

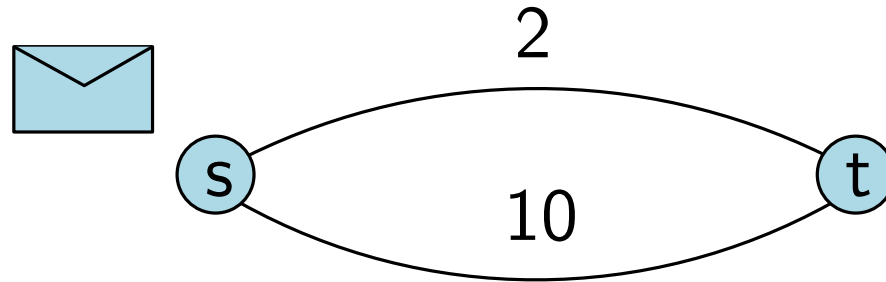
Bribeproof Mechanisms in Two-Values Domains

Matúš Mihalák
Maastricht University

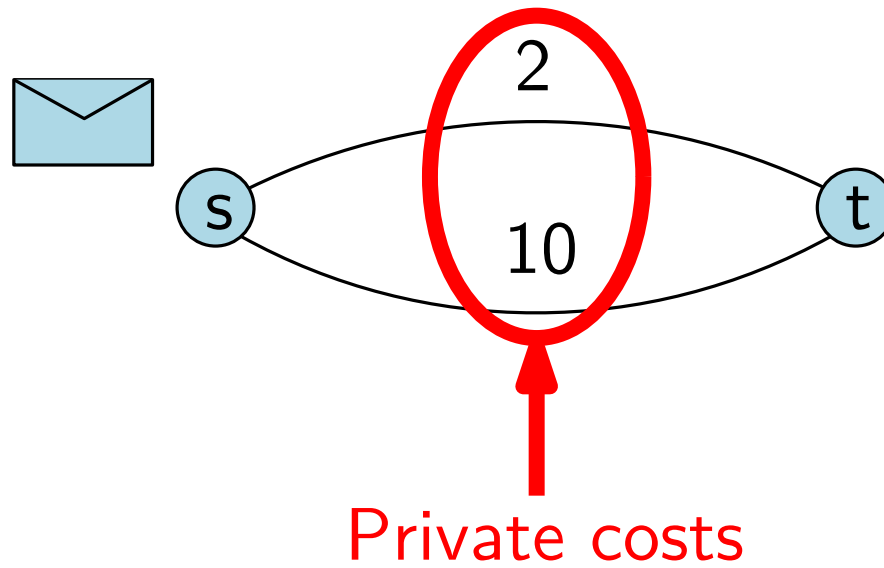
Paolo Penna
ETH Zurich

Peter Widmayer
ETH Zurich

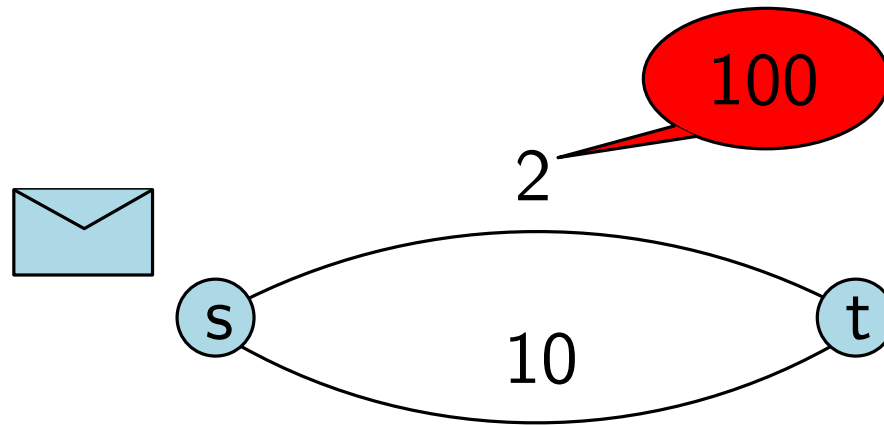
A Toy Example



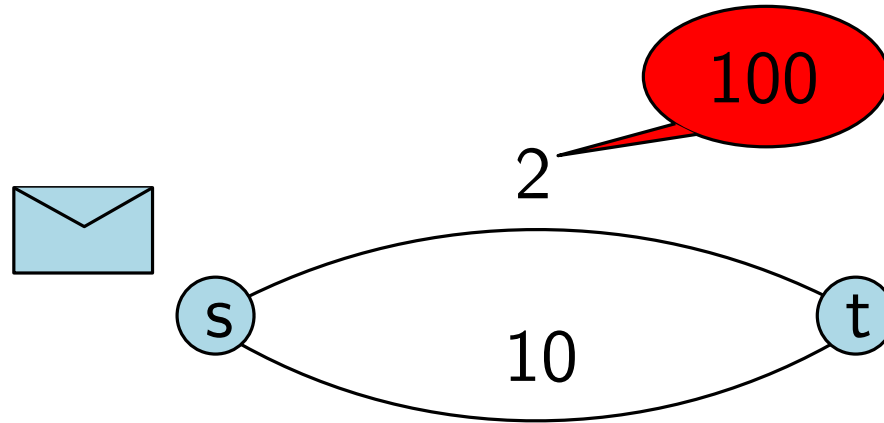
A Toy Example



A Toy Example

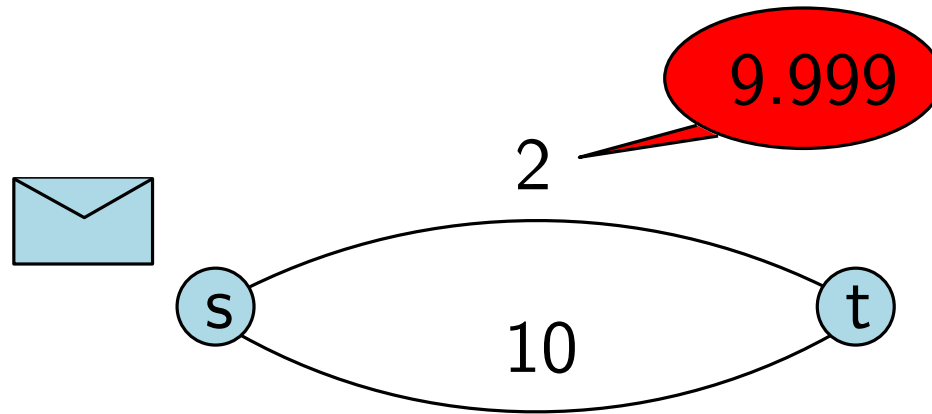


A Toy Example



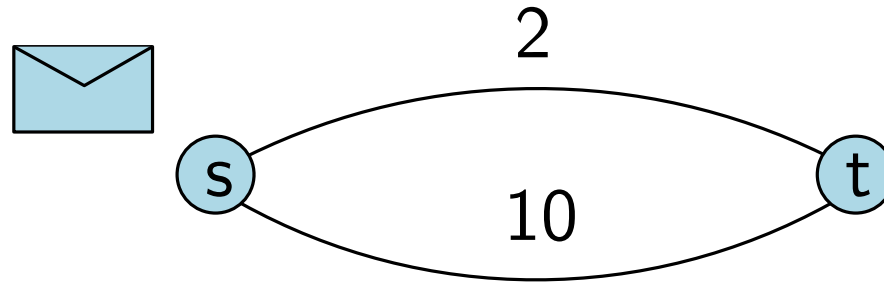
Payment = reported cost

A Toy Example



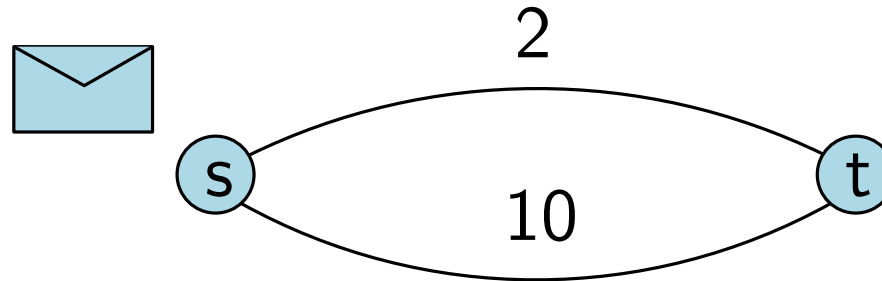
Payment = reported cost

A Toy Example



Payment = 2nd best cost

A Toy Example

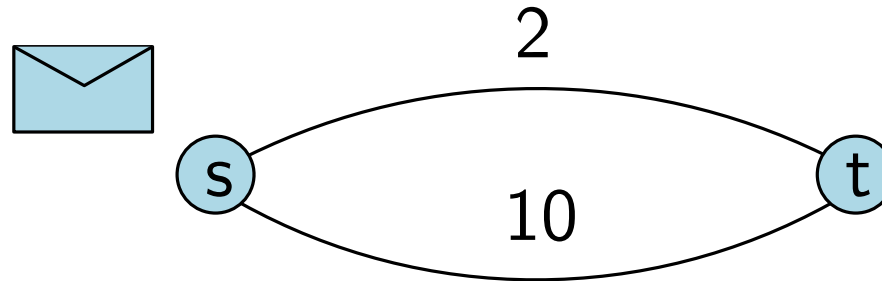


Payment = 2nd best cost

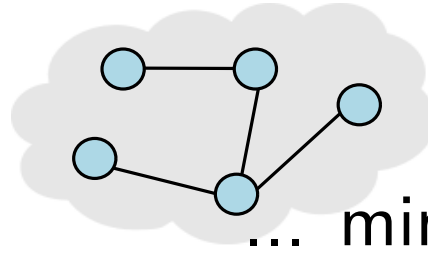
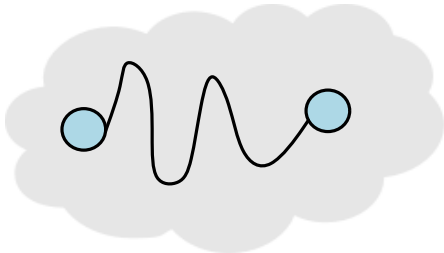
utility("truth") \geq utility("false")

Strategyproof Mechanism

A Toy Example



Shortest Path, Min Spanning Tree, Steiner Tree,...

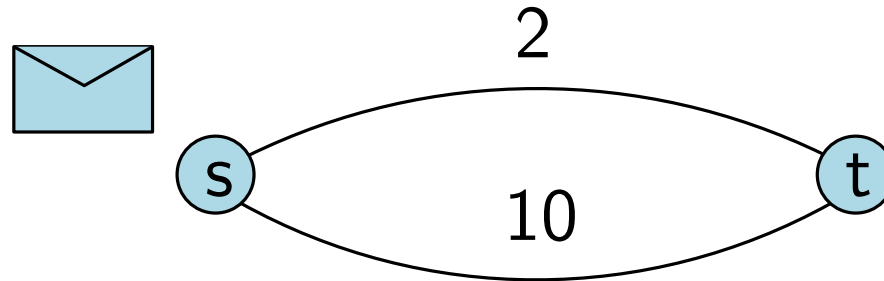


... min **sum** of all costs

Strategyproof Mechanism

(Vickrey'61 – Clarke'71 – Groves'73)

A Toy Example

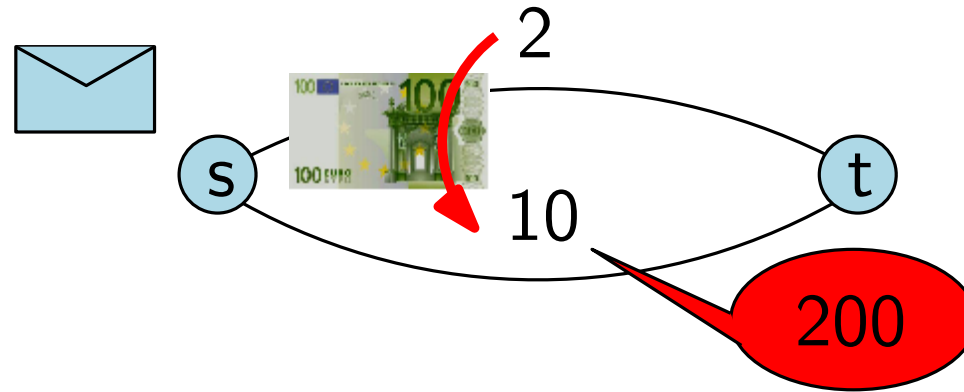


Payment = 2nd best cost

utility("truth") \geq utility("false")

Strategyproof Mechanism

A Toy Example

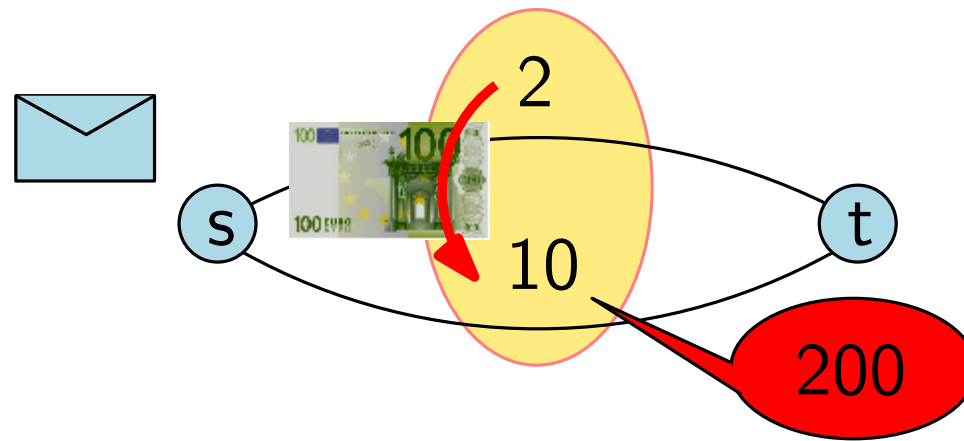


Payment = 2nd best cost

utility("truth") \geq utility("false")

