

# Rethinking Traffic Management:

Using Optimization Decomposition to Derive New Architectures

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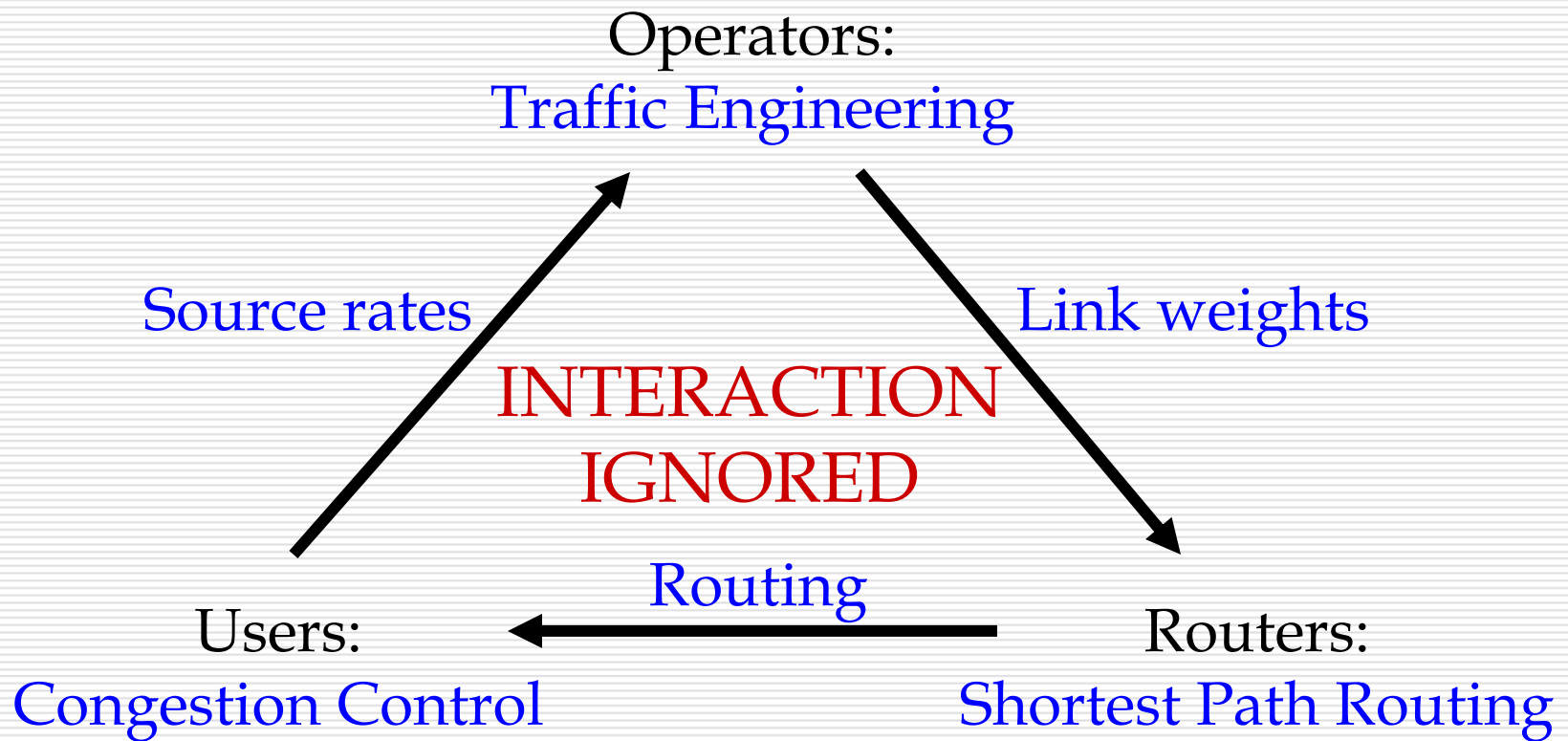
Jiayue He, Ma'ayan Bresler, and Mung Chiang

