

Learning & Optimization

Swati Gupta

PhD, Operations Research Center MIT

Microsoft Research Fellow, Simons Institute, UC Berkeley

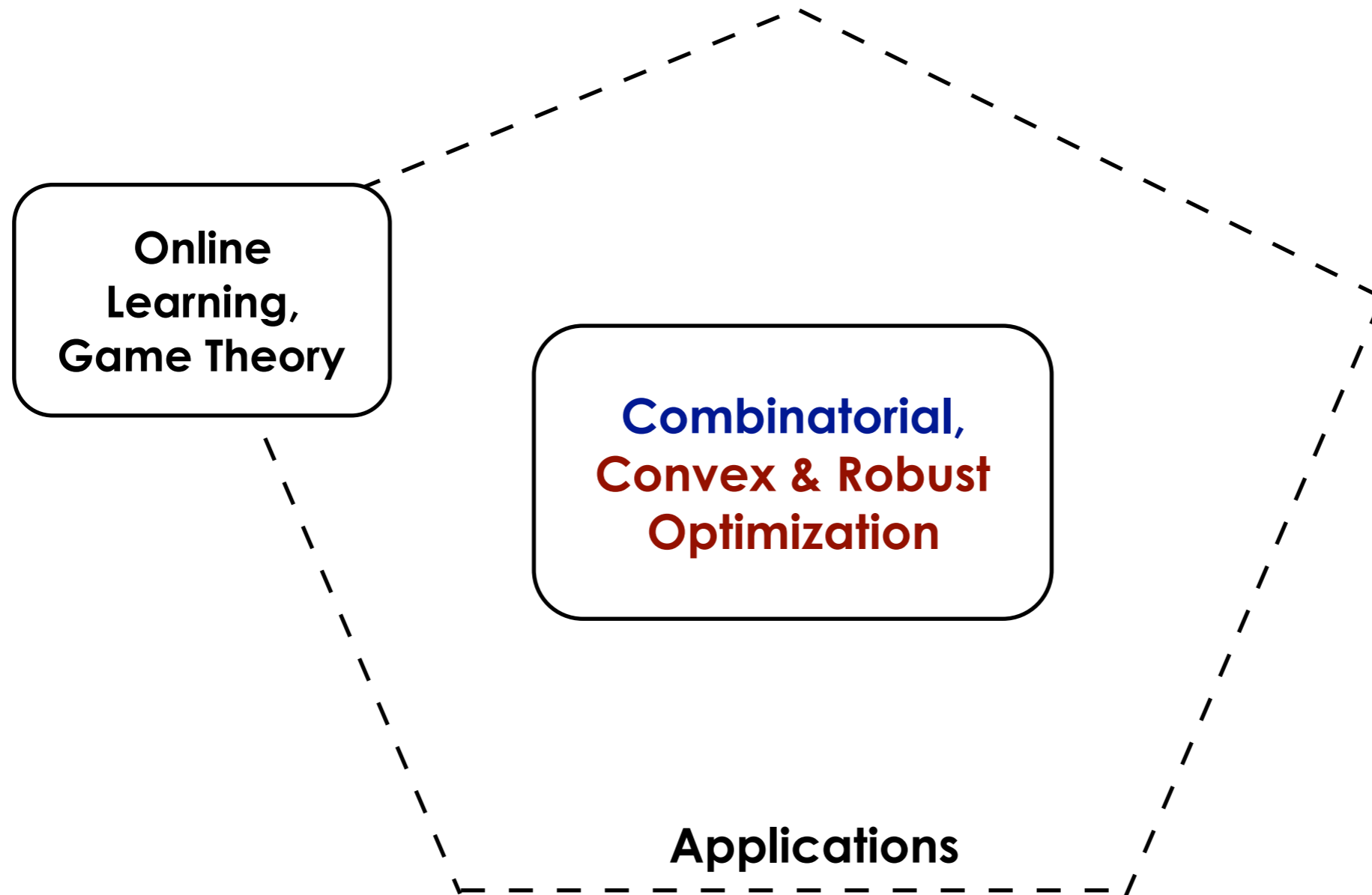
Assistant Professor, Georgia Institute of Technology

