Modeling and Processing Optimization Queries

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Optimization Queries - Examples

- What is the closest restaurant to here?
- What is the highest ranked database group according to my scoring criteria?
- What patients have the highest AST/ALT ratio?
- What coastal locations are most sensitive to environmental changes?

Model Based Queries

- Objective Function
- Optimization Objective (minimize or maximize)
- Constraints
- Adjustable parameters on functions and constraints
- k – number of objects to return

Convex Optimization Queries

- Significant subset of Model Based Queries
- Objective function is convex
- Constraints are convex

Query Types under Model

- Nearest Neighbor
- Linear Optimization
- Range
- Arbitrary Convex Functions
- Any of these can have arbitrary weights, and arbitrary convex constraints

Optimization Queries w/ Constraints - Examples

- What is the closest restaurant to here in Ohio?
- What is the highest ranked database group in the Midwest according to my scoring criteria?
- Which male patients, age 45-55, have the highest AST/ALT ratio?
- What Gulf of Mexico coastal locations are most sensitive to environmental changes?

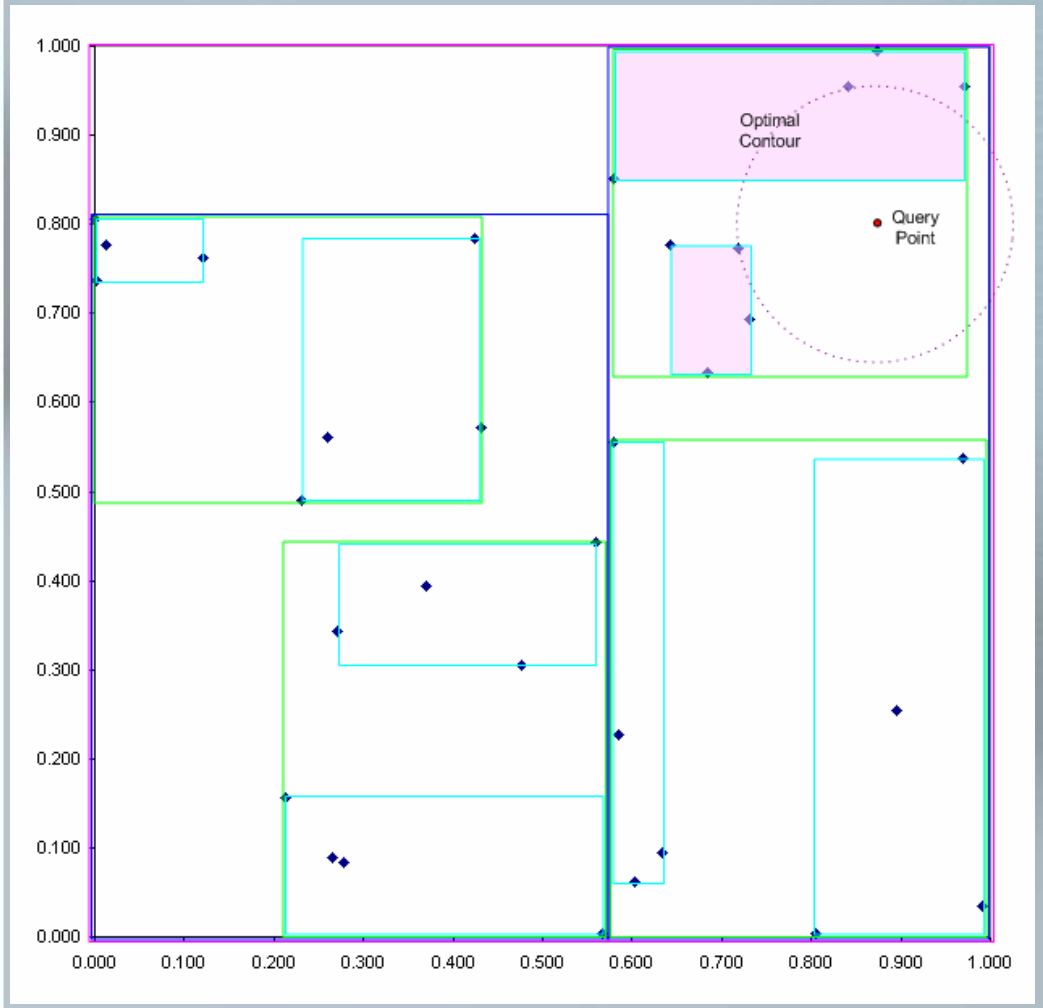
Goal

- Develop query processing framework to I/O-optimally solve:
  - Arbitrary convex function
  - Over arbitrary convex problem constraints
  - Using arbitrary access structure built over convex partitions