Or, how I learned to stop worrying and love optimization theory

Or, why I walked across the street to the EE department

# Traffic Management Today

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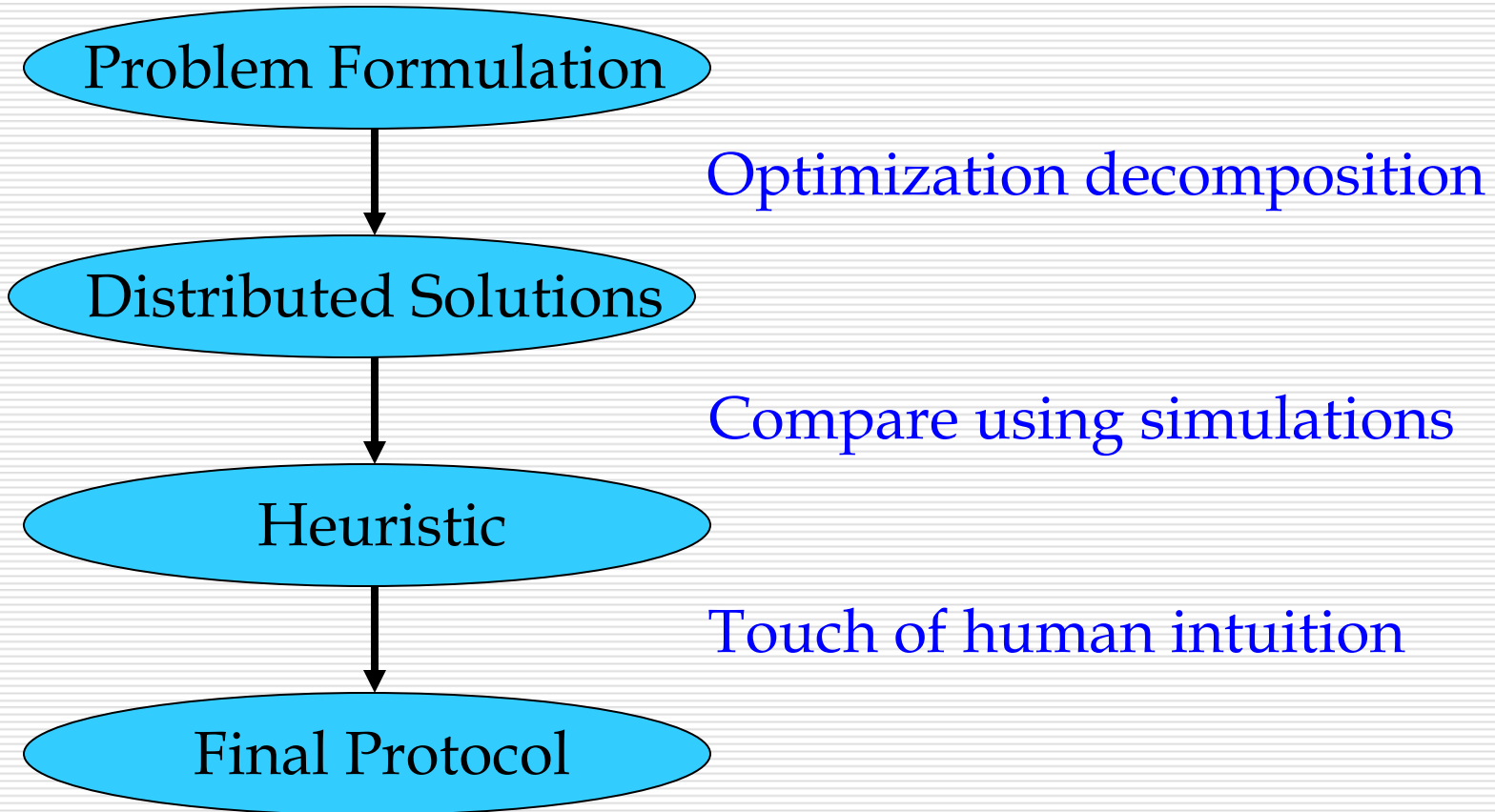