Strategyproof Mechanism

A Toy Example



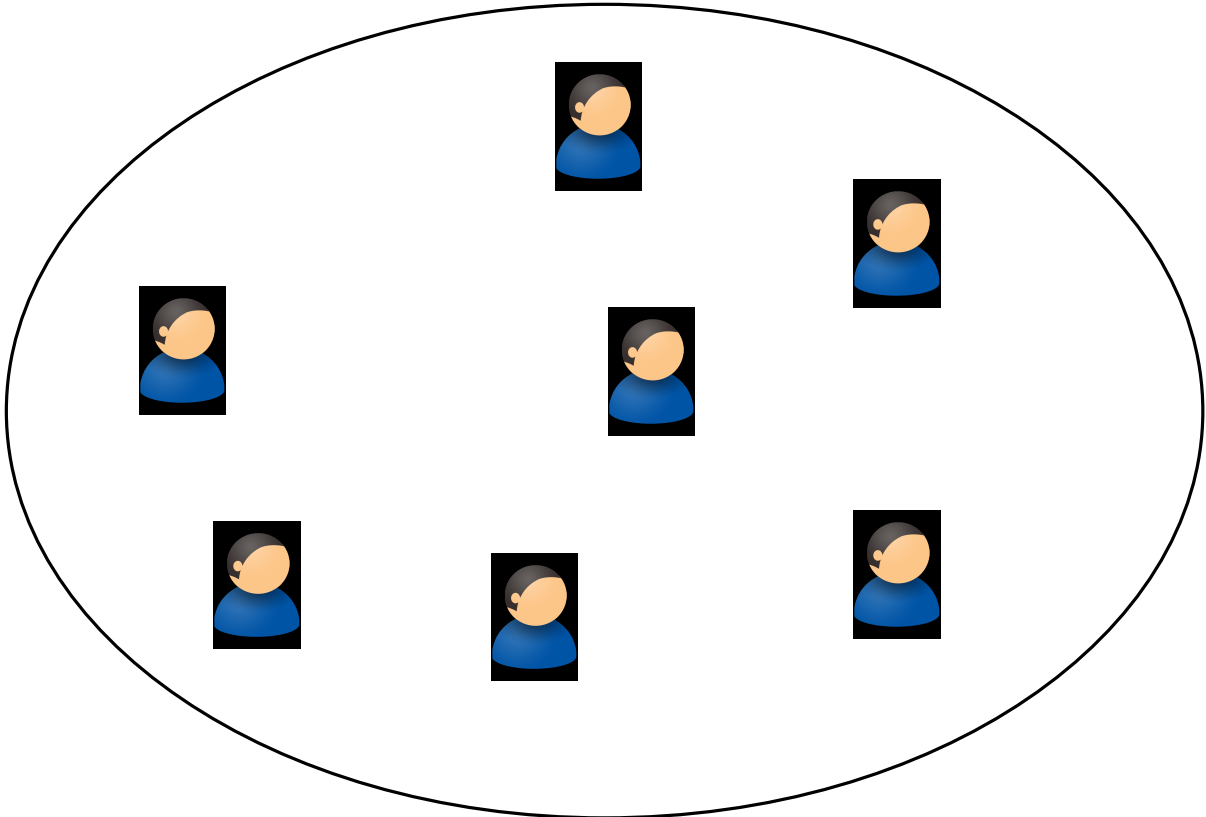
Payment = 2nd best cost

utility("truth") \geq utility("false")

Strategyproof Mechanism

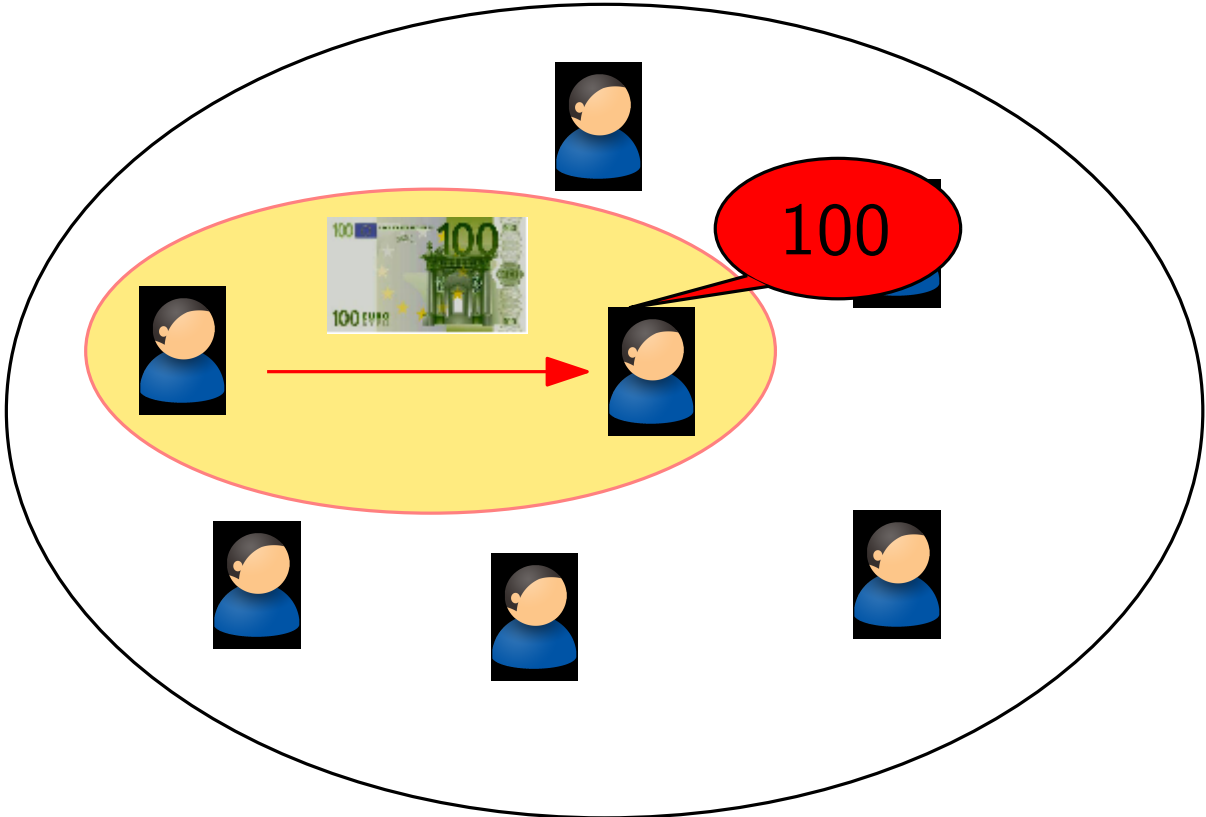
Best Strategy = Bribe (collude)!!

Bribeproofness



(Schummer'00)

Bribeproofness



(Schummer'00)

Strategyproof

Bribeproof



Strategyproof

Bribeproof

Welfare maximization

- min **sum** costs

(VCG)

Strategyproof

Welfare maximization

- min **sum** costs

(VCG)

Restricted domains:

- min **max** costs
- max revenue
-
-
-

- characterizations

(Myerson'81) (Rochet'87)...

...(Archer-Tardos'01)...

Bribeproof

Strategyproof

Welfare maximization

- min **sum** costs

(VCG)

Restricted domains:

- min **max** costs
- max revenue
-
-
-

- characterizations

(Myerson'81) (Rochet'87)...

...(Archer-Tardos'01)...

Bribeproof

Nothing useful:

- **fixed** outcome

(Schummer'00)

Strategyproof

Welfare maximization

- min **sum** costs

(VCG)

Restricted domains:

- min **max** costs
- max revenue
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Bribeproof

Nothing useful:

- **fixed** outcome

(Schummer'00)

Also in finite domains

(Mizukami'03)

Strategyproof

Welfare maximization

- min **sum** costs

(VCG)

Restricted domains:

- min **max** costs
- max revenue
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...(Archer-Tardos'01)...

Bribeproof

Nothing useful:

- **fixed** outcome

(Schummer'00)

Also in finite domains

(Mizukami'03)

Restricted Domains



Anything Useful?

Strategyproof

Welfare maximization

- min **sum** costs

(VCG)

Restricted domains:

- min **max** costs
- max revenue
-
-
-

- characterizations

(Myerson'81) (Rochet'87)...

...(Archer-Tardos'01)...

Bribeproof

Nothing useful:

- **fixed** outcome

(Schummer'00)

Also in finite domains

(Mizukami'03)

Identical Items
Posted Prices

(Goldberg-Hartline'05)...

Strategyproof

Welfare maximization

- min **sum** costs

(VCG)

Restricted domains:

- min **max** costs
- max revenue
-
-
-
- characterizations

(Myerson'81) (Rochet'87)...

...(Archer-Tardos'01)...

Bribeproof

Nothing useful:

- **fixed** outcome

(Schummer'00)

Also in finite domains

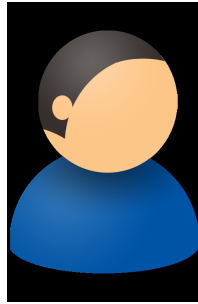
(Mizukami'03)

Restricted Domains



Anything Useful?

Setting

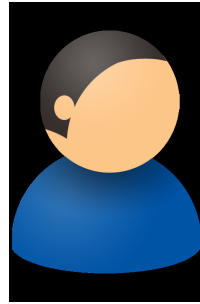


work

money

Setting

work

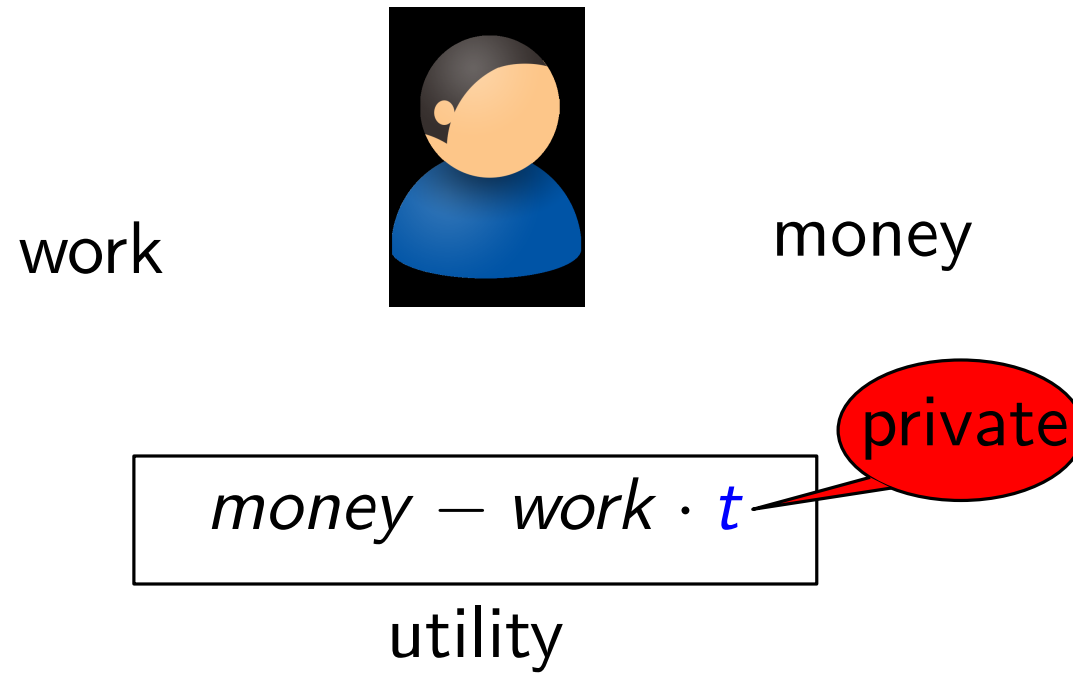


money

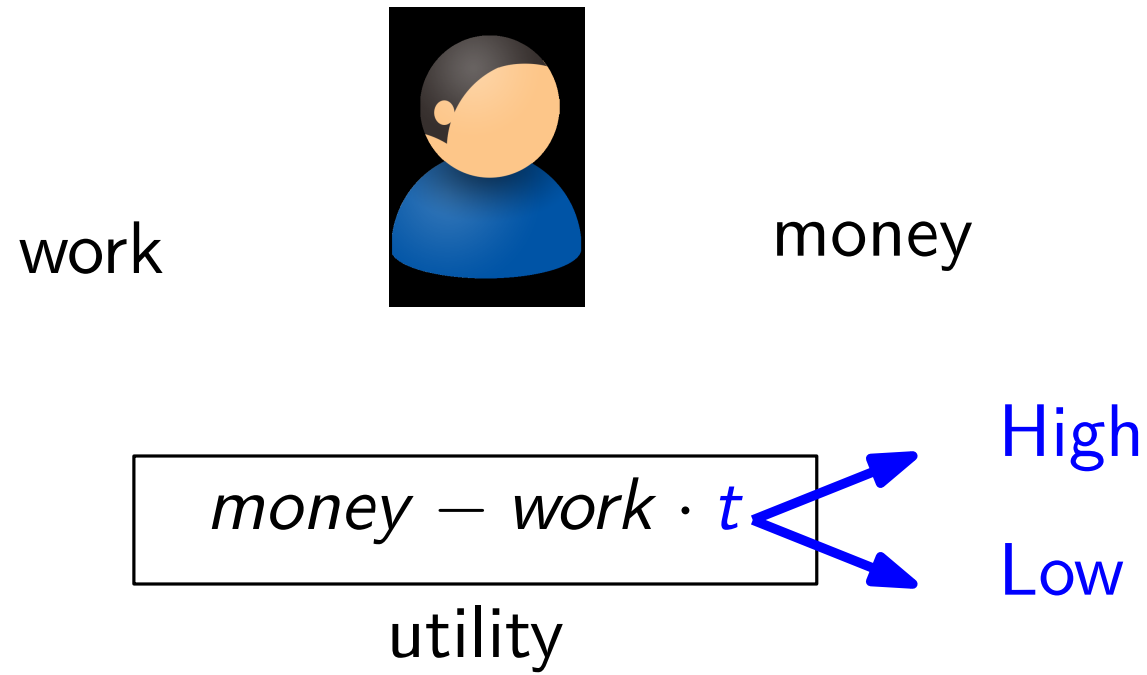
$$\text{money} - \text{work} \cdot t$$

utility

Setting



Setting



Two-values domain

Setting

work



money

$$\text{money} - \text{work} \cdot t$$

High

Low

utility



High

Low



High

Low



High

Low

Two-values domain

Main Contribution

Bribeproof Mechanisms

Sufficient Condition

Characterizations

Two-values domain

Main Contribution

Bribeproof Mechanisms

- max welfare
- simple

Sufficient Condition

Characterizations

Two-values domain

Main Contribution

Bribeproof Mechanisms

- max welfare
- simple

$$\text{pay} = \text{work} \times q$$

Sufficient Condition

Characterizations

Two-values domain

Main Contribution

Bribeproof Mechanisms

- max welfare
- simple

$$\text{pay} = \text{work} \times q$$

Sufficient Condition

- algorithm
(allocation rule)

