Strategic Analysis in Telecommunications Markets

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Non-cooperative game theory

- Players motivated by individual incentives
- Interactions resulting in payoffs

Explains:

- Selfish but collectively damaging behavior
- How to think strategically
- More than one possible equilibrium (stable outcome)
- Rules of the game matter
- Selfish behavior in networks

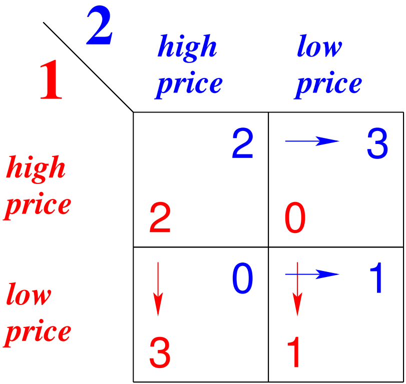
Explain selfish behavior

Price-setting game

1 \ 2	*high price*	*low price*
high price	2 2	3 0
low price	0 3	1 1

Explain selfish behavior

Price-setting game



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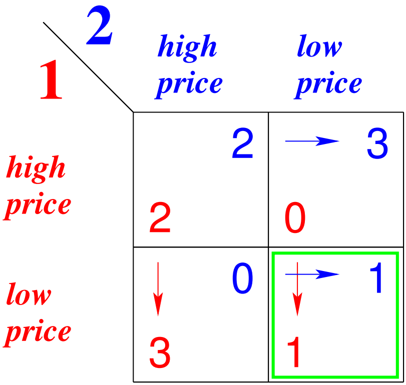
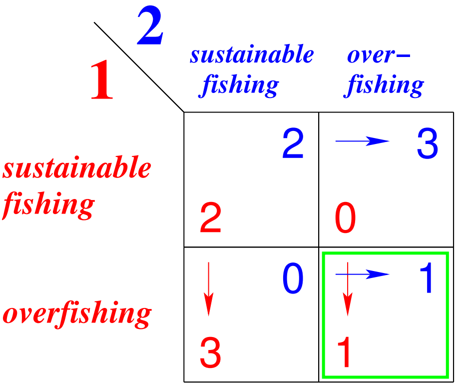


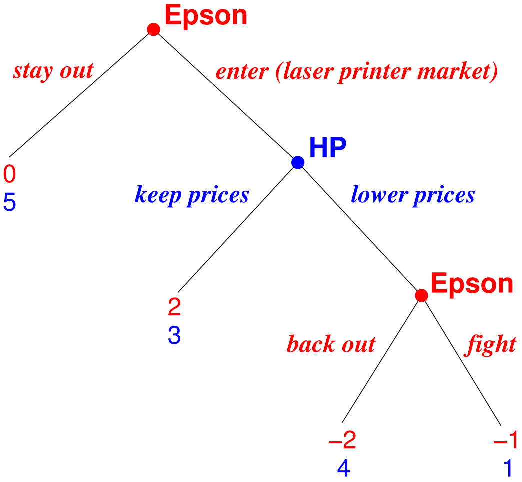
Explain selfish behavior

Fishing game



price competition positive for consumers, but same game between fishing nations detrimental for all!

Thinking strategically: Epson vs. HP



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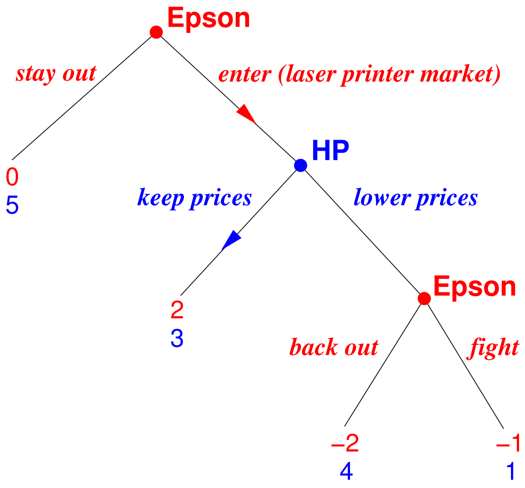