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Division of labor evolved organically

# Top-down Redesign

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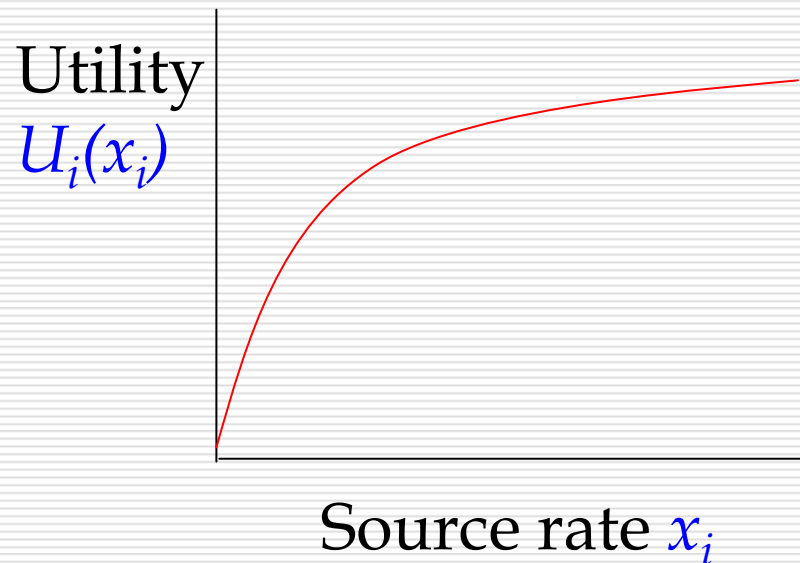
Using optimization to design protocols

# So, What Do We Want?

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□ **Users:** maximize utility, fairness

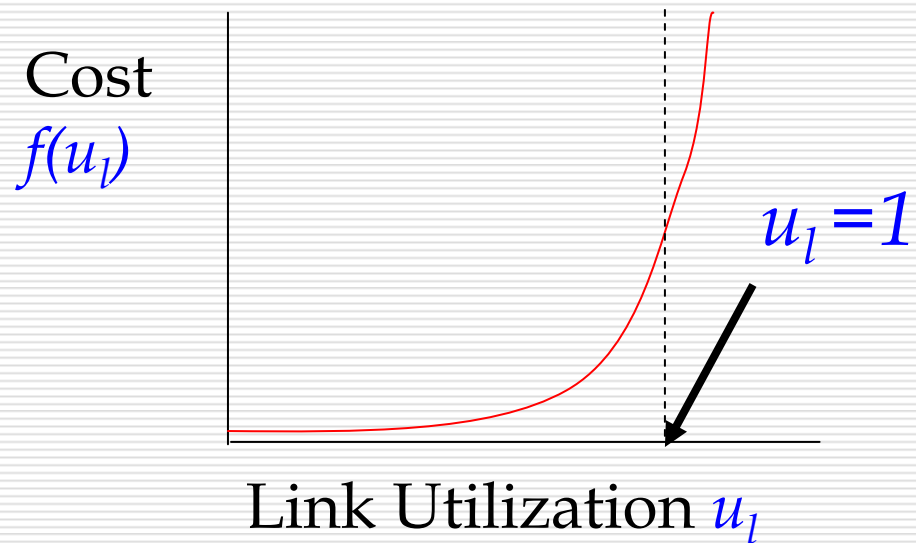
Users are indexed by  $i$



maximize  $sum(U_i(x_i))$

□ **Operators:** load balancing, robustness

Links are indexed by  $l$



minimize  $sum(f(u_l))$

# Balanced Objective

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Can be at odds!