Characterizations

Two-values domain

Main Contribution

Bribeproof Mechanisms

- max welfare
- simple

$$\text{pay} = \text{work} \times q$$

Sufficient Condition

- algorithm
(allocation rule)

Characterizations

- only mechanism
- best possible result

Two-values domain

Main Contribution

Bribeproof Mechanisms

- max welfare
- simple

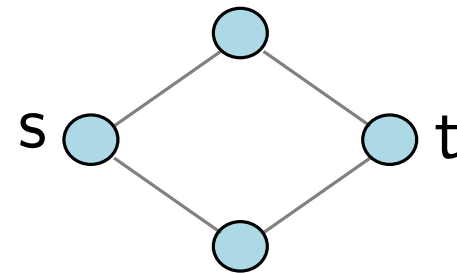
$$\text{pay} = \text{work} \times q$$

Sufficient Condition

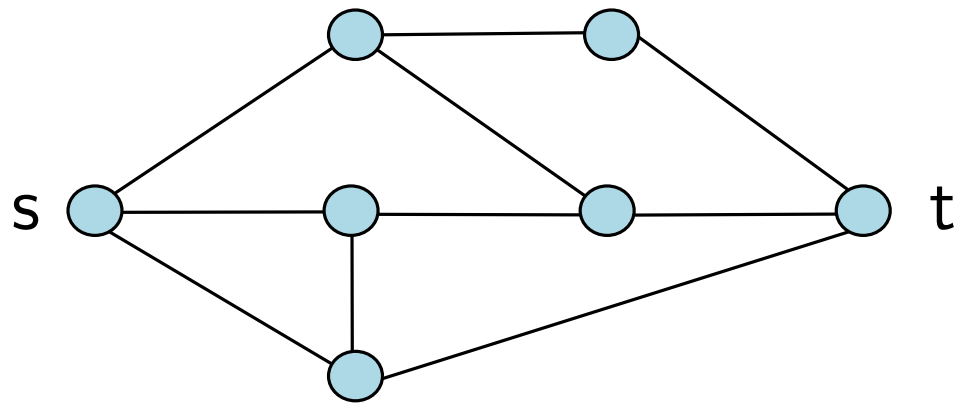
- algorithm
(allocation rule)