(5+9)/2+01=8

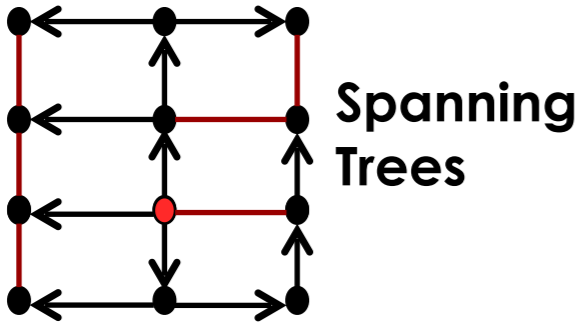
Simons Institute, Industry Day

swatigupta.tech

Overview



Overview



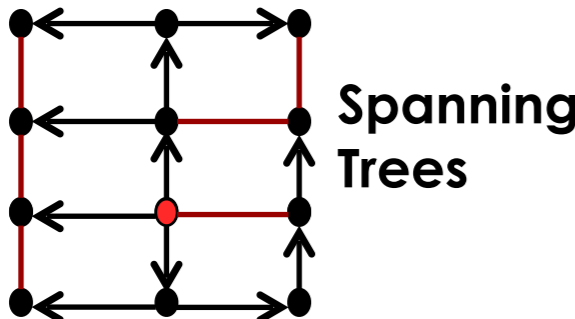
Rankings
1, 2, 3, 4,
2, 3, 1, 4,

**Online
Learning,
Game Theory**

**Combinatorial,
Convex & Robust
Optimization**

Applications

Overview

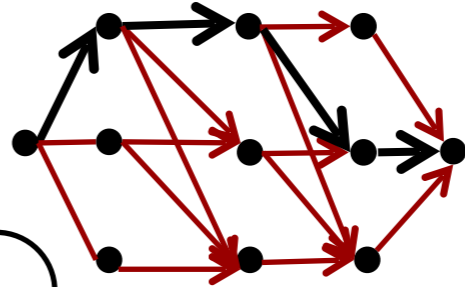


Spanning
Trees

Rankings
1, 2, 3, 4,
2, 3, 1, 4,

**Online
Learning,
Game Theory**

**Dynamic Pricing,
Transportation,
Routing**

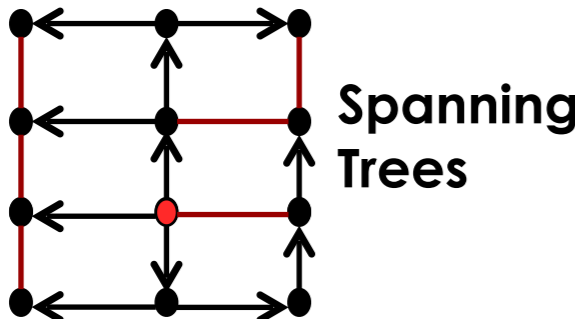


s-t paths

**Combinatorial,
Convex & Robust
Optimization**

Applications

Overview

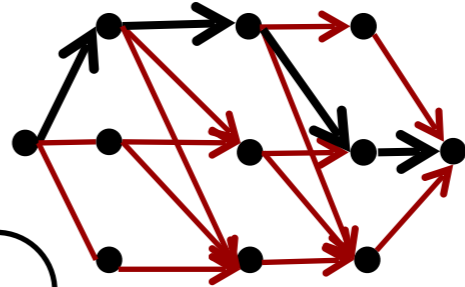


Spanning
Trees

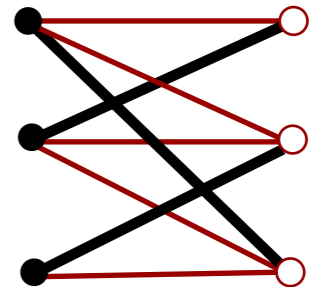
Rankings
1, 2, 3, 4,
2, 3, 1, 4,

**Online
Learning,
Game Theory**

**Dynamic Pricing,
Transportation,
Routing**



s-t paths

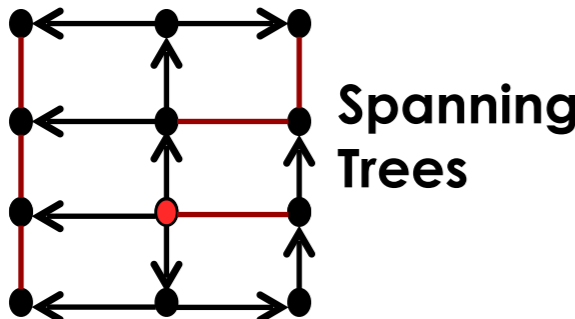


e.g., supply-demand

**Combinatorial,
Convex & Robust