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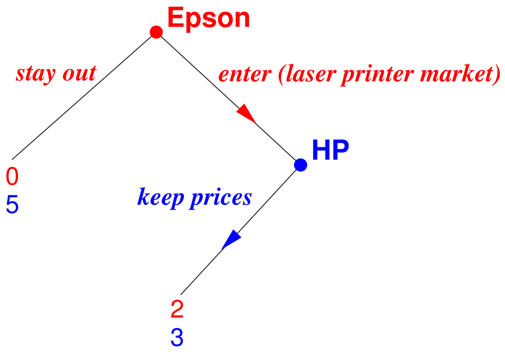

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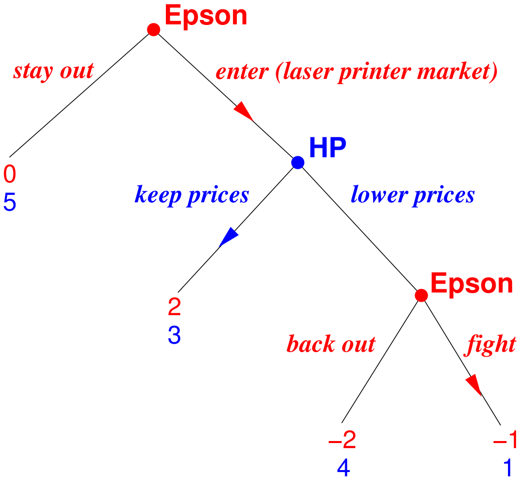

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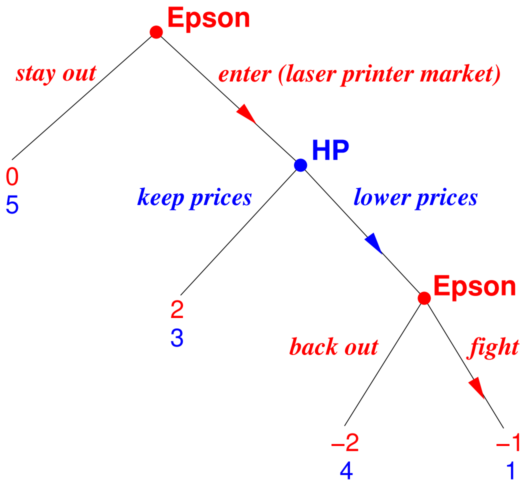

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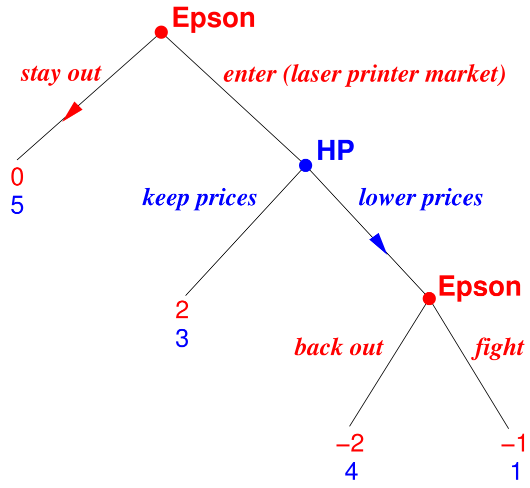

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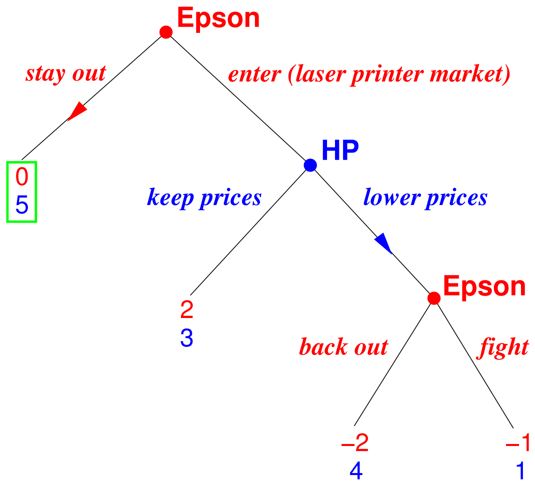