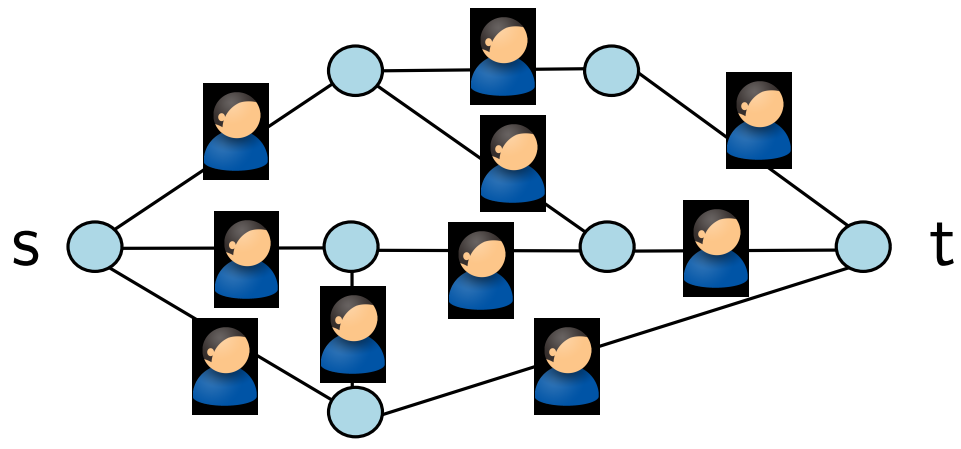
Characterizations

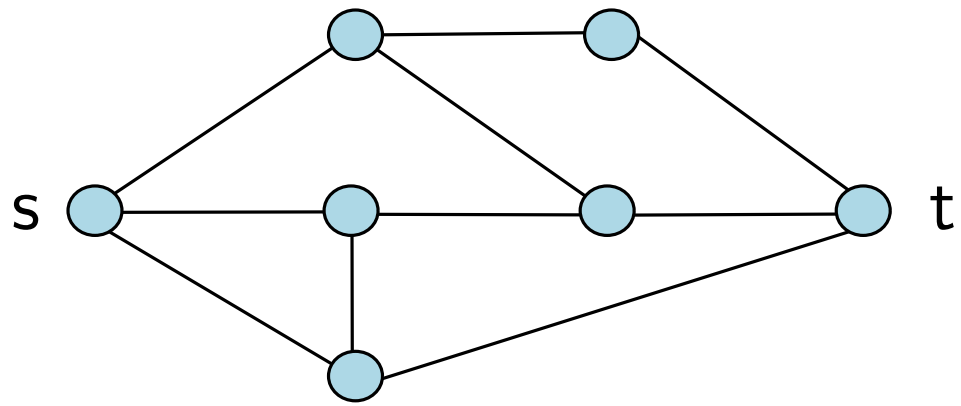
- only mechanism
- best possible result

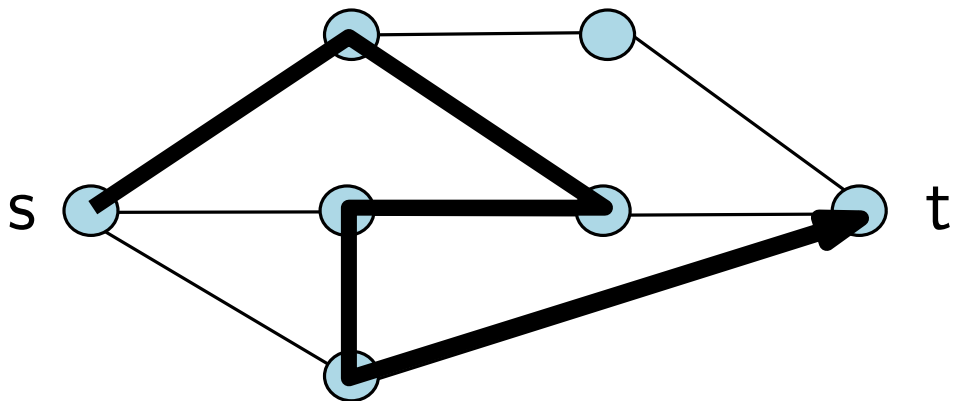


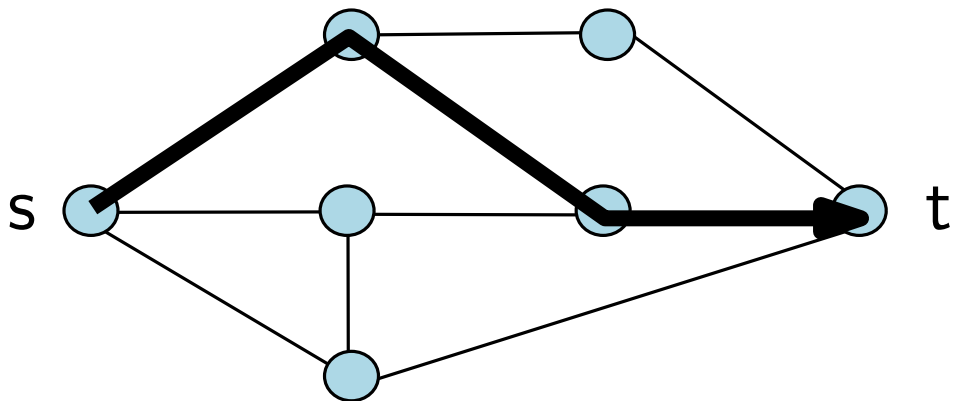
Two-values domain

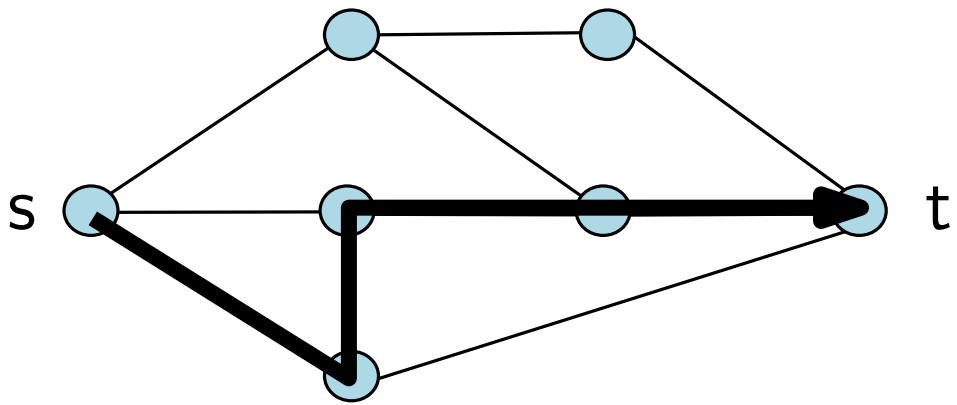


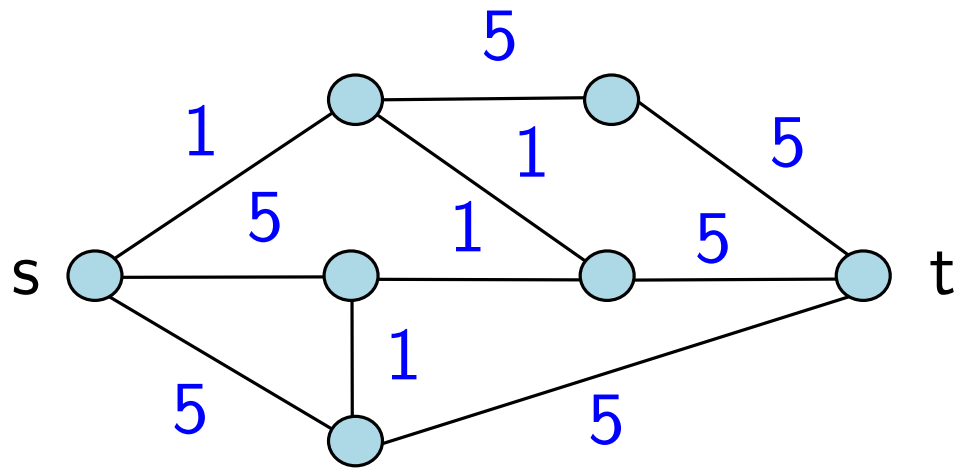


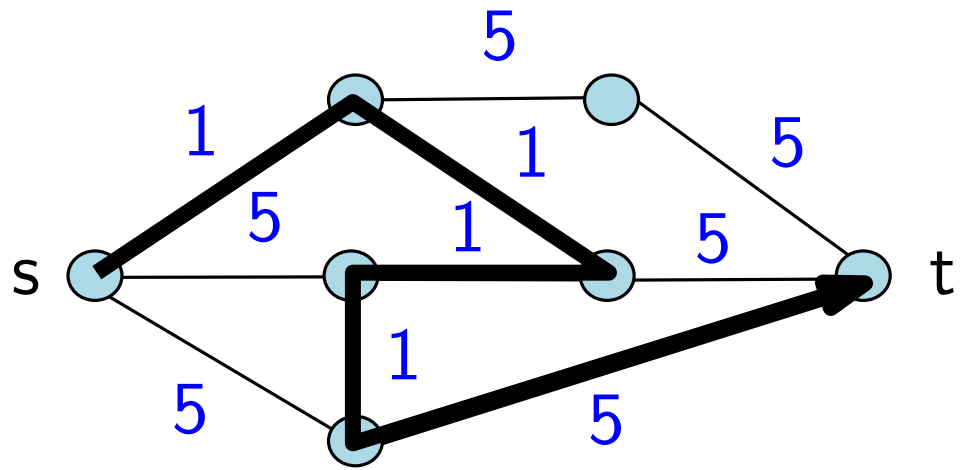


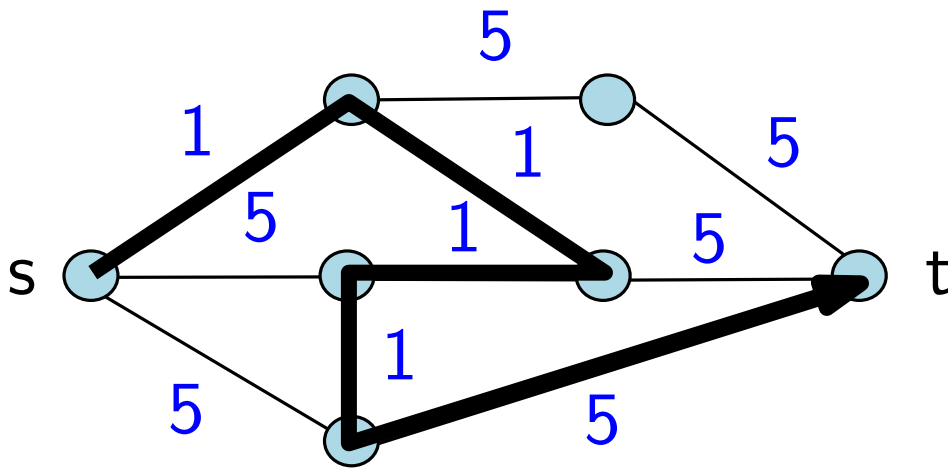






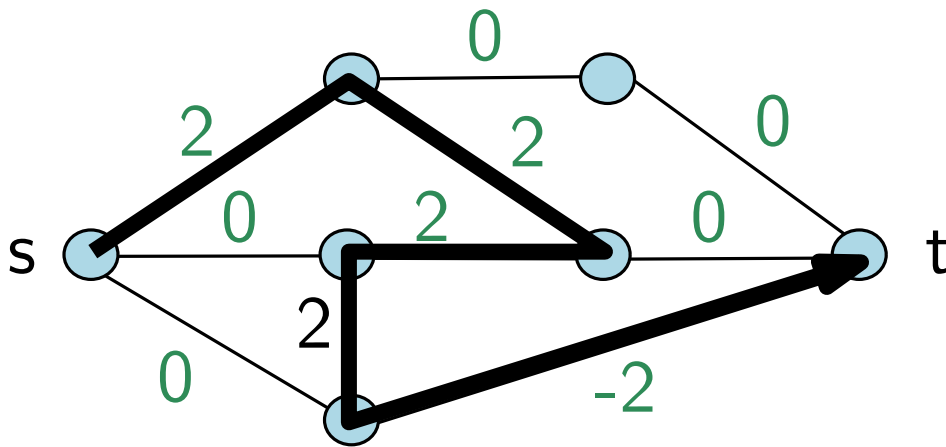






pay

$$\frac{L+H}{2} = 3$$

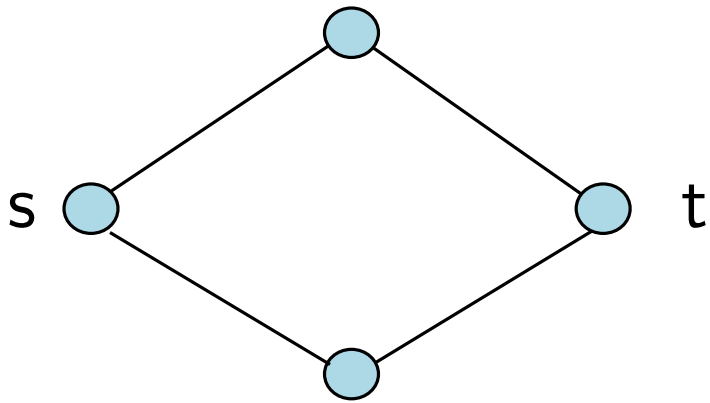


utility

pay

$$\frac{L+H}{2} = 3$$

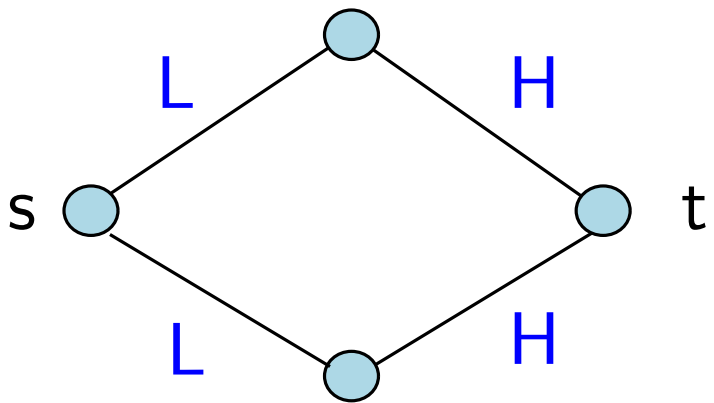
Does it work?



pay

$$\frac{L+H}{2} = 3$$

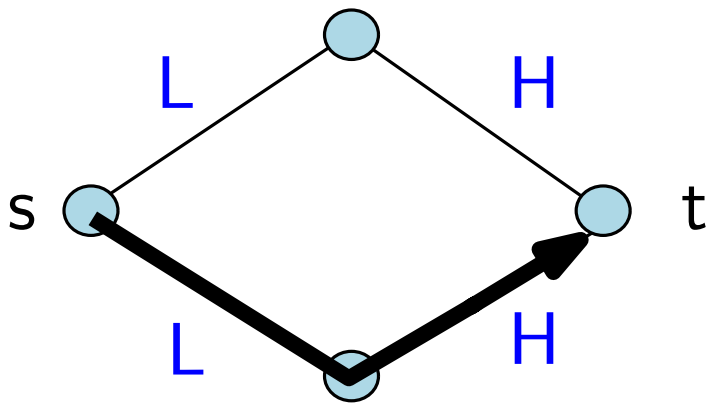
Does it work?



pay

$$\frac{L+H}{2}$$

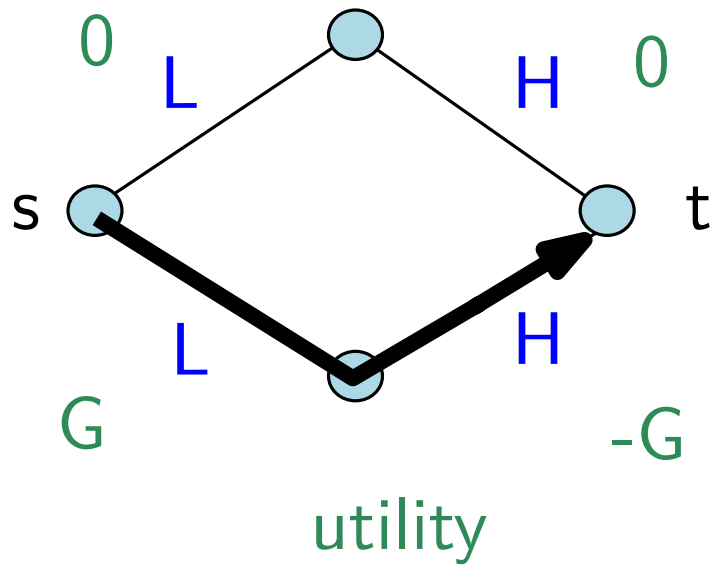
Does it work?



pay

$$\frac{L+H}{2}$$

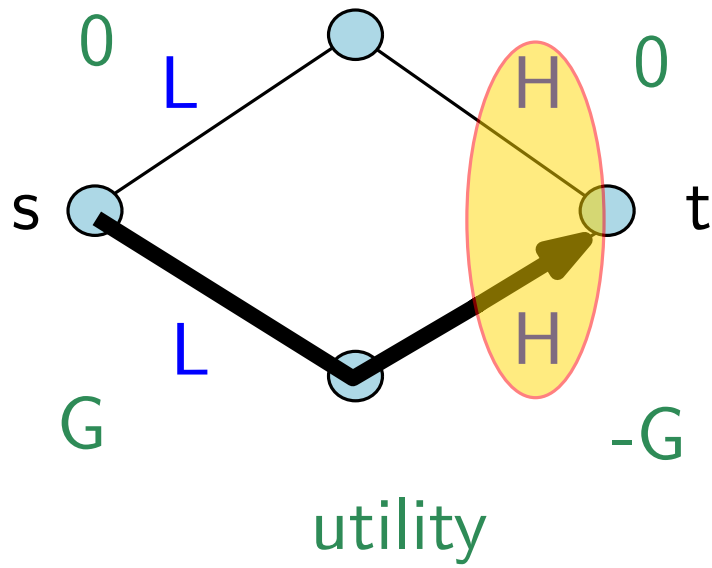
Does it work?



pay

$$\frac{L+H}{2}$$

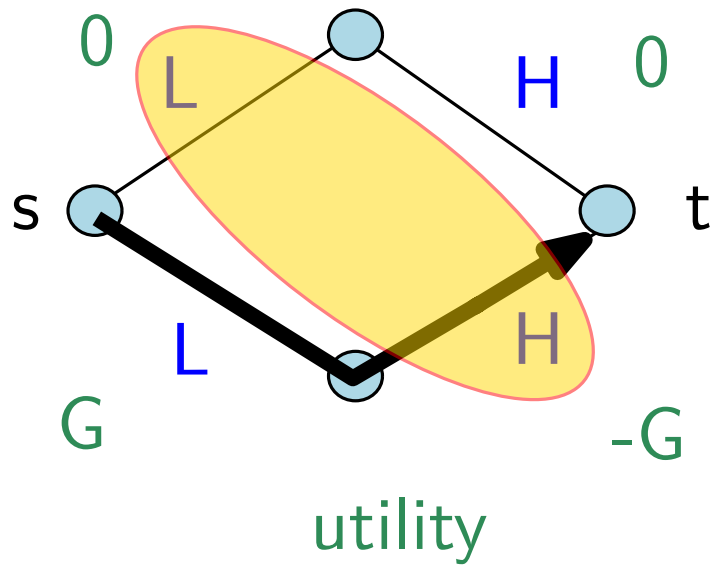
Does it work?



pay

$$\frac{L+H}{2}$$

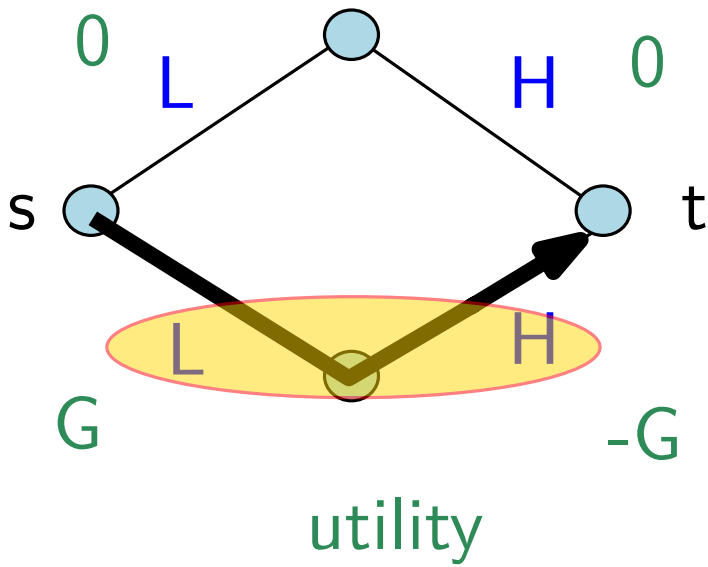
Does it work?



pay

$$\frac{L+H}{2}$$

Does it work?



pay

$$\frac{L+H}{2}$$

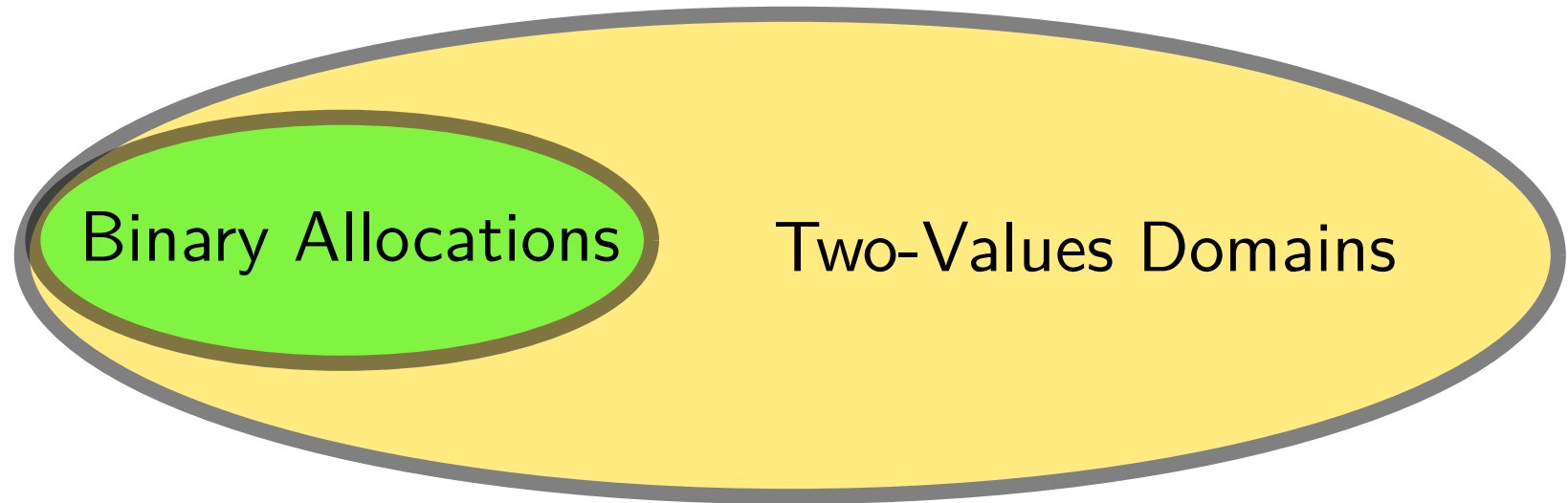
Does it work?