Optimization**

Applications

Overview

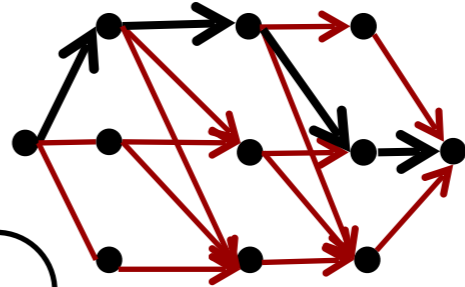


Spanning Trees

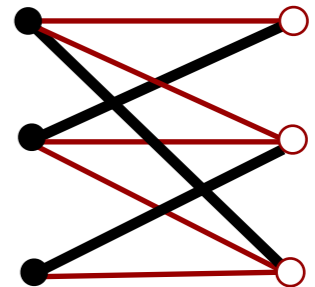
Rankings
1, 2, 3, 4,
2, 3, 1, 4,

Online Learning,
Game Theory

Dynamic Pricing,
Transportation,
Routing



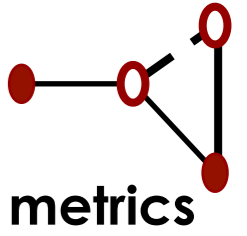
s-t paths



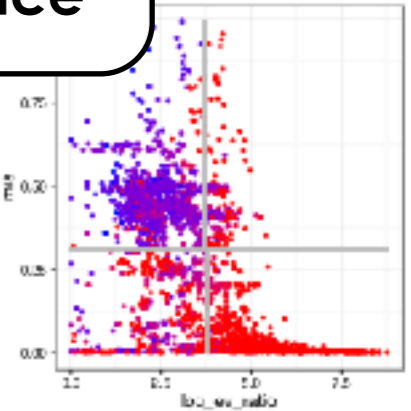
e.g., supply-demand

Combinatorial,
Convex & Robust
Optimization

Predicting
Heuristic
Performance

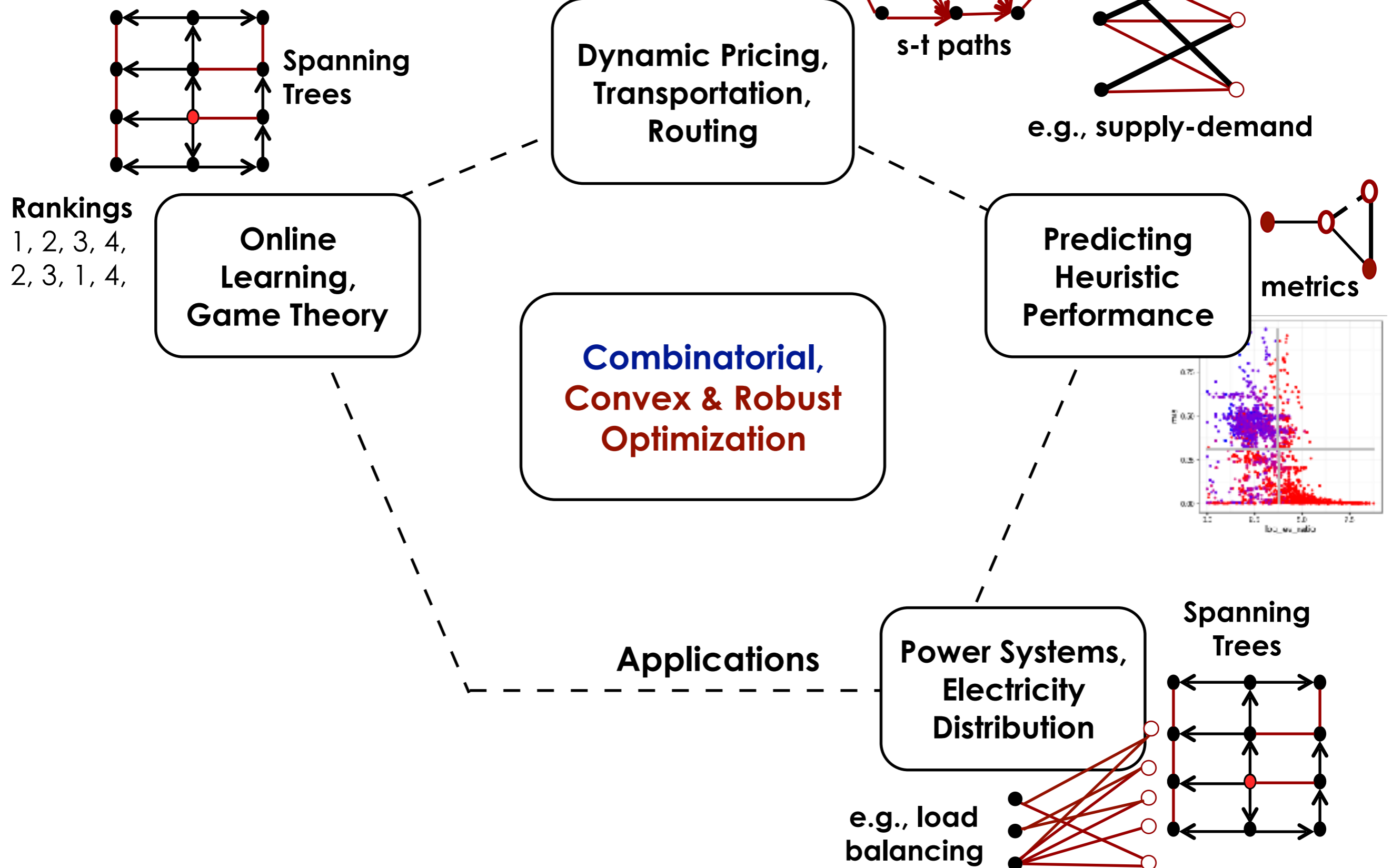


metrics

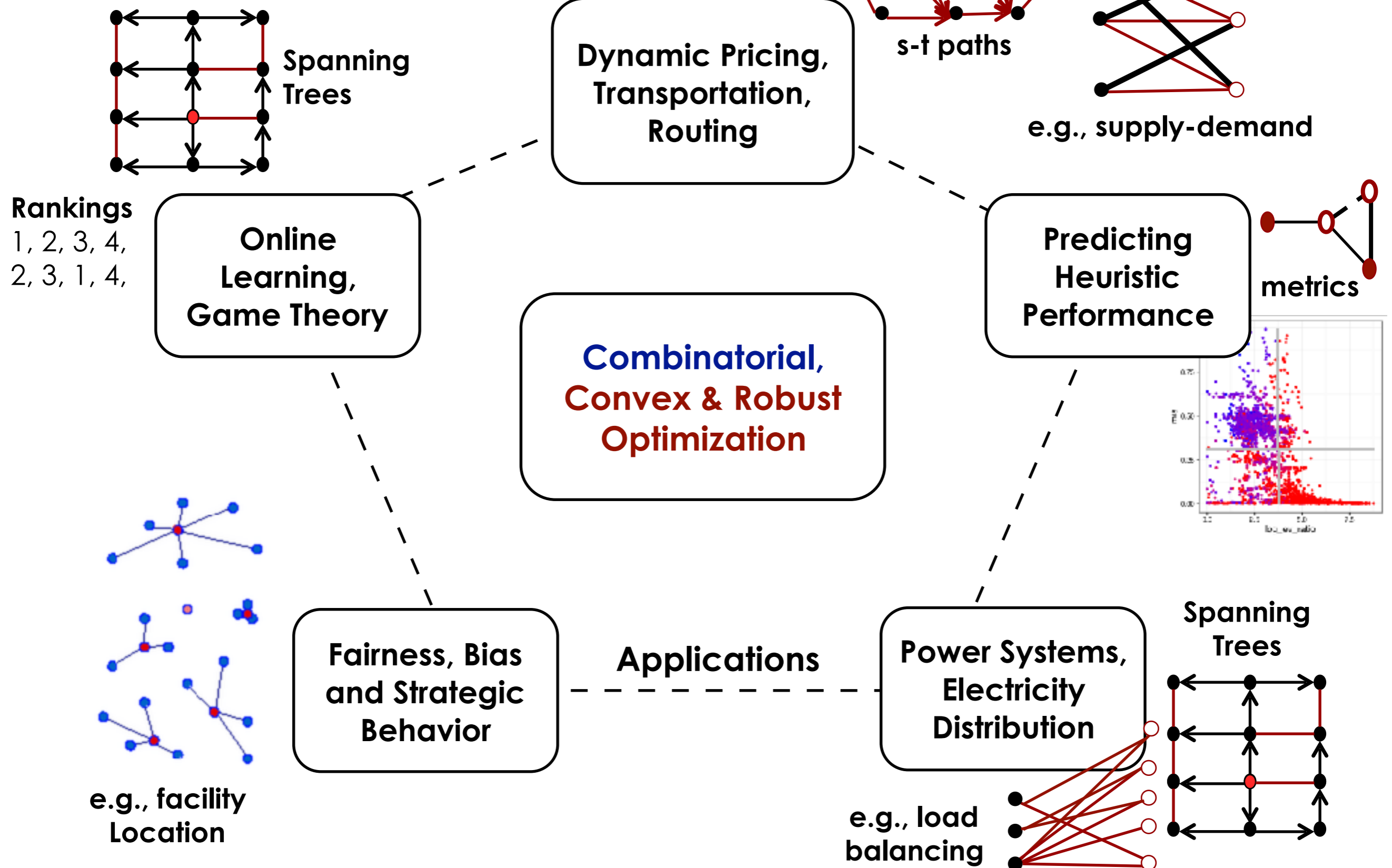


Applications

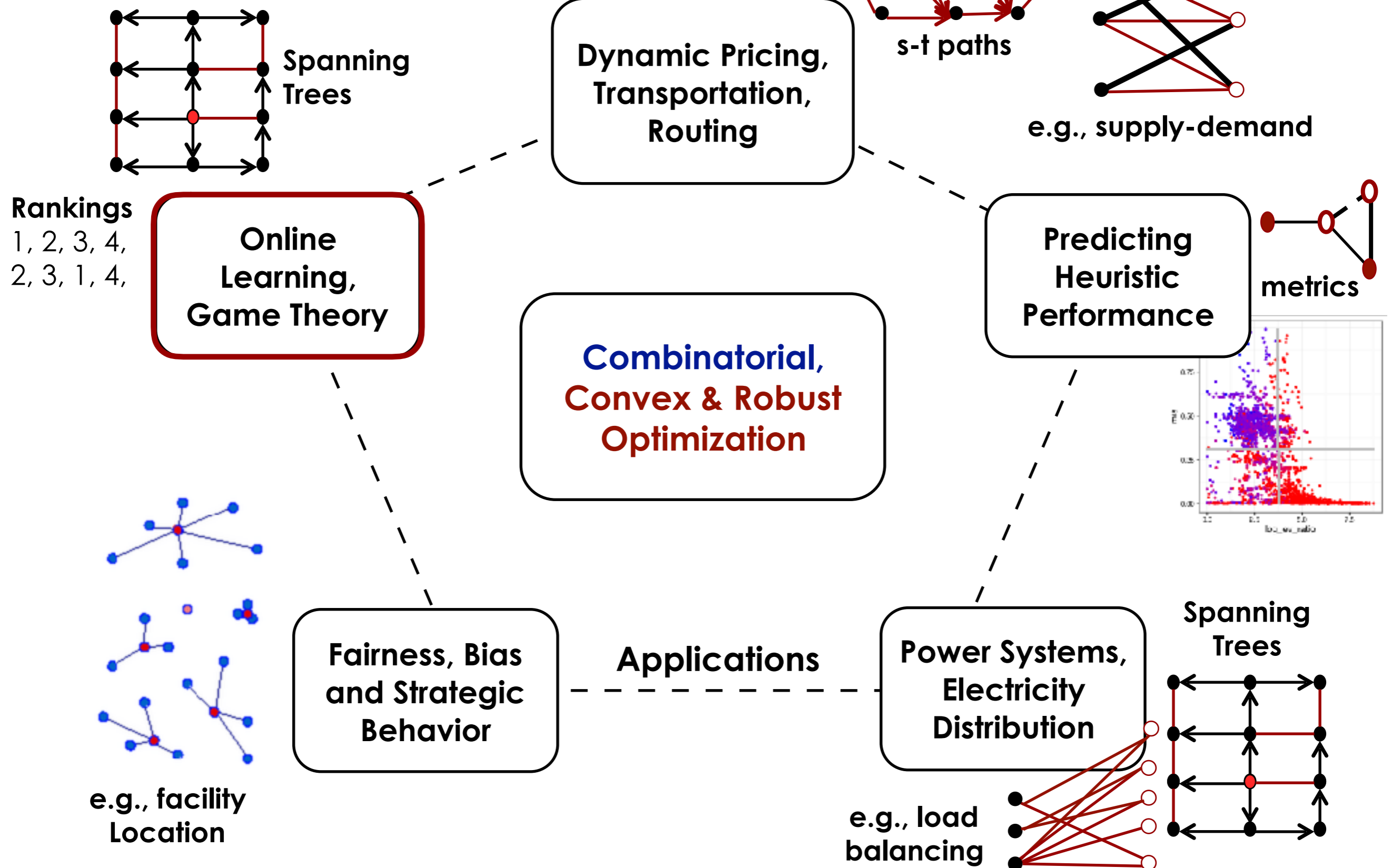
Overview



Overview



Overview



Example

Recommender Systems

What order to display items in?

Customers Who Bought This Item Also Bought



The screenshot shows a horizontal list of four book recommendations. Each item includes a book cover, title, author, star rating, number of reviews, binding type, and price with the Prime logo.