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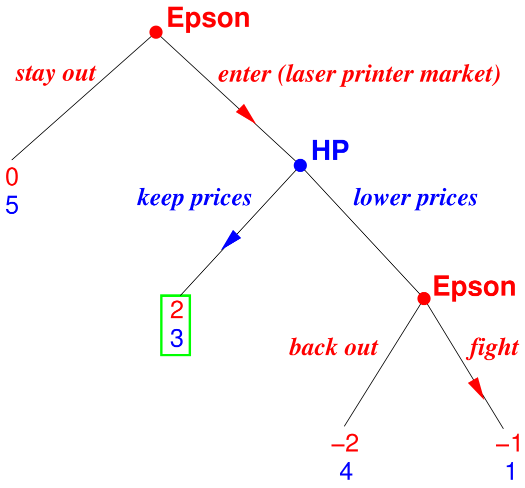

More than one possible equilibrium

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For example, in the **Epson** vs. **HP** game:

Equilibrium 1: (*stay out*, *lower prices*)

Equilibrium 2: (*enter / fight*, *keep prices*)

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Equilibrium 1: (*stay out*, *lower prices*)

Equilibrium 2: (*enter / fight*, *keep prices*)

not an equilibrium: (*enter / fight*, *lower prices*)

The bandwidth choice game

1 \ 2	high bandwidth	low bandwidth
high bandwidth	5 5	1 0
low bandwidth	0 1	1 1

The bandwidth choice game

1 \ 2	high bandwidth	low bandwidth
high bandwidth	5, 5	0, 1
low bandwidth	1, 0	1, 1

The bandwidth choice game

Which equilibrium?

1 \ 2	high bandwidth	low bandwidth
high bandwidth	5, 5	0, 1
low bandwidth	1, 0	1, 1

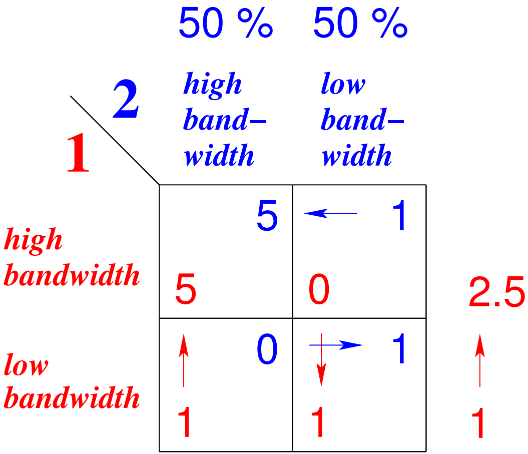
The bandwidth choice game

Which equilibrium? **Evolved** from starting distribution:

1 \ 2	*high bandwidth* (30 %)	*low bandwidth* (70 %)	
high bandwidth	5, 5	0, 1	1.5
low bandwidth	1, 0	1, 1	1

The bandwidth choice game

Which equilibrium? **Evolved** from starting distribution:



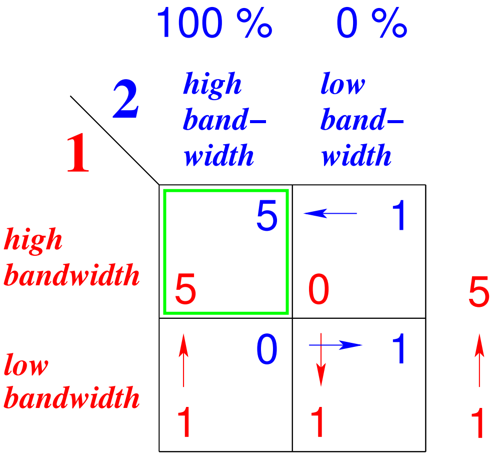
The bandwidth choice game

Which equilibrium? **Evolved** from starting distribution:

1 \ 2	*high bandwidth* (80 %)	*low bandwidth* (20 %)	
high bandwidth	5, 5	0, 1	4
low bandwidth	1, 0	1, 1	1

The bandwidth choice game

Which equilibrium? **Evolved** from starting distribution:



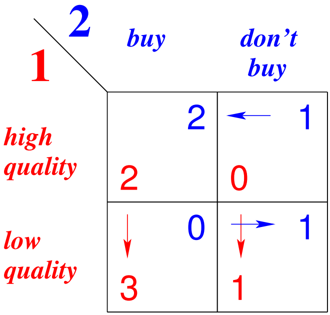
Rules of the game matter

The **Quality Game**

1 \ 2	*buy*	*don't buy*
high quality	2, 2	0, 1
low quality	3, 0	1, 1

Rules of the game matter

The **Quality Game**



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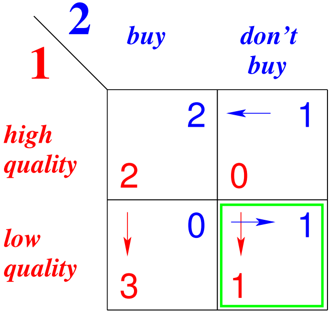

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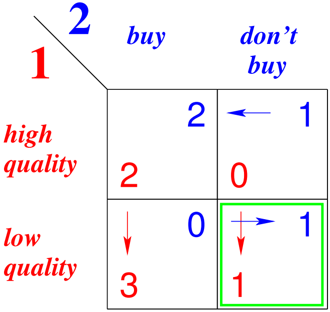
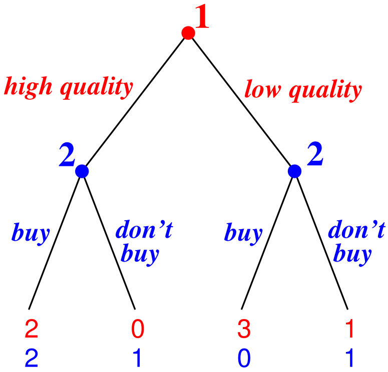
The **Quality Game** changed to a game with **commitment**





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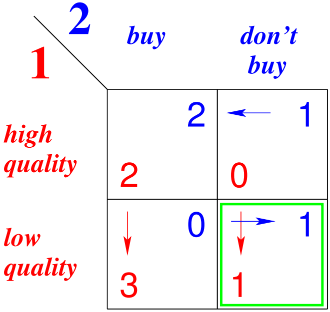

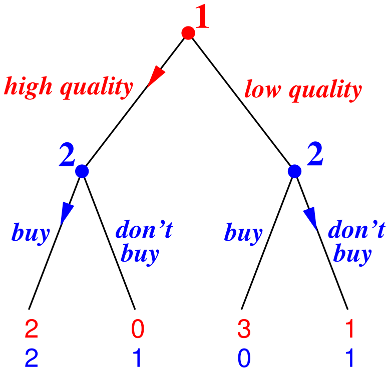

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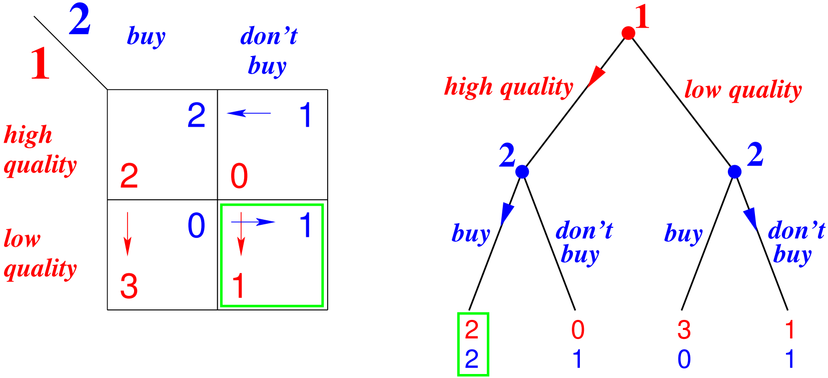