Bribeproof Mechanisms

Binary Allocations

max social welfare \Rightarrow bribeproof

Bribeproof Mechanisms

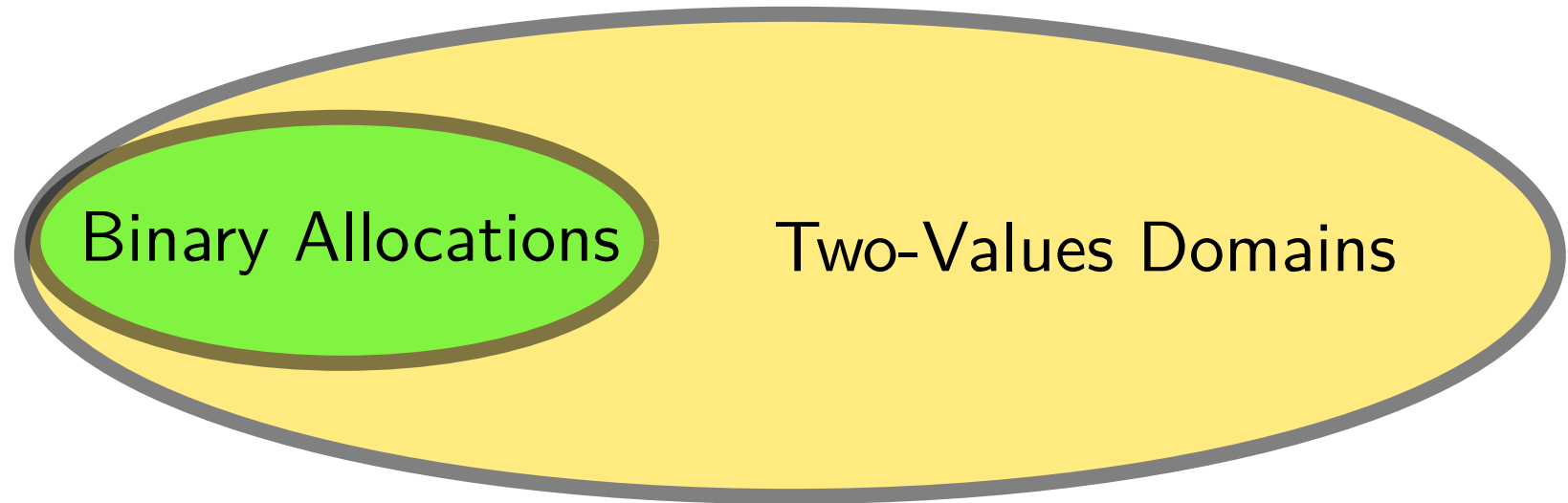


Bounded Influence \Rightarrow Bribeproof

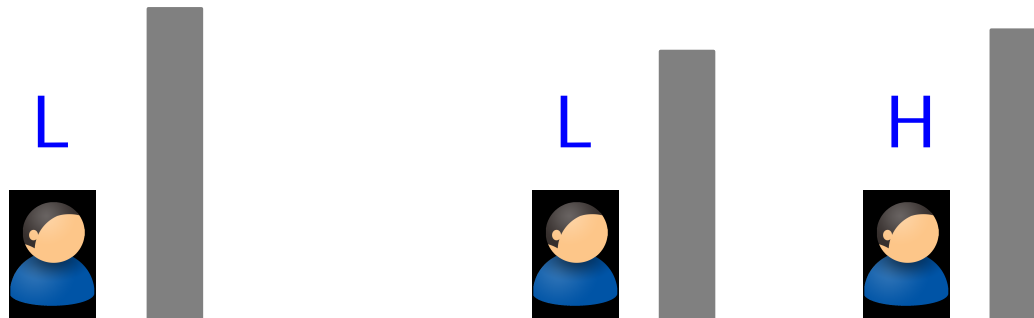
pay

$$work \times \frac{L+H}{2}$$

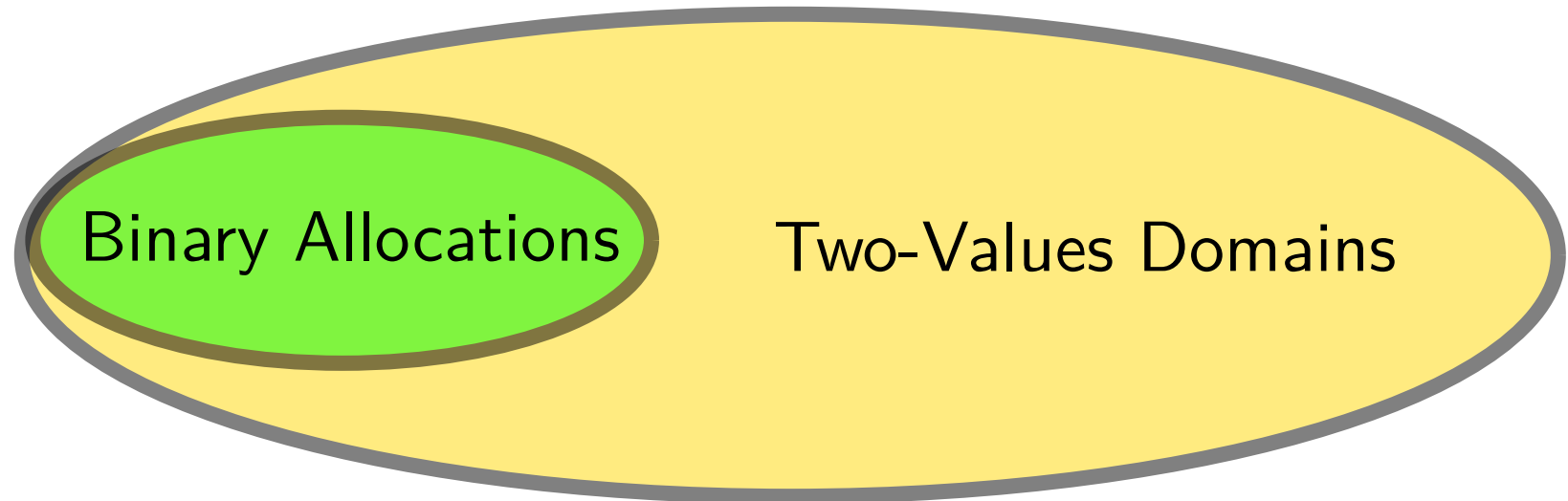
Bribeproof Mechanisms



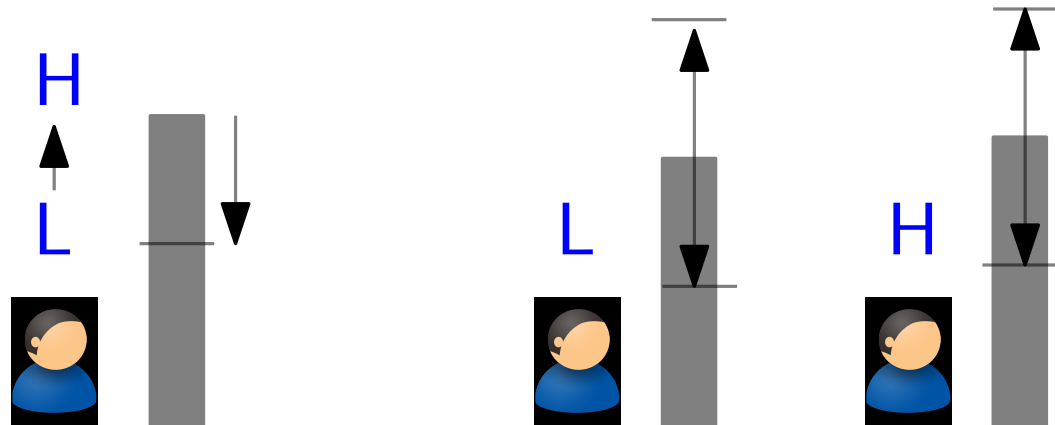
Bounded Influence \Rightarrow Bribeproof



Bribeproof Mechanisms

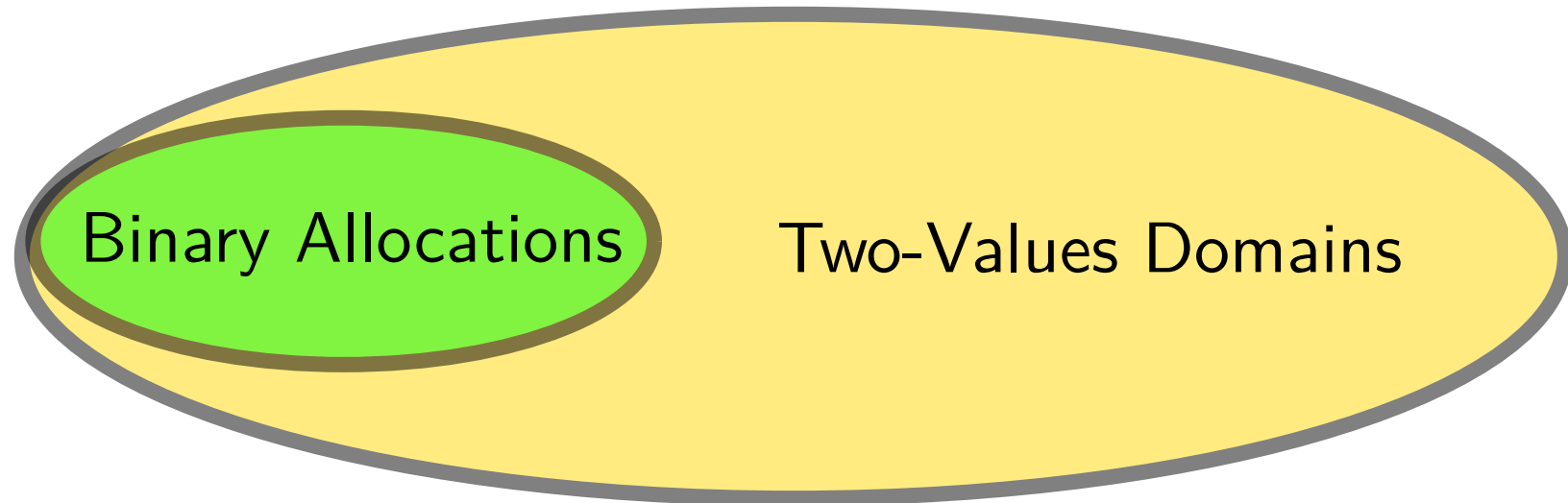


Bounded Influence \Rightarrow Bribeproof

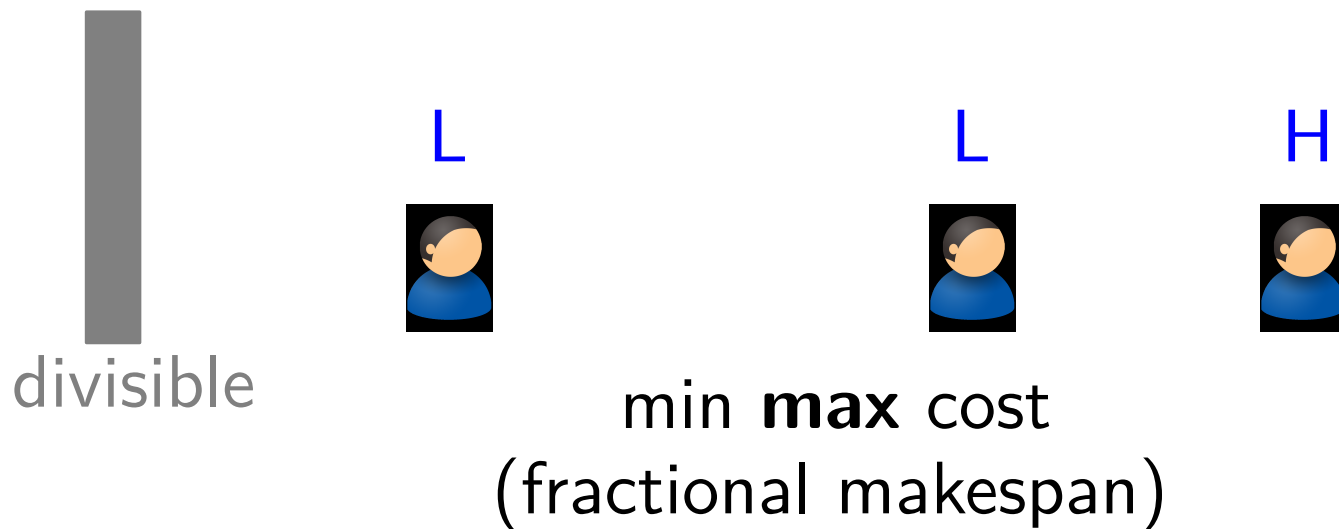


cannot affect the others more than yourself

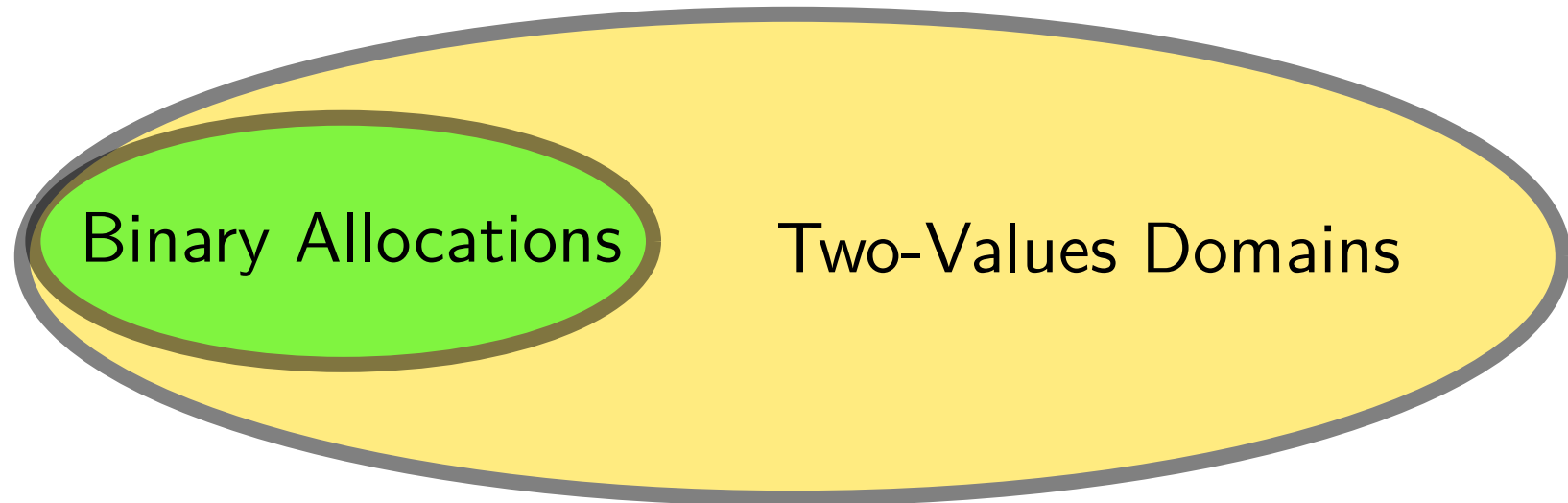
Bribeproof Mechanisms



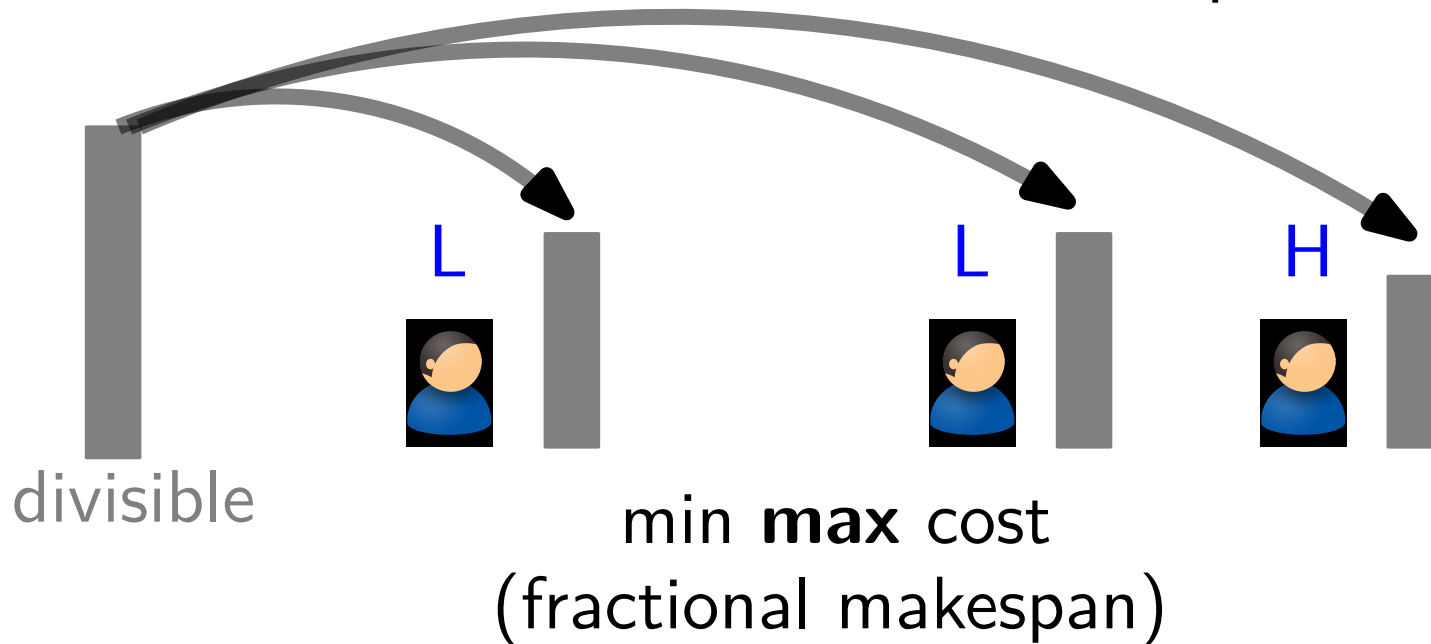
Bounded Influence \Rightarrow Bribeproof



