function.
- Forms of prior information:
 - Monotonicity
 - Concavity/convexity
- “Whiten” the black box as one approaches the region around the optima.

Barriers to Practice

- Terminology and Communication
- Community “silos”
- Lack of standardization in representation of problems
- Test problem standardization
- Software compatibility challenges

More Barriers to Practice

Theory and Practice Mismatch

- Do convergence criteria actually inhibit practical performance?
- Finding common ground between theory & practice.
- Asymptotic is even farther than “Far Far Away”!



Next Steps?

- Collaboration with other communities
 - Interdisciplinary research – e.g., interacting with machine learning, statistics
 - Cross-fertilization in the physical sciences
- Challenge problems/competitions
- Performance analysis
- More test problems
- Far, far more funding (\$)!

The Key Point!

Boldly go where no one has gone before



Exploration / exploitation tradeoffs: BIN

Balance computational effort

Innovative algorithm implementations

Novel algorithm designs

Thank you

- My group is still very unruly!
- We argued profusely!
- We disagreed constantly!
- They did a great job!
- It was a pleasure!