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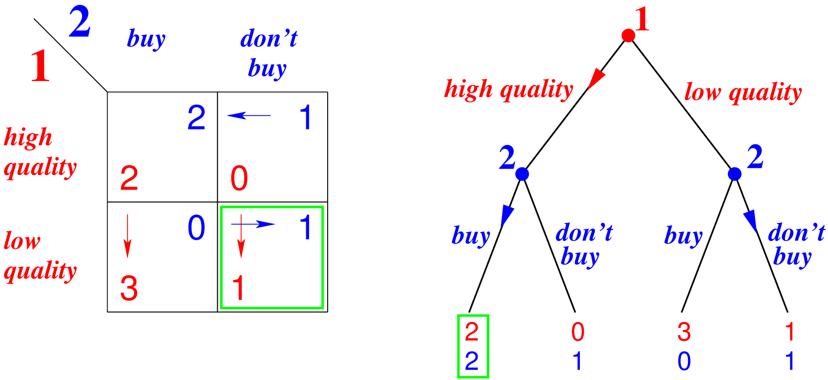
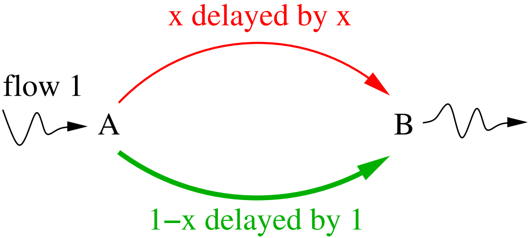


⇒ **Commitment power** can help both players!

Selfish routing in networks



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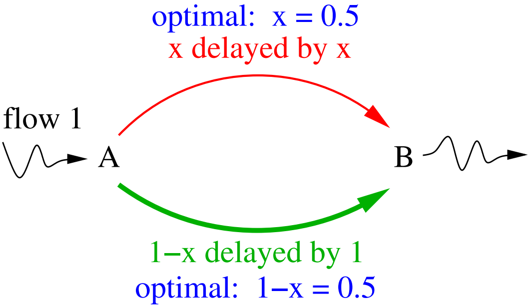
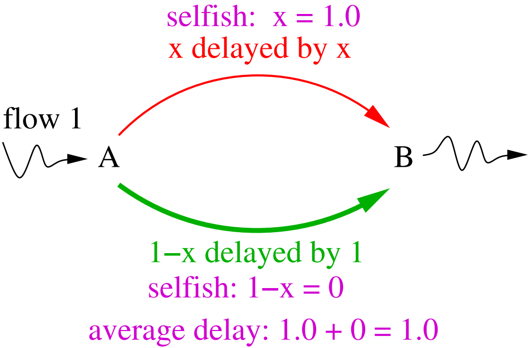


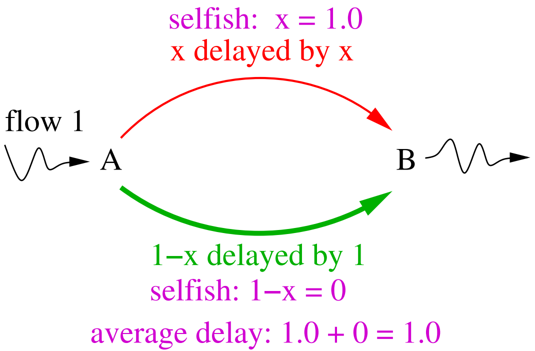
average delay: 0.25 + 0.5 = 0.75

Selfish routing in networks



Selfish routing 33% worse than optimal, centrally planned routing

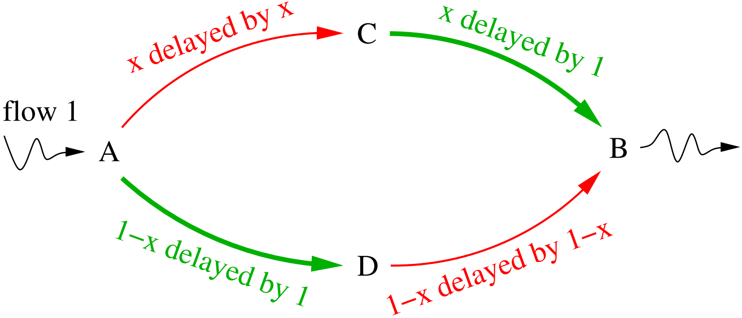
Selfish routing in networks



Selfish routing 33% worse than optimal, centrally planned routing

(33% longer delay is worst possible if delay functions are linear, e.g. flow ***x*** delayed by ***x***)