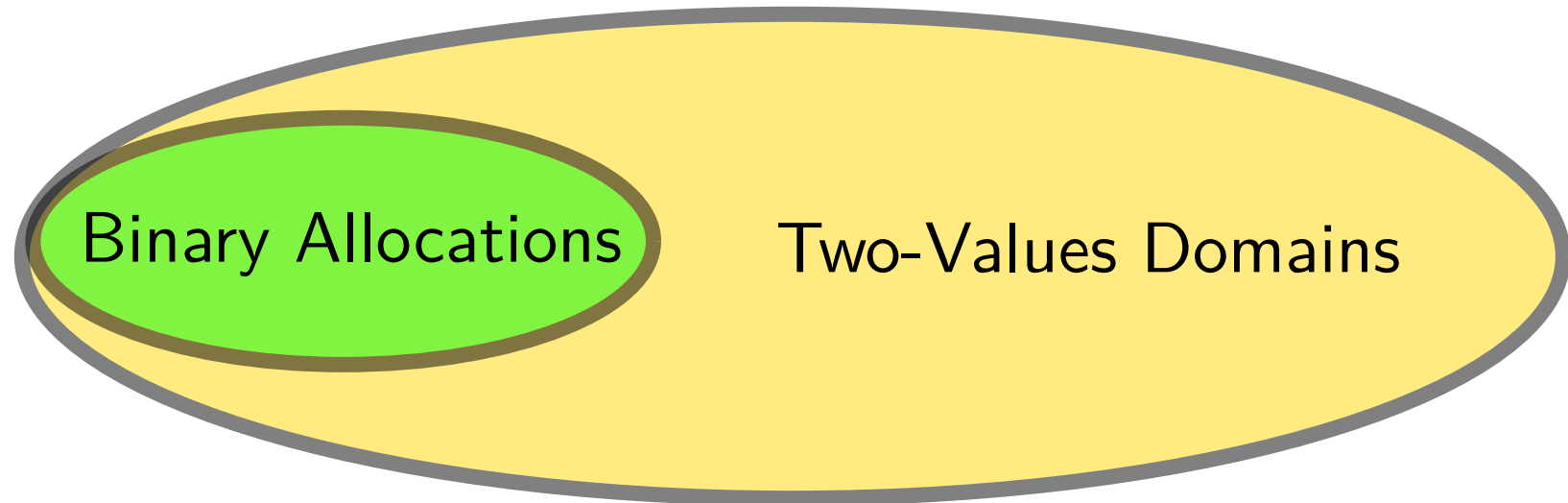
Bribeproof Mechanisms



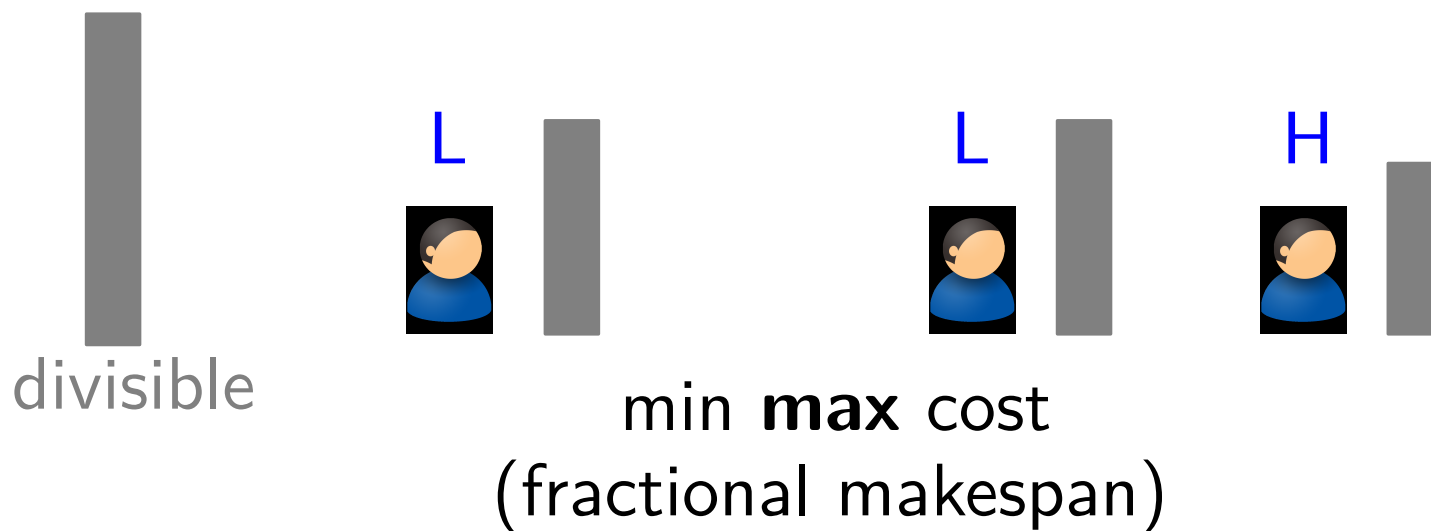
Bounded Influence \Rightarrow Bribeproof



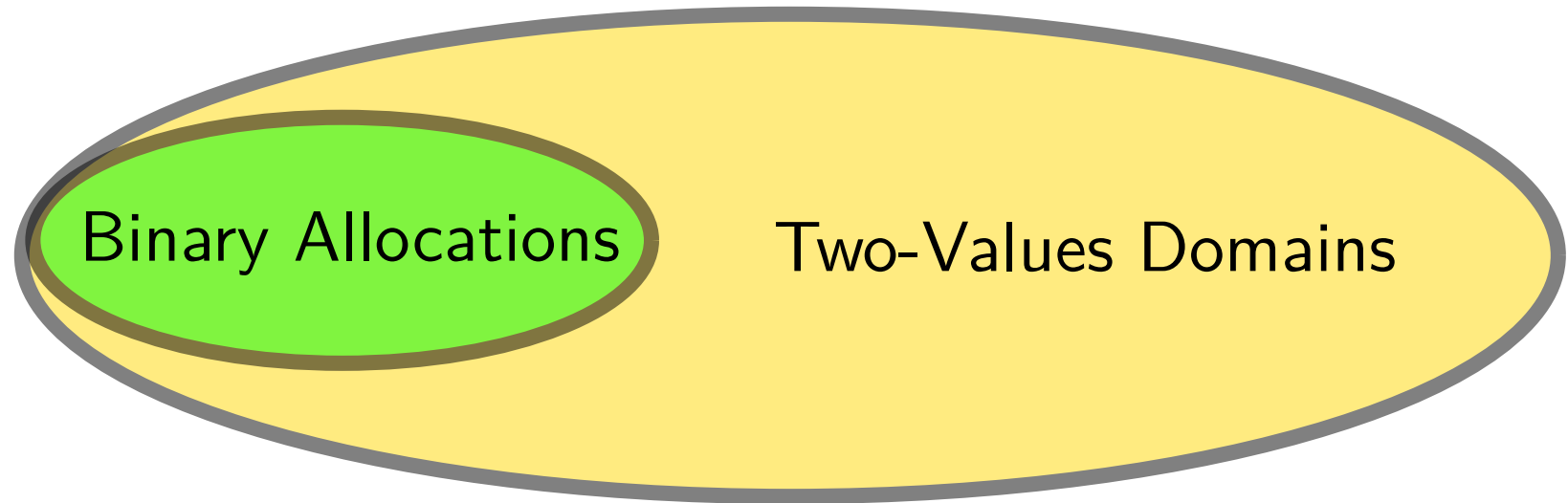
Bribeproof Mechanisms



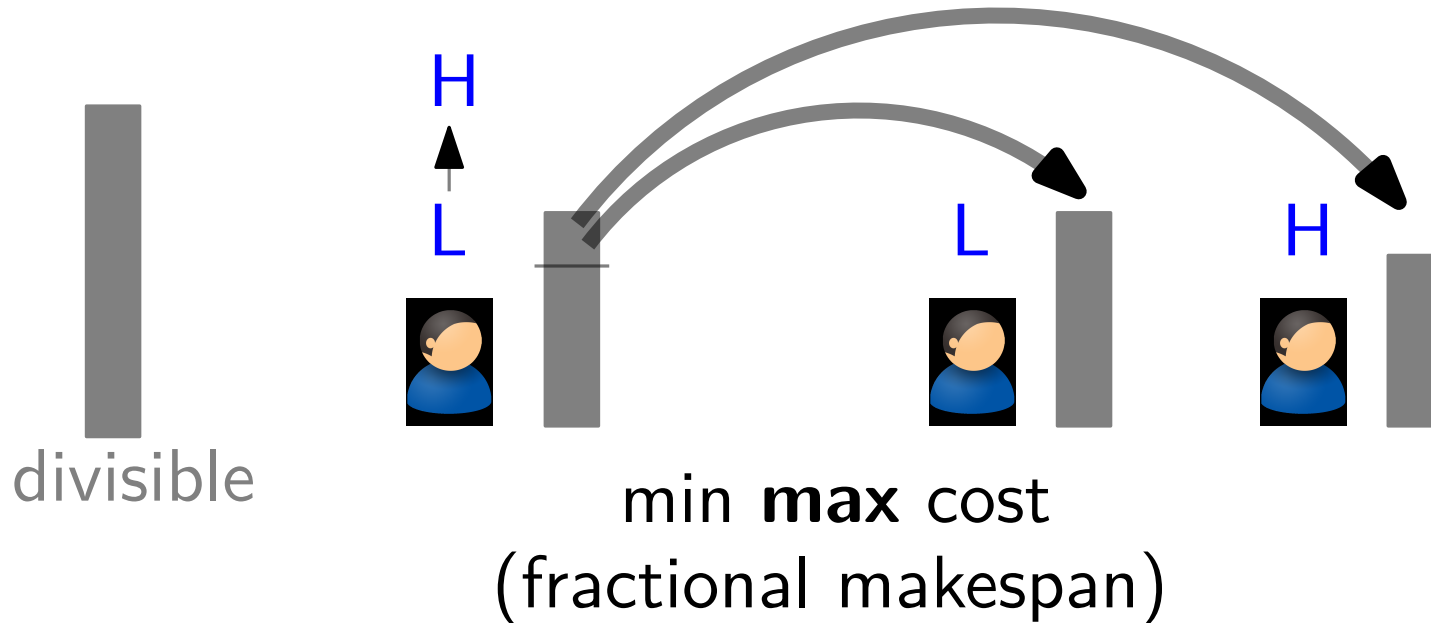
Bounded Influence \Rightarrow Bribeproof