I/O Optimal Query Processing

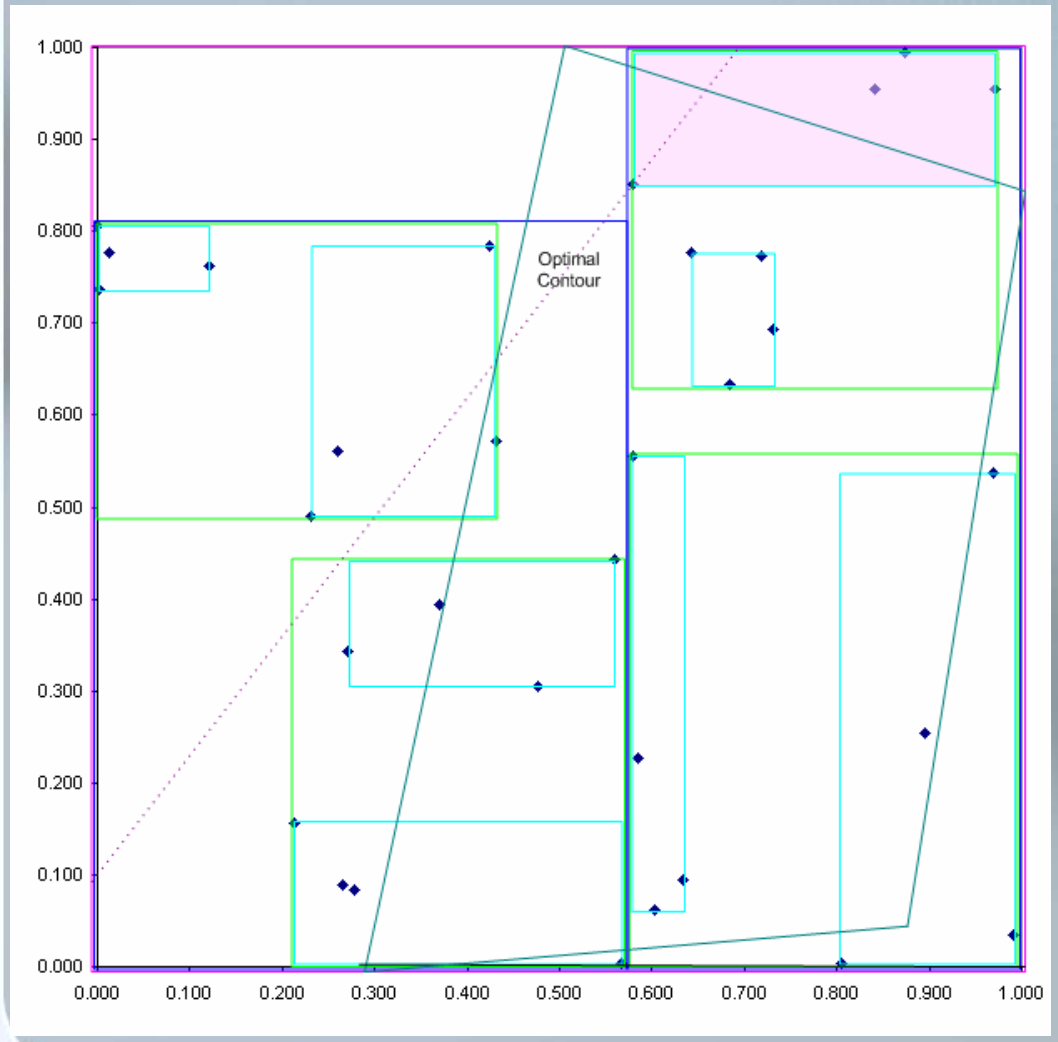
- Solve convex optimization problems as access structure is traversed
- Incorporate problem constraints and partition constraints to find optimal functional objective value for candidate partition
- Keep partitions ordered according to how promising they are
- Stop when partitions can not yield an optimal point