| Book Title | Author | Rating | Reviews | Binding | Price |
|---|-------------------|--------|---------|-----------|---------|
| Streaming, Sharing, Stealing: Big Data and the Future of Entertainment... | Michael D. Smith | ★★★★★ | 12 | Hardcover | \$18.17 |
| Weapons of Math Destruction: How Big Data Increases Inequality and... | Cathy O'Neil | ★★★★★ | 190 | Hardcover | \$15.85 |
| Networked Theology: Negotiating Faith in Digital Culture (Engaging Culture) | Heidi A. Campbell | ★★★★★ | 3 | Paperback | \$13.88 |
| Weapons of Math Destruction | Cathy O'Neil | ★★★★★ | 190 | Paperback | |

Example

Recommender Systems

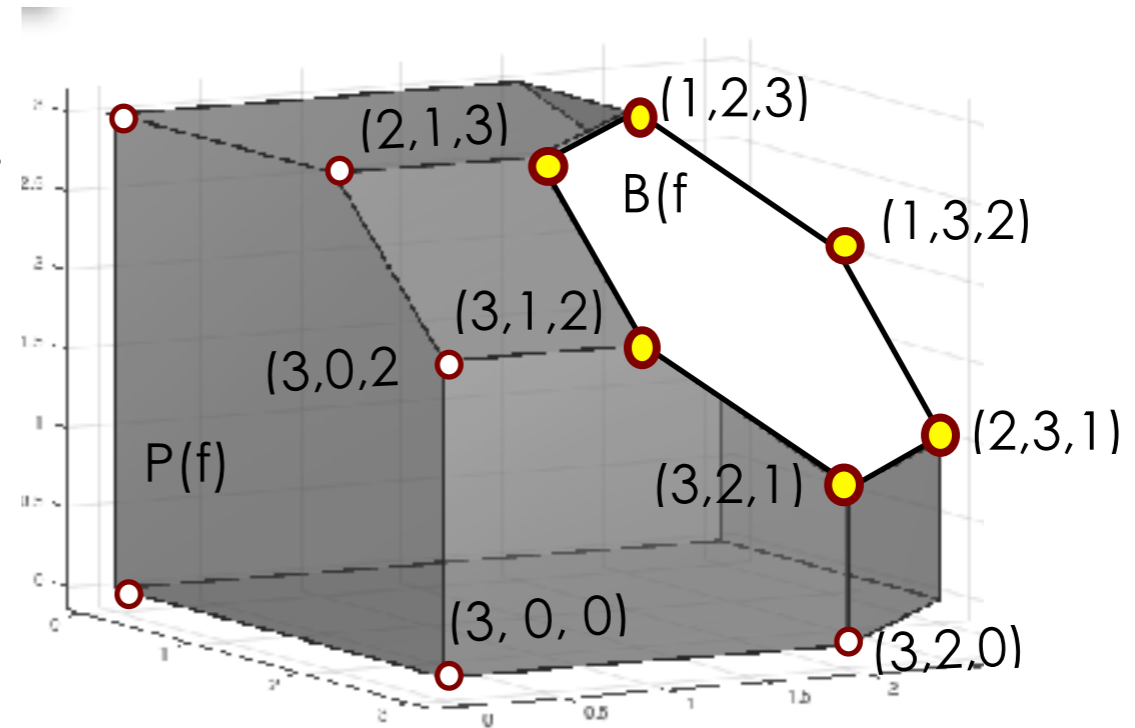
What order to display items in?

Framework:

Online Learning

Learn over permutations $(1,2,3,4), (2,3,1,4), \dots$

Customers Who Bought This Item Also Bought



Example

Recommender Systems

What order to display items in?