Selfish routing can be optimal



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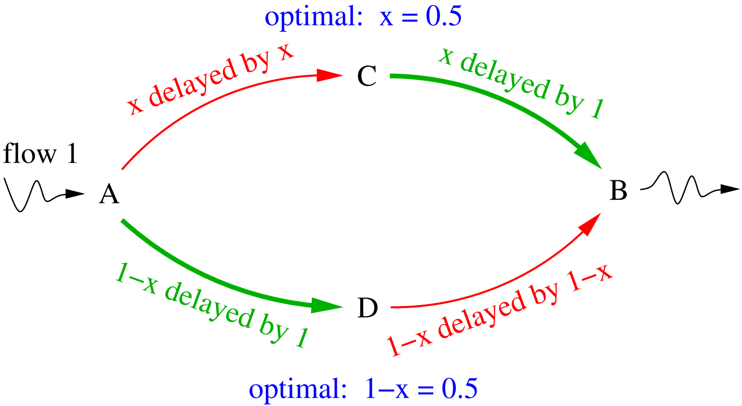
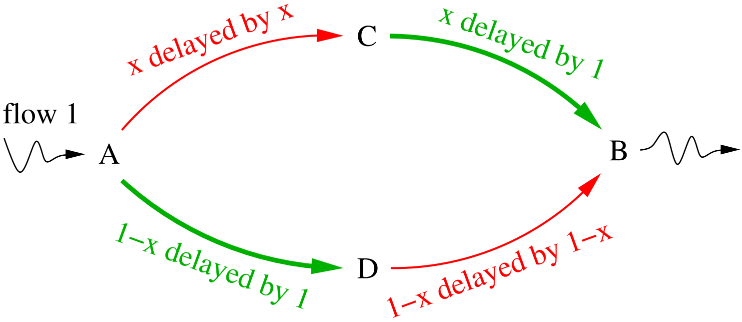