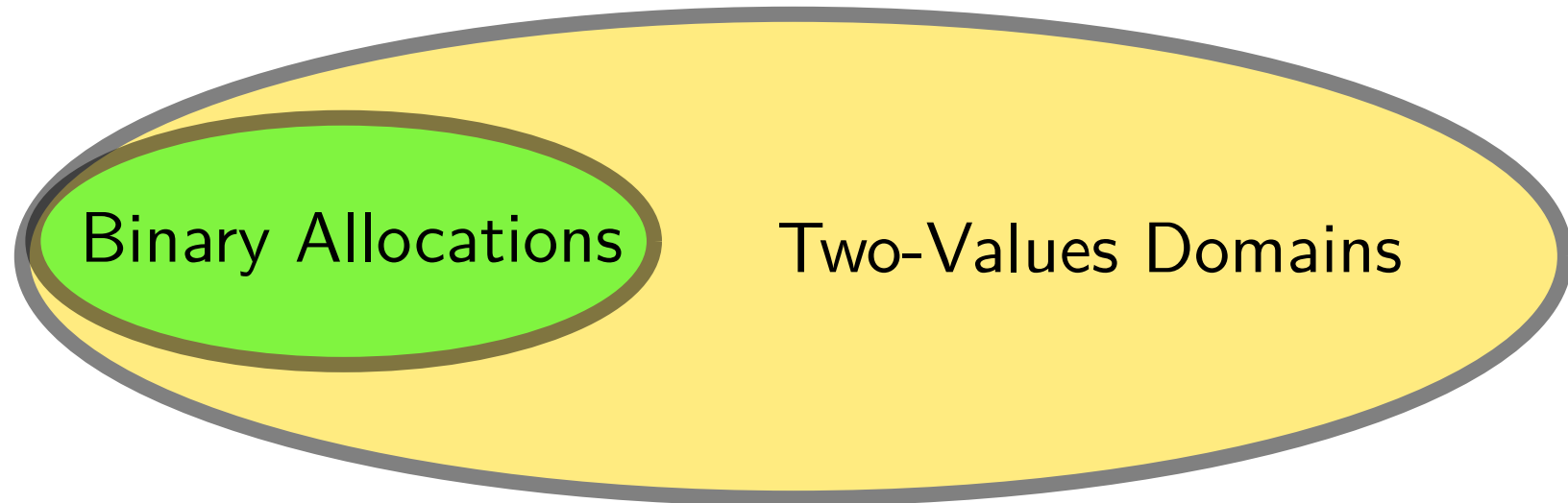
Bribeproof Mechanisms



Bounded Influence \Rightarrow Bribeproof



Bribeproof Mechanisms

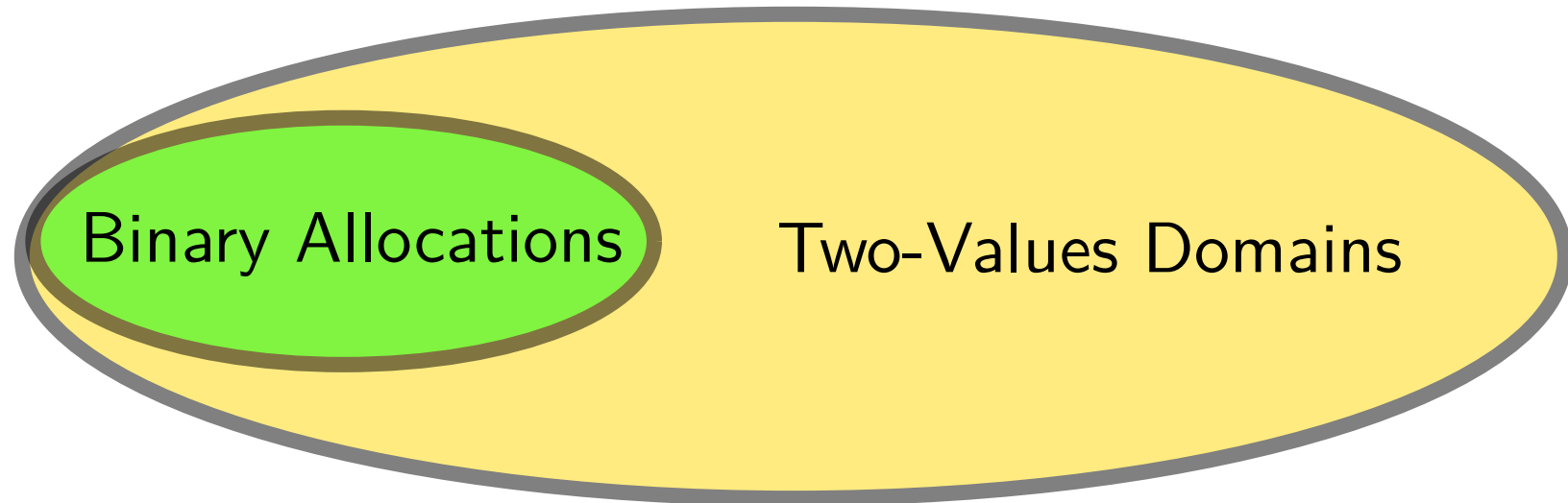


Bounded Influence \Rightarrow Bribeproof



min **max** cost
(makespan)

Bribeproof Mechanisms



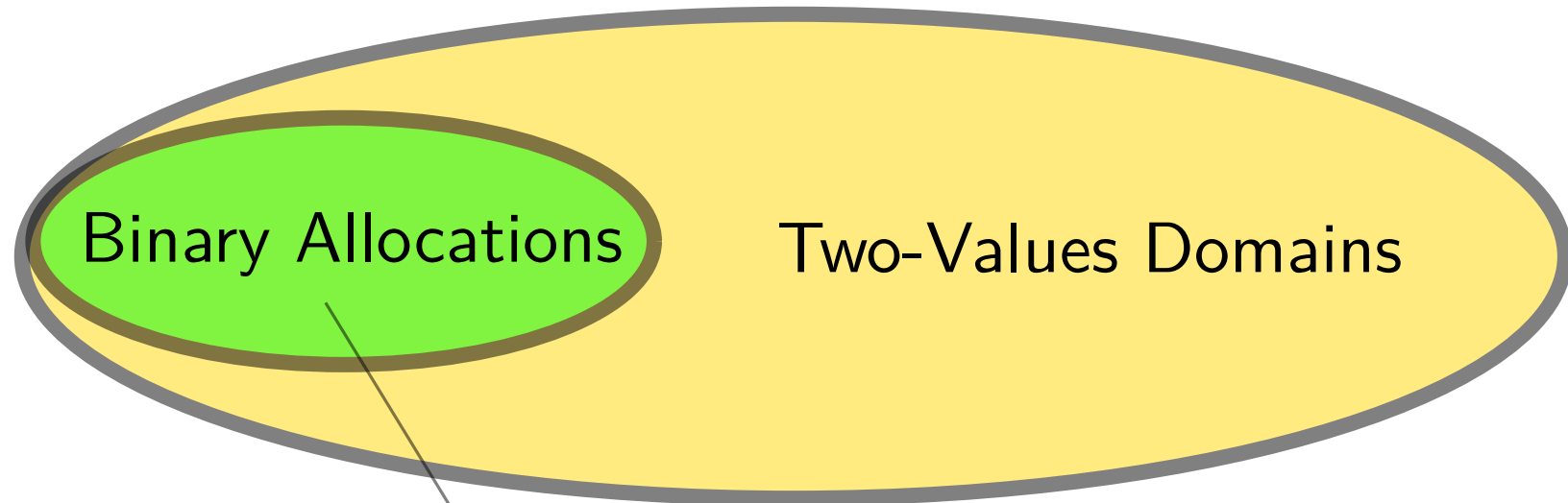
Bounded Influence \Rightarrow Bribeproof

NO



min **max** cost
(makespan)

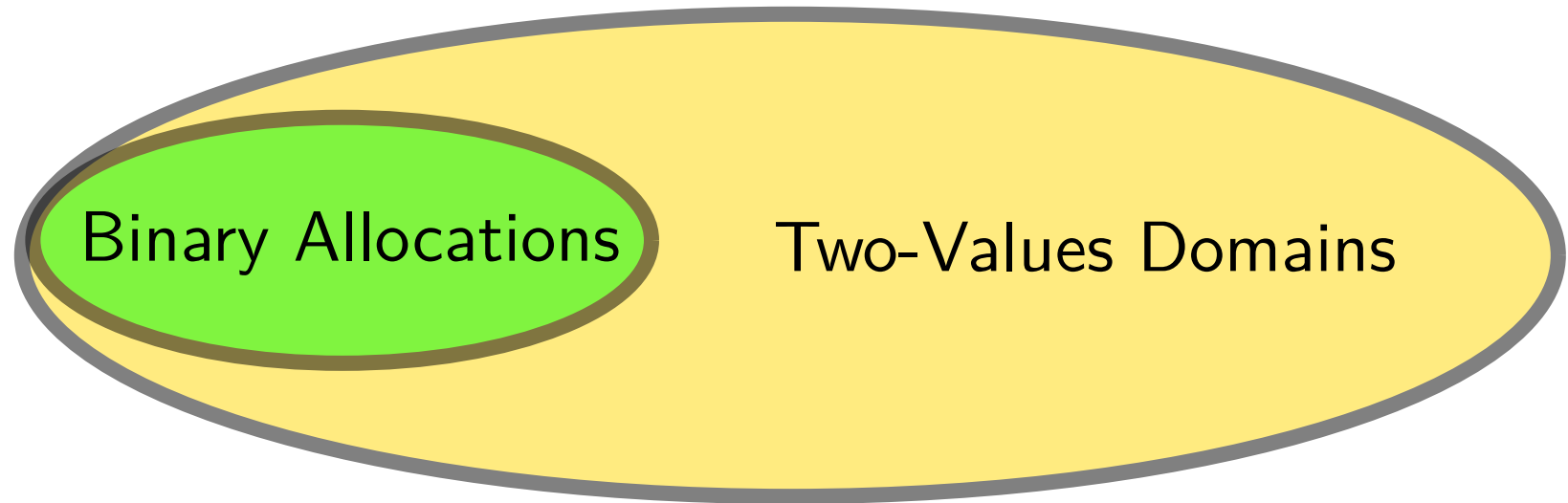
Bribeproof Mechanisms



Bounded Influence \Rightarrow Bribeproof

non-bossy \Rightarrow bribeproof

Bribeproof Mechanisms

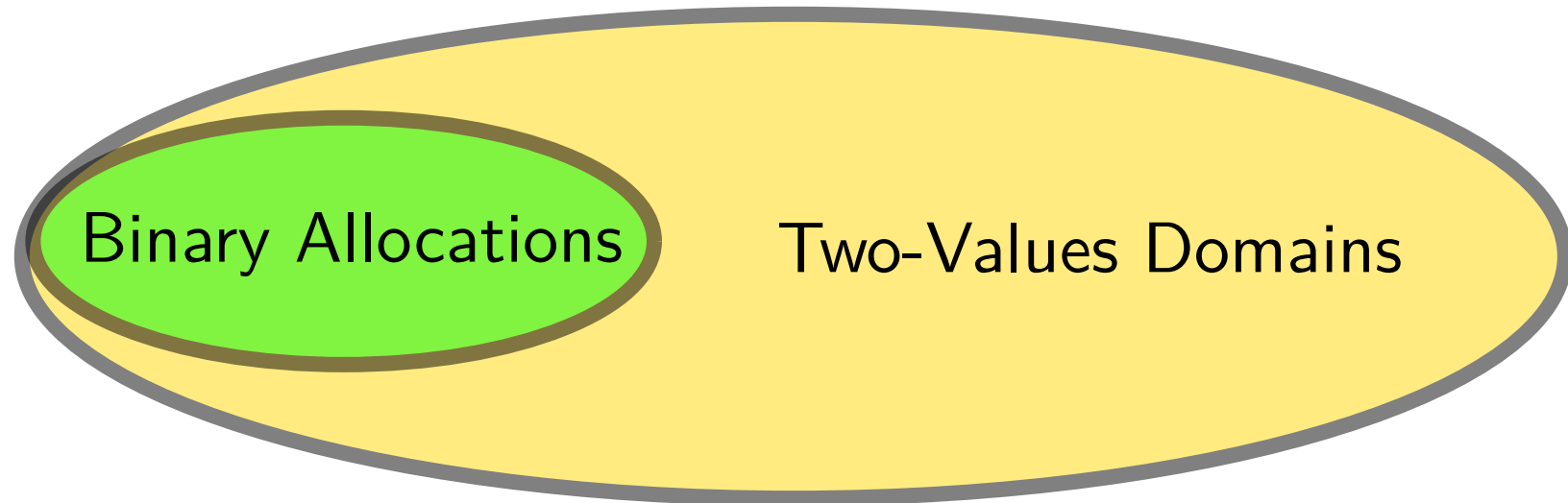


Bounded Influence \Rightarrow Bribeproof

pay

$$work \times \frac{L+H}{2}$$

Bribeproof Mechanisms

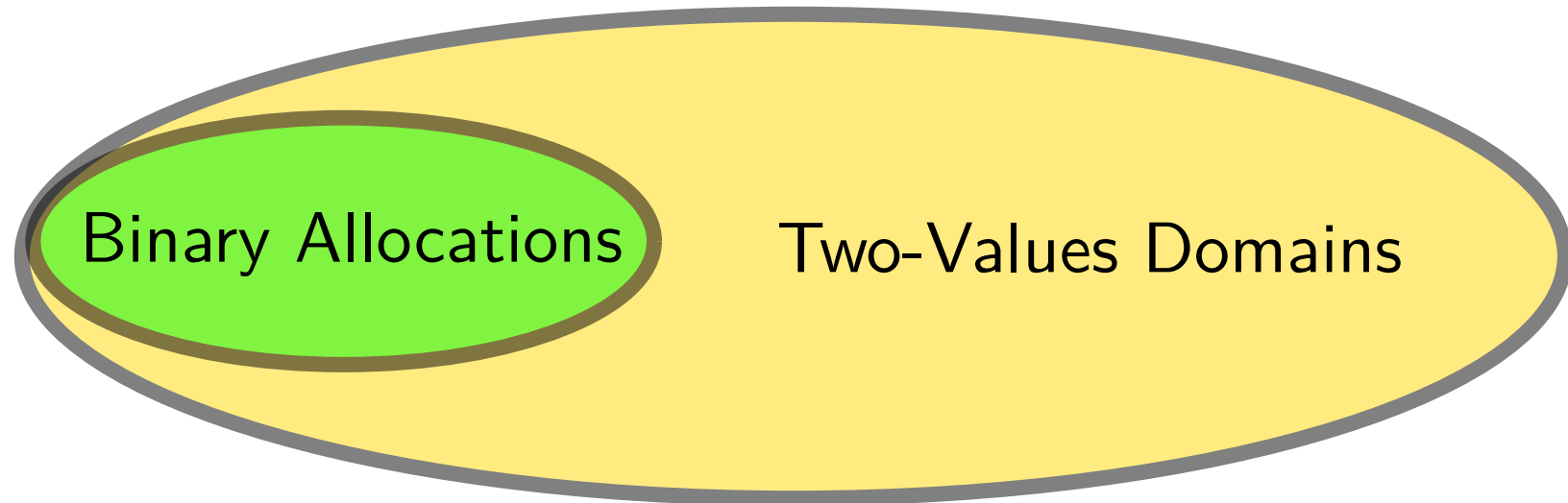


Bounded Influence \Rightarrow Bribeproof

more complex?