Framework:

Online Learning

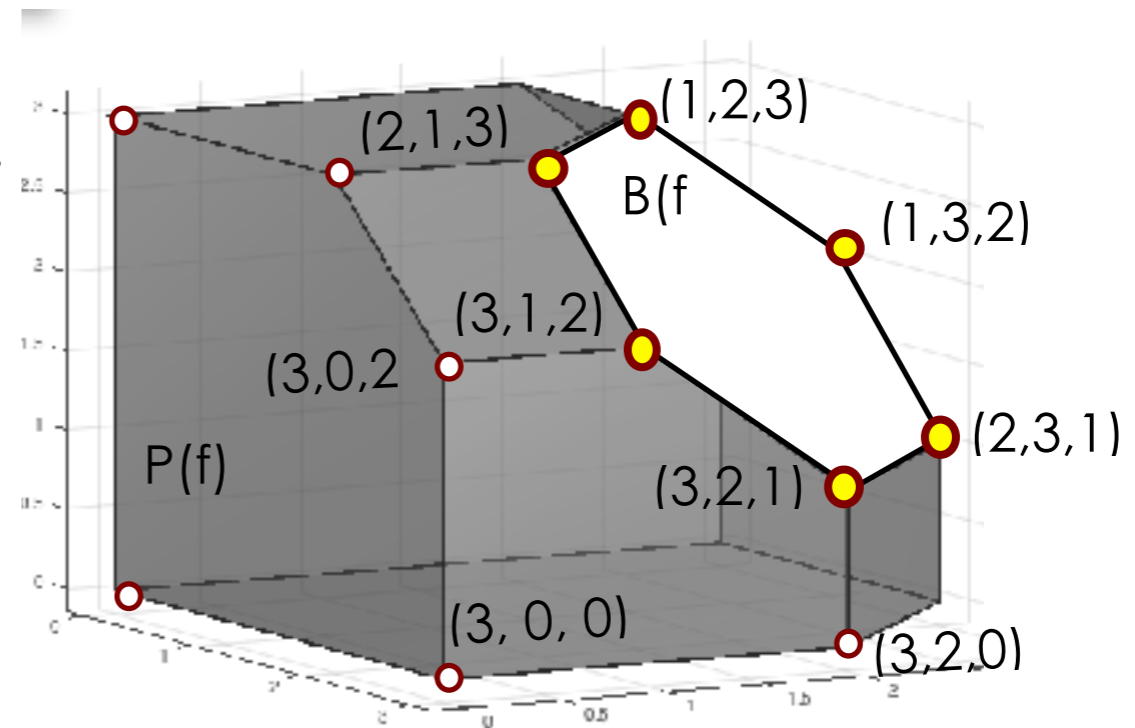
Learn over permutations $(1,2,3,4), (2,3,1,4)...$

Technique

Online Mirror Descent

Optimal regret for many cases

Customers Who Bought This Item Also Bought



Example

Recommender Systems

What order to display items in?

Framework:

Online Learning

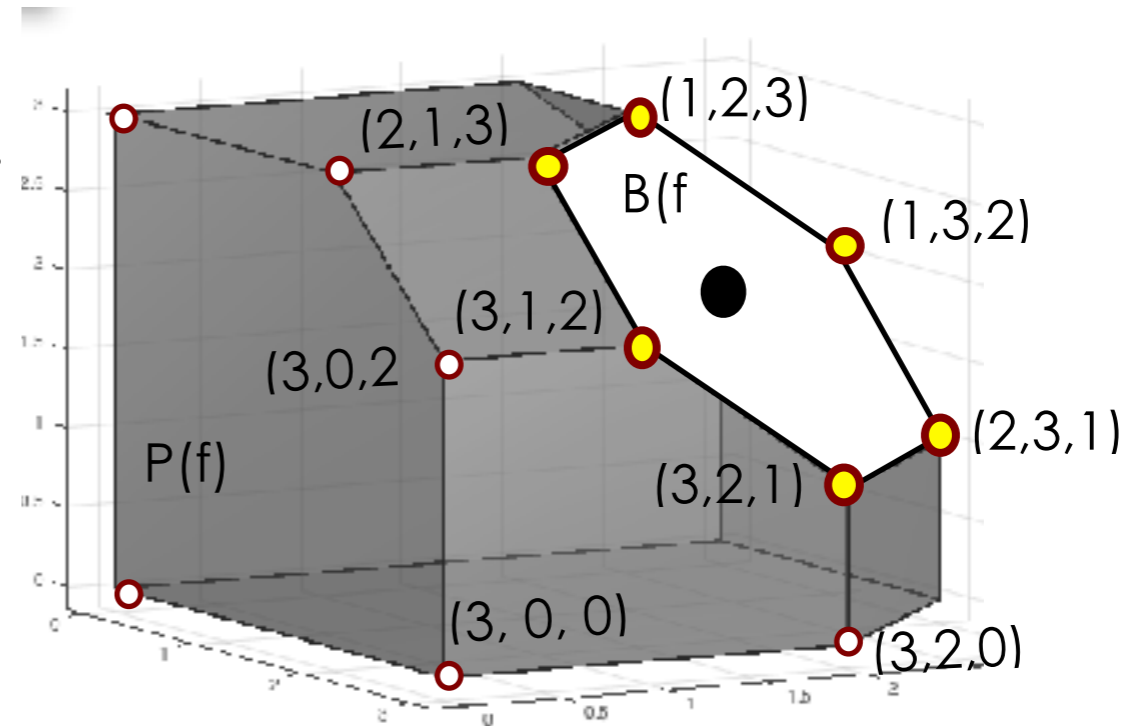
Learn over permutations $(1,2,3,4), (2,3,1,4)...$

Technique

Online Mirror Descent

Optimal regret for many cases

Customers Who Bought This Item Also Bought



Example

Recommender Systems

What order to display items in?

Framework:

Online Learning

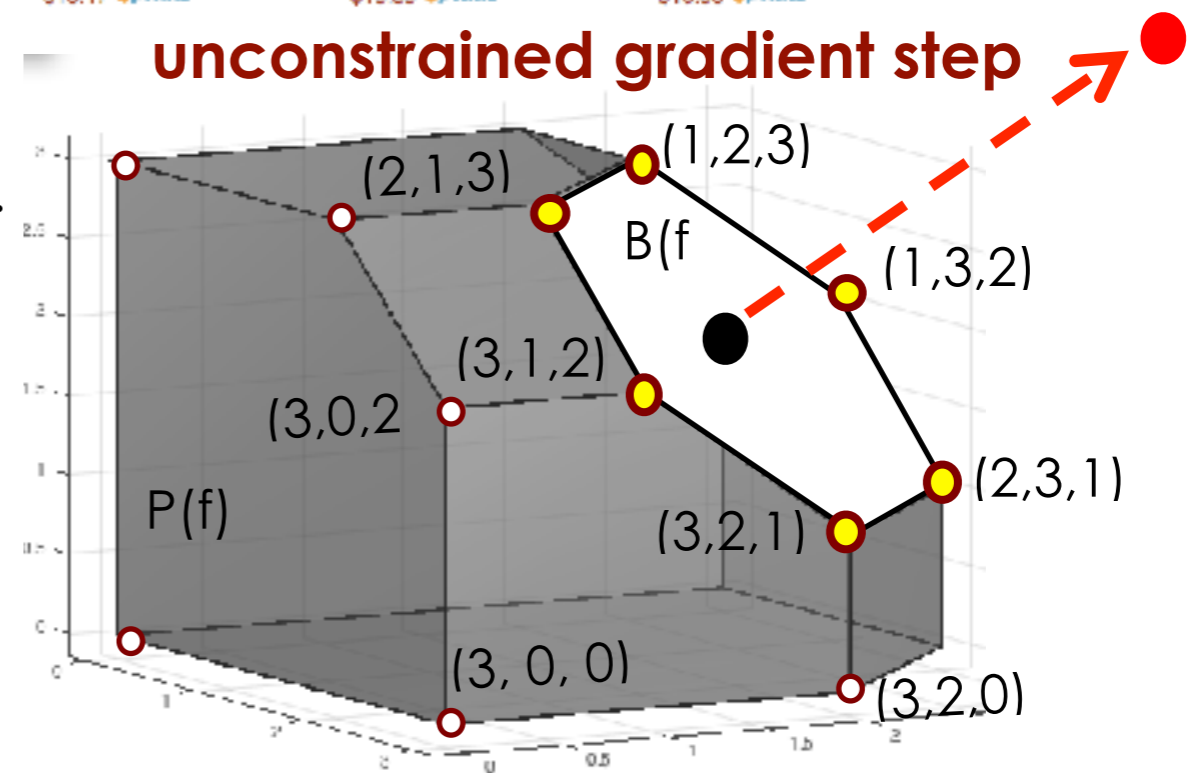
Learn over permutations $(1,2,3,4)$, $(2,3,1,4)$...

Technique

Online Mirror Descent

Optimal regret for many cases

Customers Who Bought This Item Also Bought



Example

Recommender Systems

What order to display items in?

Framework:

Online Learning

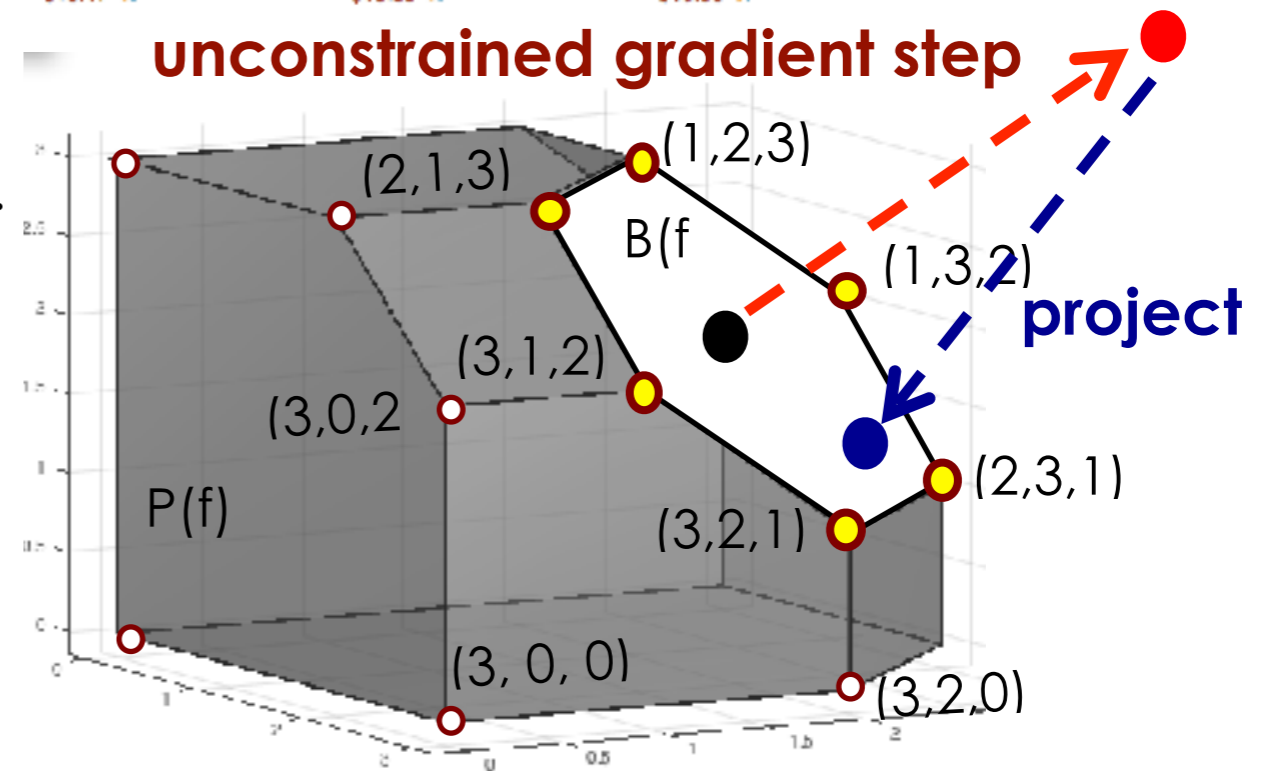
Learn over permutations $(1,2,3,4)$, $(2,3,1,4)$...

Technique

Online Mirror Descent

Optimal regret for many cases

Customers Who Bought This Item Also Bought



Example

Recommender Systems

What order to display items in?

Framework:

Online Learning

Learn over permutations $(1,2,3,4)$, $(2,3,1,4)$...