Example – Nearest Neighbor



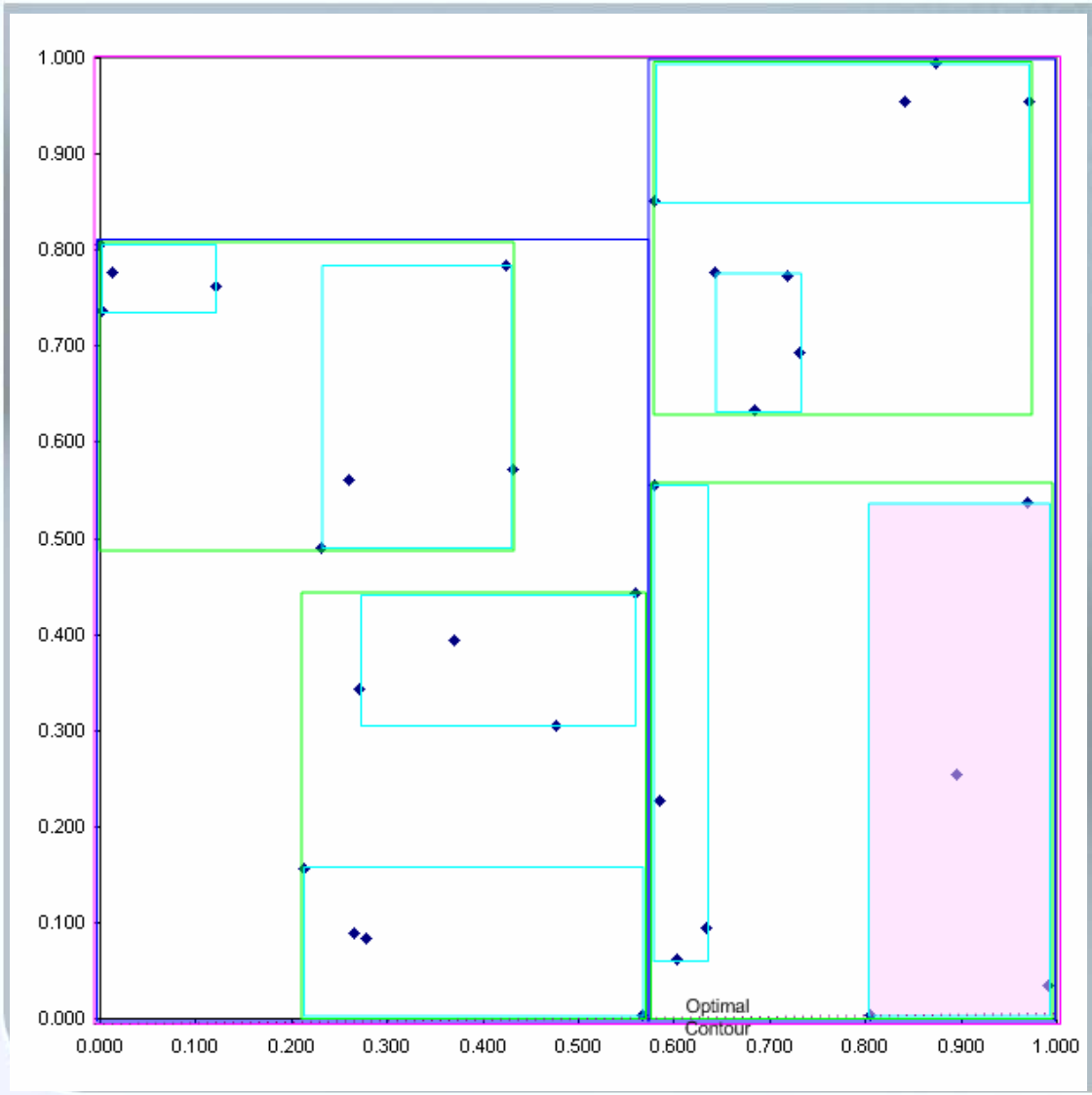
- Hierarchical Access Structure
- Only access partitions that intersect Optimal Contour

Example – Constrained Linear Optimization



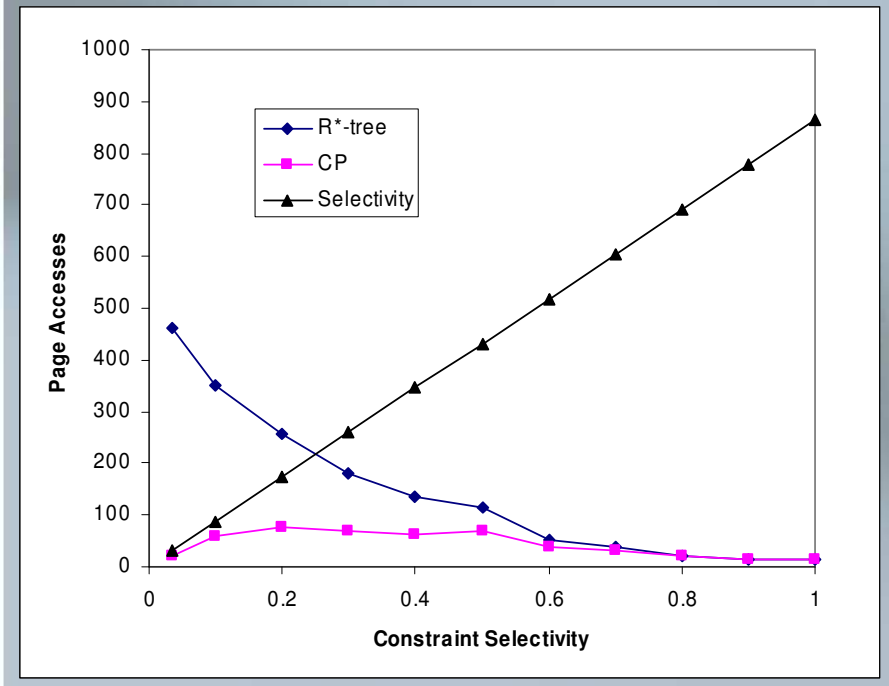
- Maximize f=-6x+5y
- Within constrained area