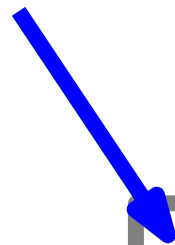
A blue arrow points from the text "more complex?" to a rectangular box. Inside the box is the formula:
$$\text{pay} = \text{work} \times \frac{L+H}{2}$$

Bribeproof Mechanisms



Bounded Influence \Rightarrow Bribeproof

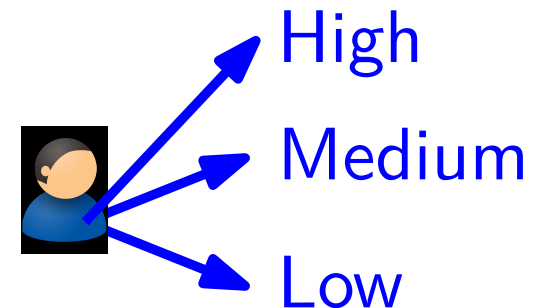
more complex?



pay

$$work \times \frac{L+H}{2}$$

three-values

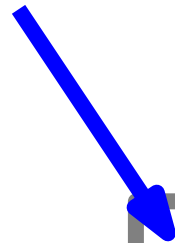


Bribeproof Mechanisms

Binary Allocations

max social welfare \Rightarrow bribeproof

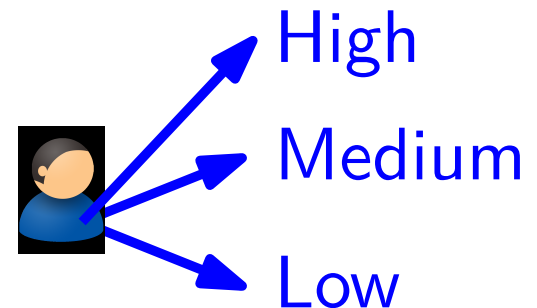
more complex?



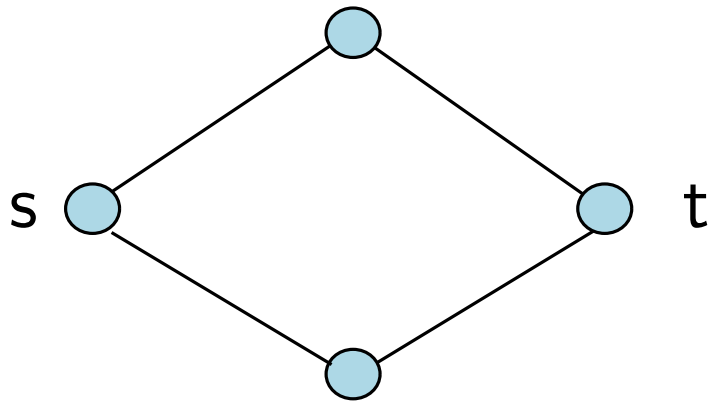
pay

$$work \times \frac{L+H}{2}$$

three-values



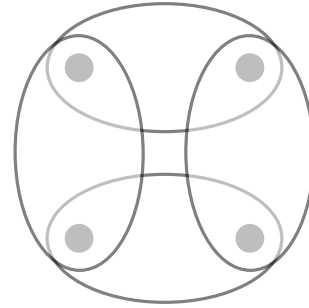
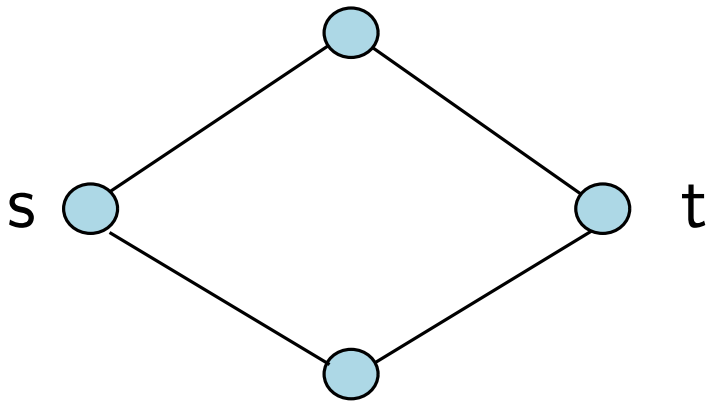
max social welfare



pay

$$work \times \frac{L+H}{2}$$

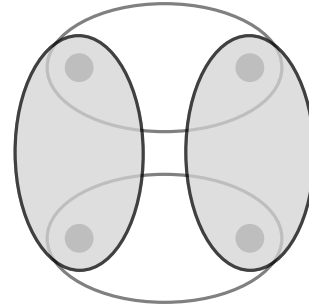
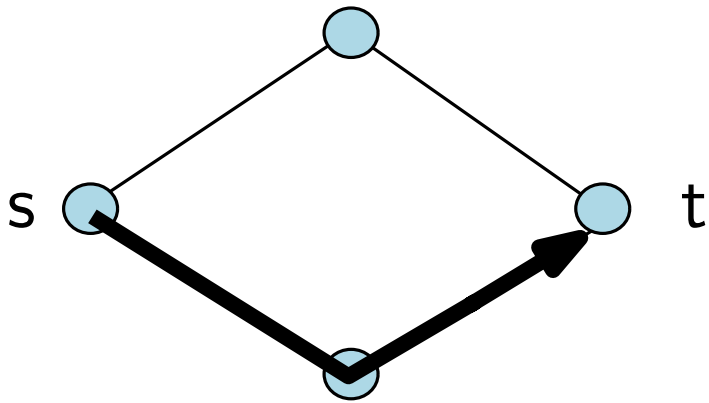
max social welfare



pay

$$work \times \frac{L+H}{2}$$

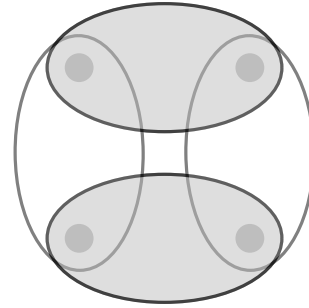
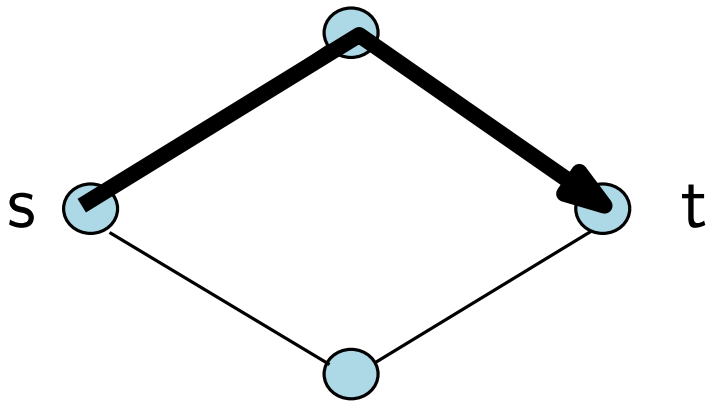
max social welfare



pay

$$work \times \frac{L+H}{2}$$

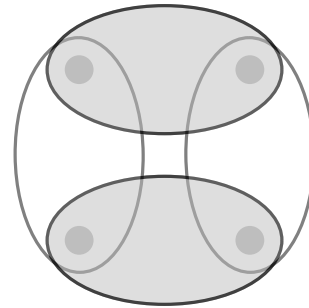
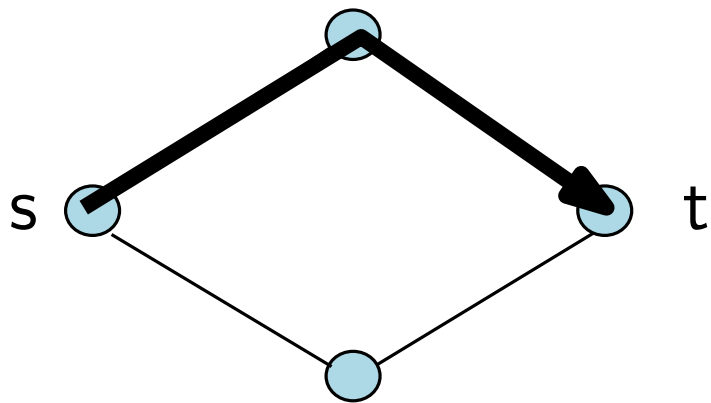
max social welfare



pay

$$work \times \frac{L+H}{2}$$

max social welfare

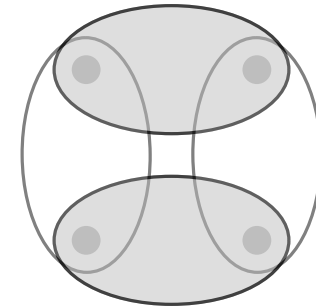
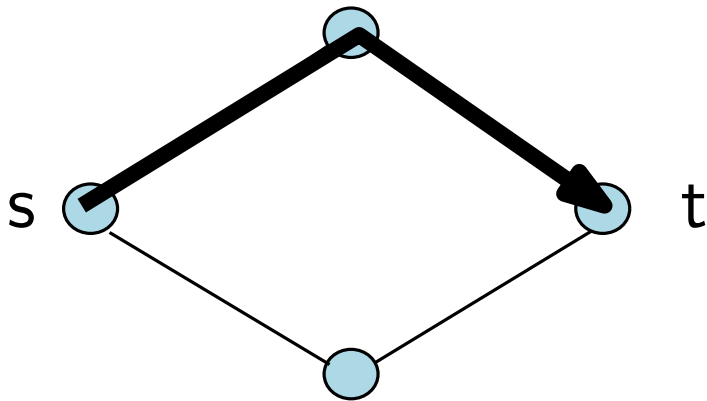


unique bribeproof mechanism

pay

$$work \times \frac{L+H}{2}$$

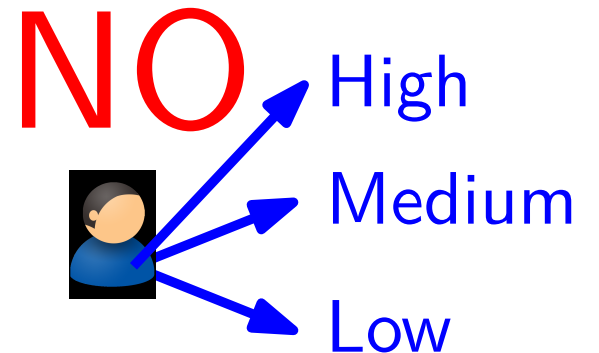
max social welfare



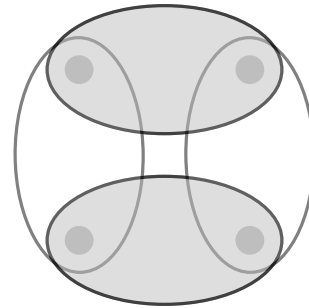
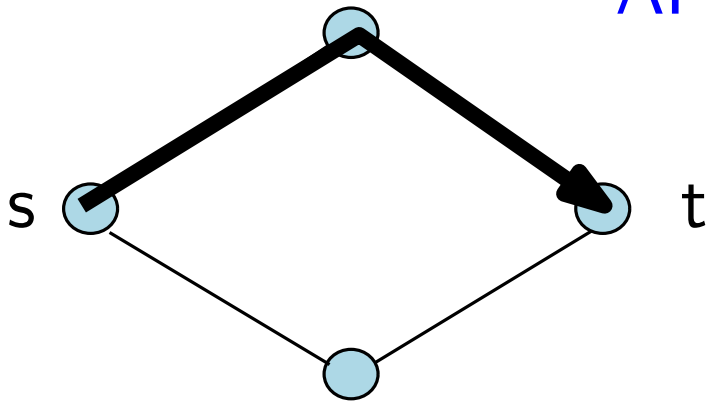
unique bribeproof mechanism

pay

$$work \times \frac{L+H}{2}$$



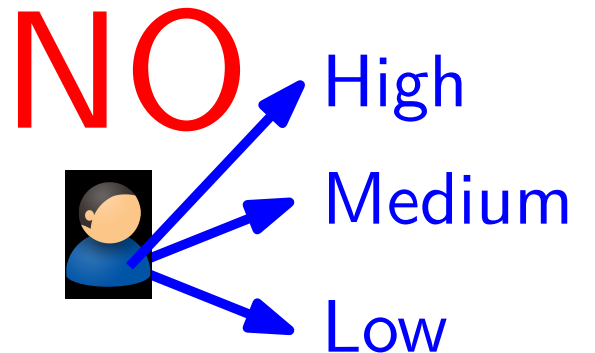
~~max~~ social welfare
APX?



unique bribeproof mechanism

pay

$$work \times \frac{L+H}{2}$$



social welfare

two-values



OPT

“rich”

arbitrarily bad
(Schummer'00)

social welfare

two-values



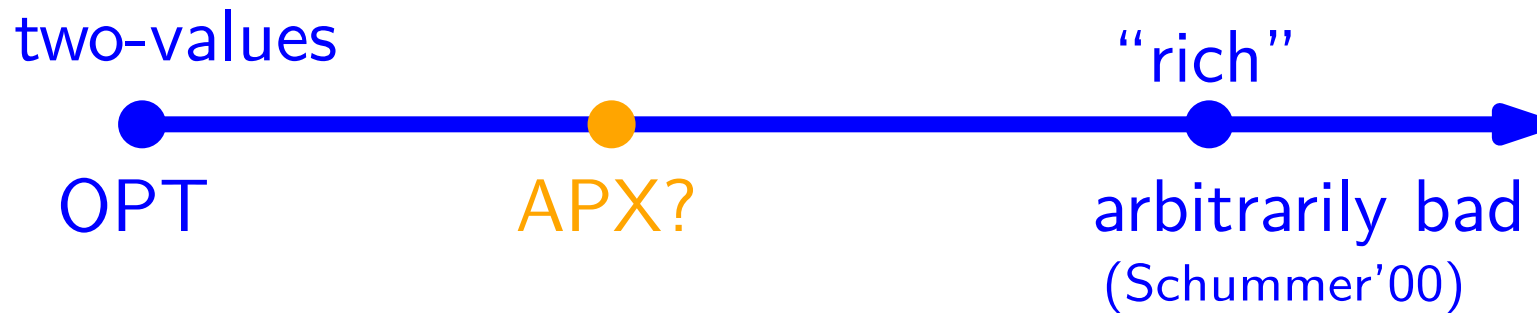
OPT

APX?

“rich”

arbitrarily bad
(Schummer'00)

social welfare



APX shortest path?

Combinatorial Auction (Known Single Minded)?

APX Makespan Related Machines?

Thank You