Technique

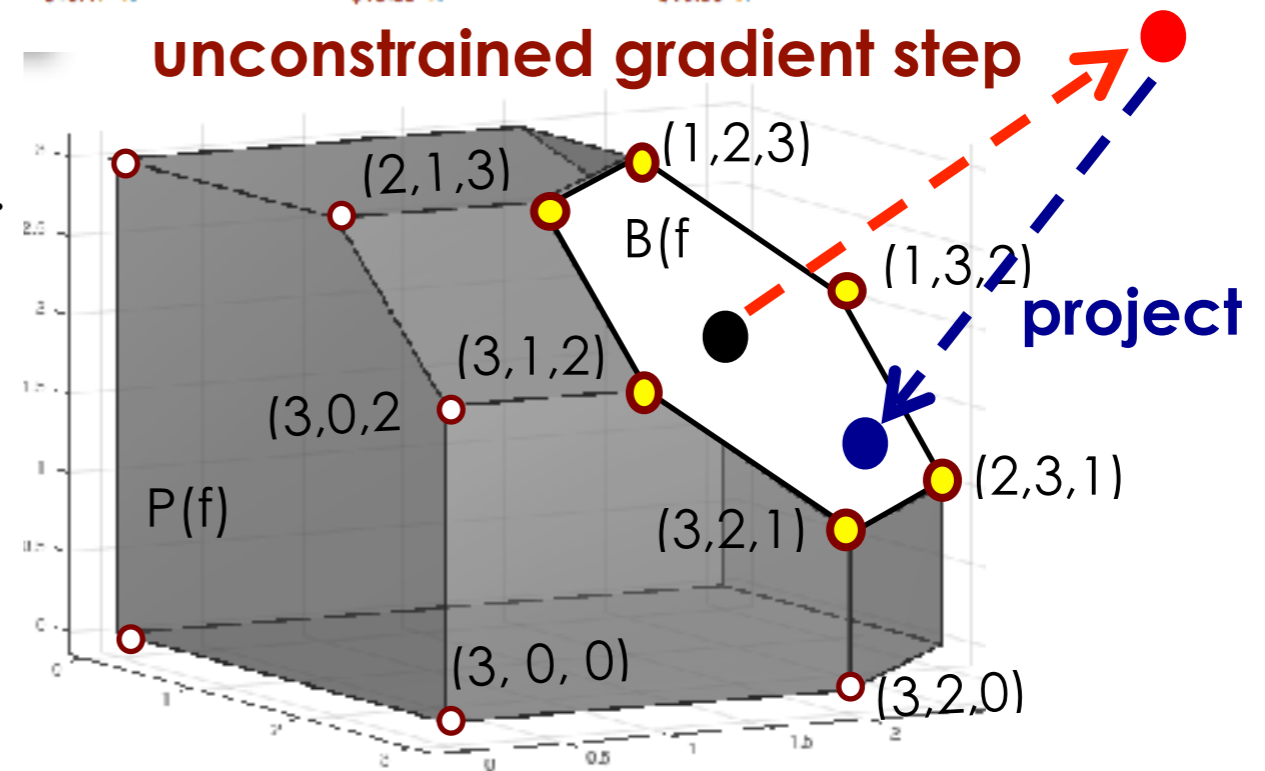
Online Mirror Descent

Optimal regret for many cases

Challenge:

Computing “Generalized” Projections

Customers Who Bought This Item Also Bought



Example

Recommender Systems

What order to display items in?

Customers Who Bought This Item Also Bought



Framework:

Online Learning

Learn over permutations $(1,2,3,4), (2,3,1,4)...$

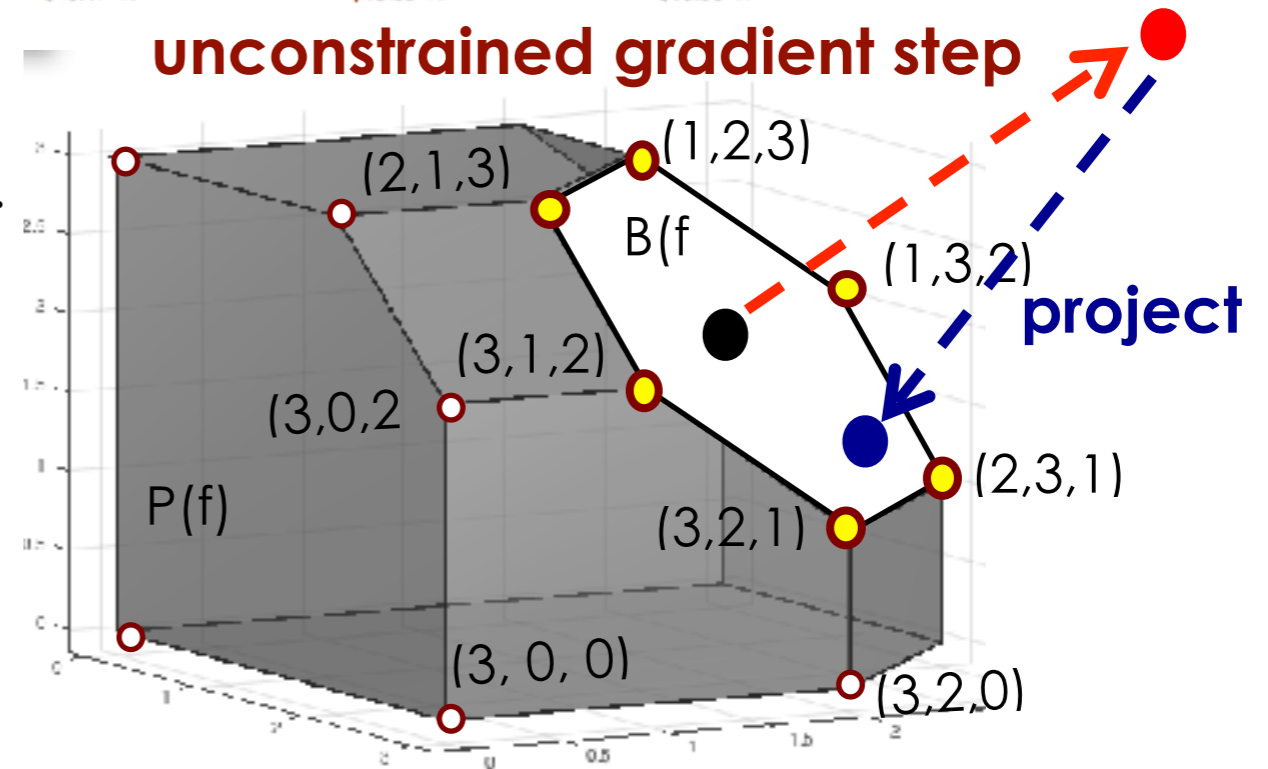
Technique

Online Mirror Descent

Optimal regret for many cases

Challenge:

Computing "Generalized" Projections



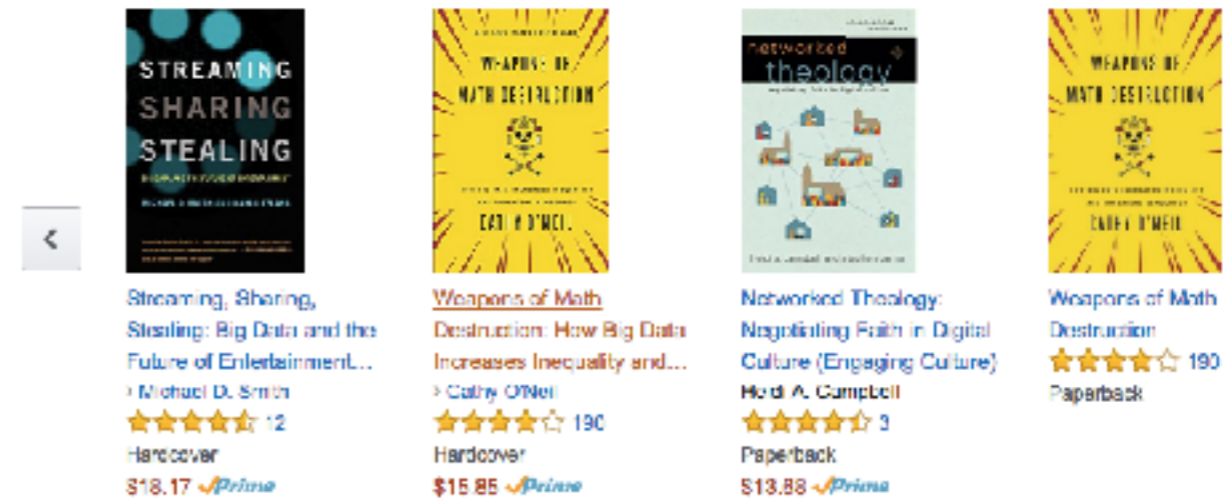
We give a novel method "**Inc-Fix**" for minimizing separable convex functions over submodular base polytopes

Example

Recommender Systems

What order to display items in?

Customers Who Bought This Item Also Bought



Framework:

Online Learning

Learn over permutations $(1,2,3,4), (2,3,1,4)...$

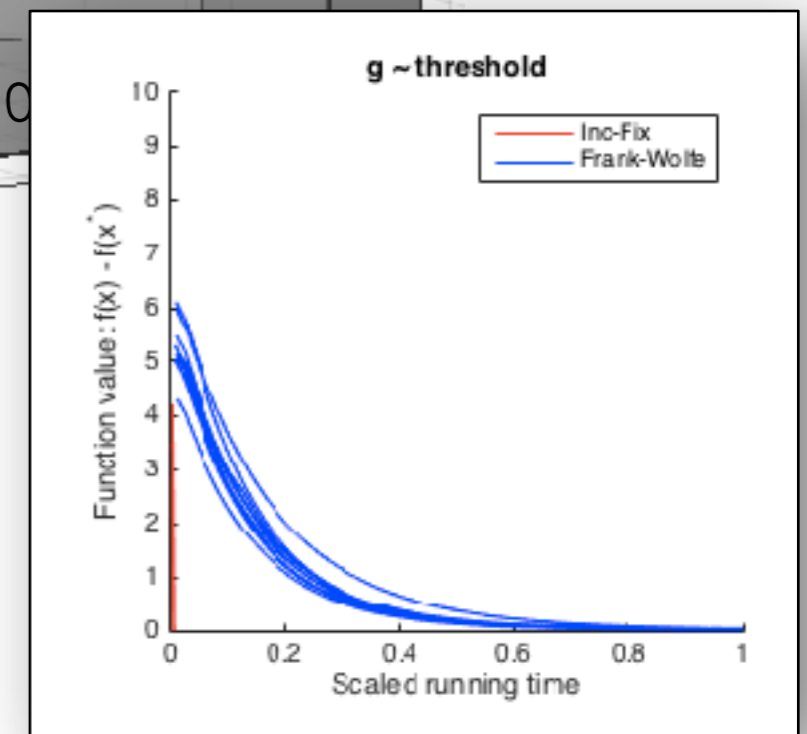
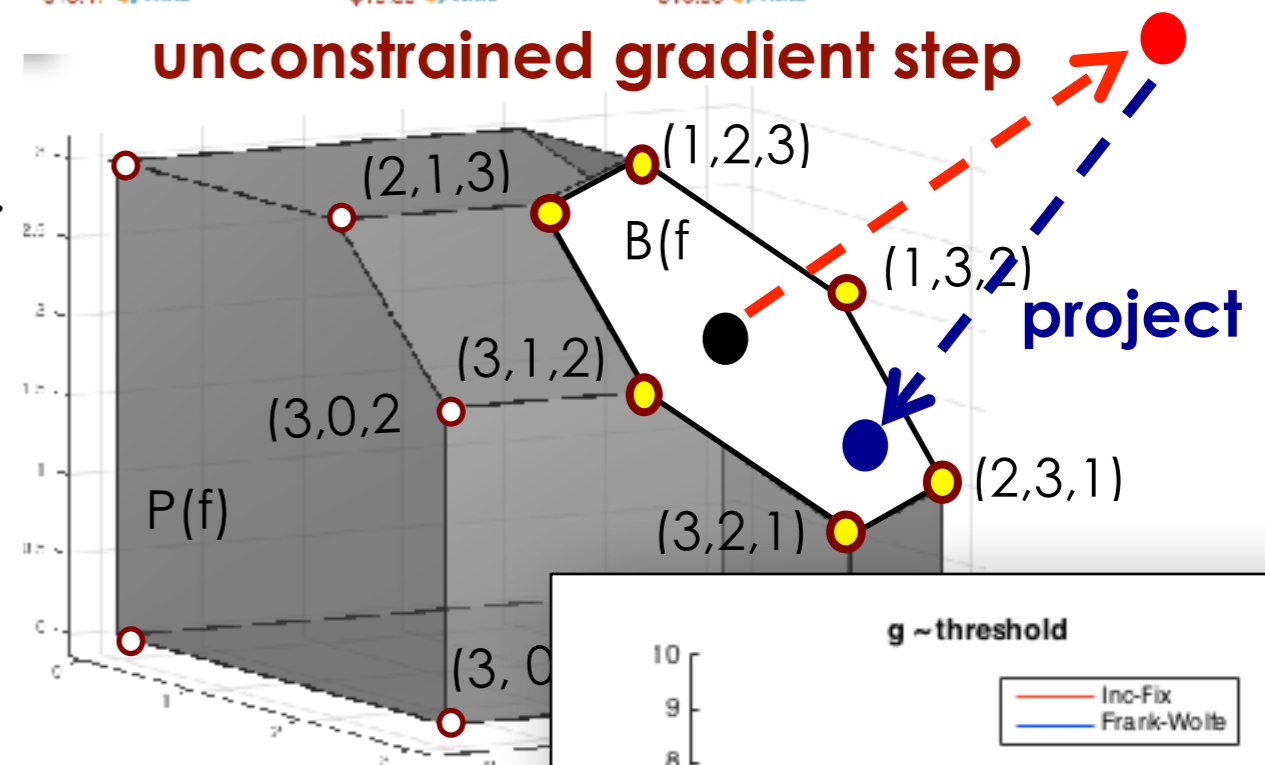
Technique

Online Mirror Descent

Optimal regret for many cases

Challenge:

Computing "Generalized" Projections



We give a novel method "**Inc-Fix**" for minimizing separable convex functions over submodular base polytopes

Thank You!