optimal average delay: 0.75 + 0.75 = 1.5

Selfish routing can be optimal

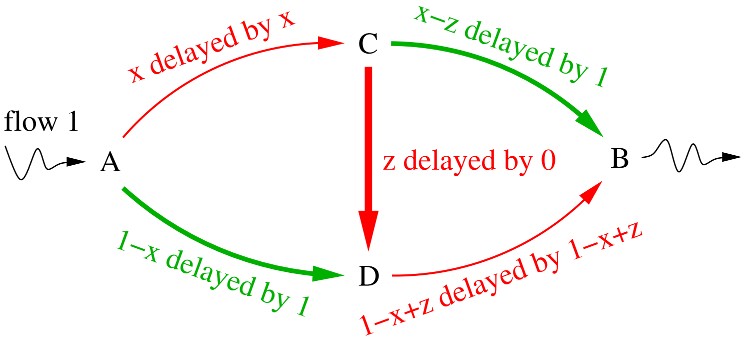
selfish = optimal: x = 0.5



selfish = optimal: 1−x = 0.5

optimal average delay: 0.75 + 0.75 = 1.5

Add a shortcut



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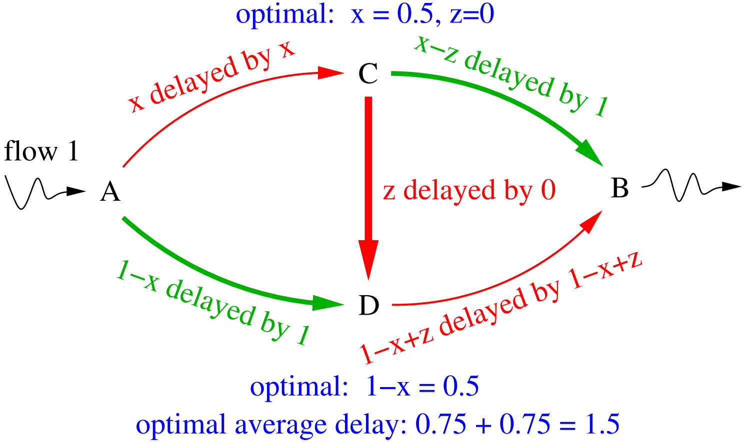

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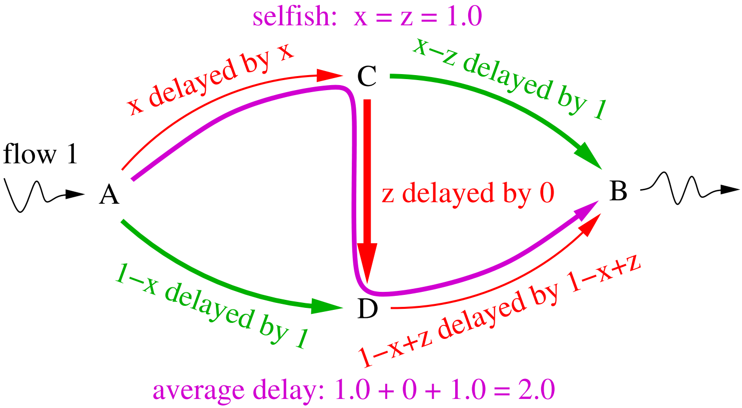
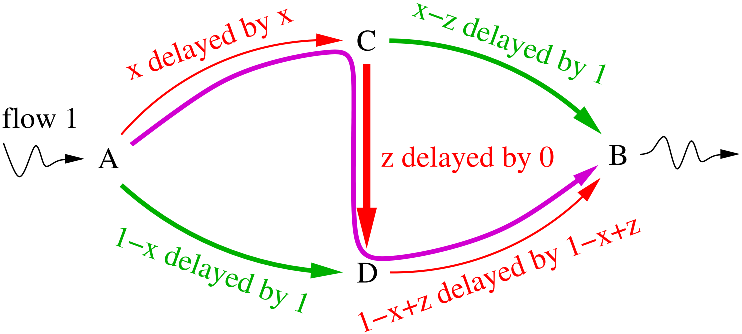


Add a shortcut

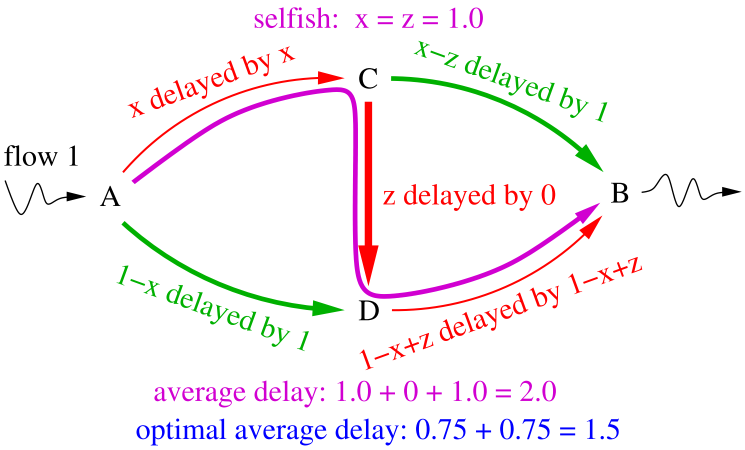
selfish: $x = z = 1.0$



average delay: $1.0 + 0 + 1.0 = 2.0$

optimal average delay: $0.75 + 0.75 = 1.5$

Braess's paradox



Increasing network capacity can **worsen** equilibrium congestion!

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- **explain: selfish behavior** in competition, networks and routing
- many more applications: design of auctions, optimal bidding, . . .