$$\max. \sum_i U_i(x_i) - w \sum_j f(u_j)$$

↑  
Weight of penalty

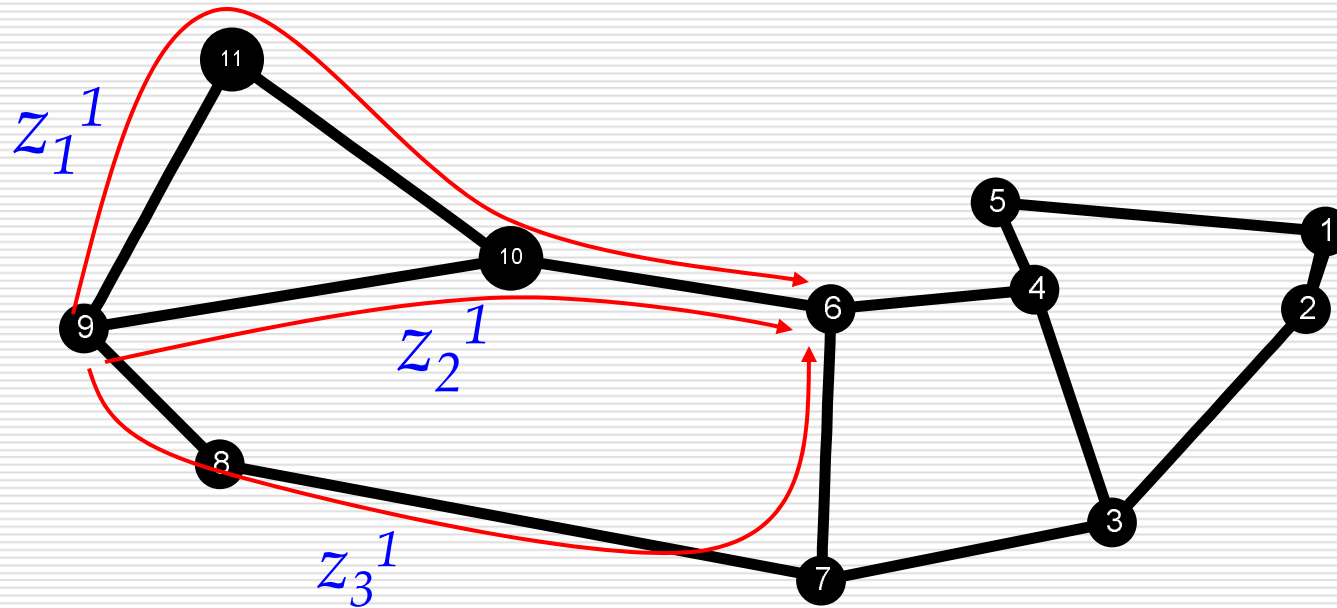
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Tweaking  $w$  allows for striking the balance

# Decomposing the Optimization Problem

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- Multiple paths with flexible splitting
  - Tune sending rate on each path
  - Based on feedback from the links



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Provably optimal and stable!

# Several Different Decompositions

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- Multiple decomposition techniques
    - All multi-path protocols with link feedback
    - Different link feedback and rate updates
    - Different number of tunable parameters
  - Math doesn't answer all questions
    - Sensitivity of tunable parameters
    - Speed of convergence
  - Need for simulations and intuition
    - Combining the best of each algorithm
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# New Division of Functionality

	<b>Today</b>	<b>Tomorrow</b>
<i>Operators</i>	Tune link weights Set penalty function $f$	(Set-up multi-path) Tune $f$ , $w$ , & stepsize
<i>Sources</i>	Adapt source rates	Adapt path rates $z$
<i>Routers</i>	Shortest path routing	(Compute prices)

- **Sources:** end hosts or edge routers?
- **Feedback:** implicit or explicit?
- **Computation:** centralized or distributed?

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Mathematics leaves open architecture questions

# Experimental Requirements

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- Revisiting traffic management
    - Routers: multi-path routing/forwarding
    - Hosts: end-host rate adaptation
  - Realistic traffic patterns
    - Realistic synthetic models
    - Real users
  - Composition with others
    - Beyond “distributed algorithms”
    - To a real network architecture
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