Example – Non-Linear Maximization



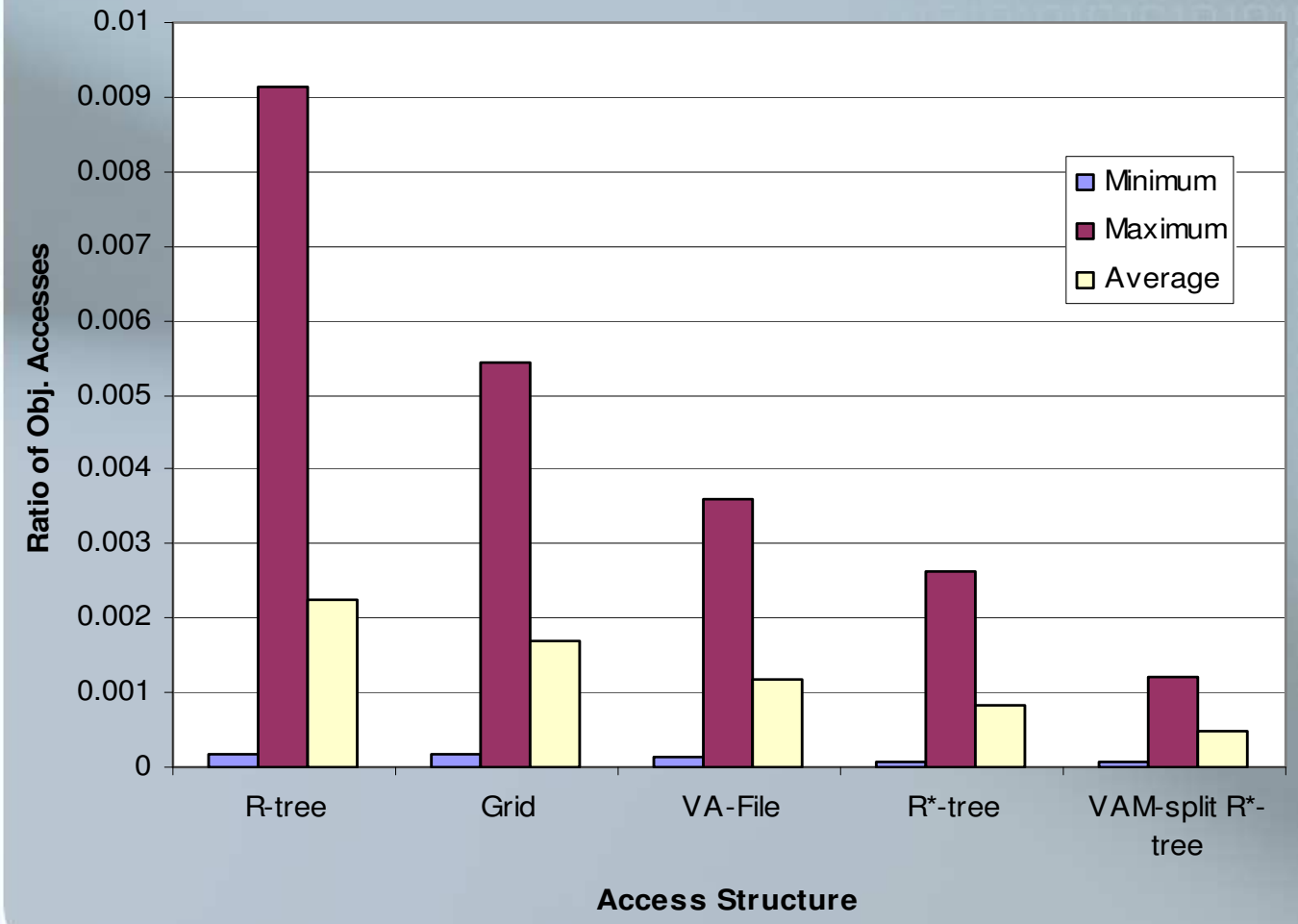
- Maximize $f=x^2/y$

Incorporating Constraints During Search



- Prune MBR's as they are discovered to be infeasible

Random Functions, Different Access Structures



Conclusions

- Handle any Convex Function
- Incorporate Constraints during Access Structure Traversal
- A Unified Tool/Algorithm for any Convex Optimization Query