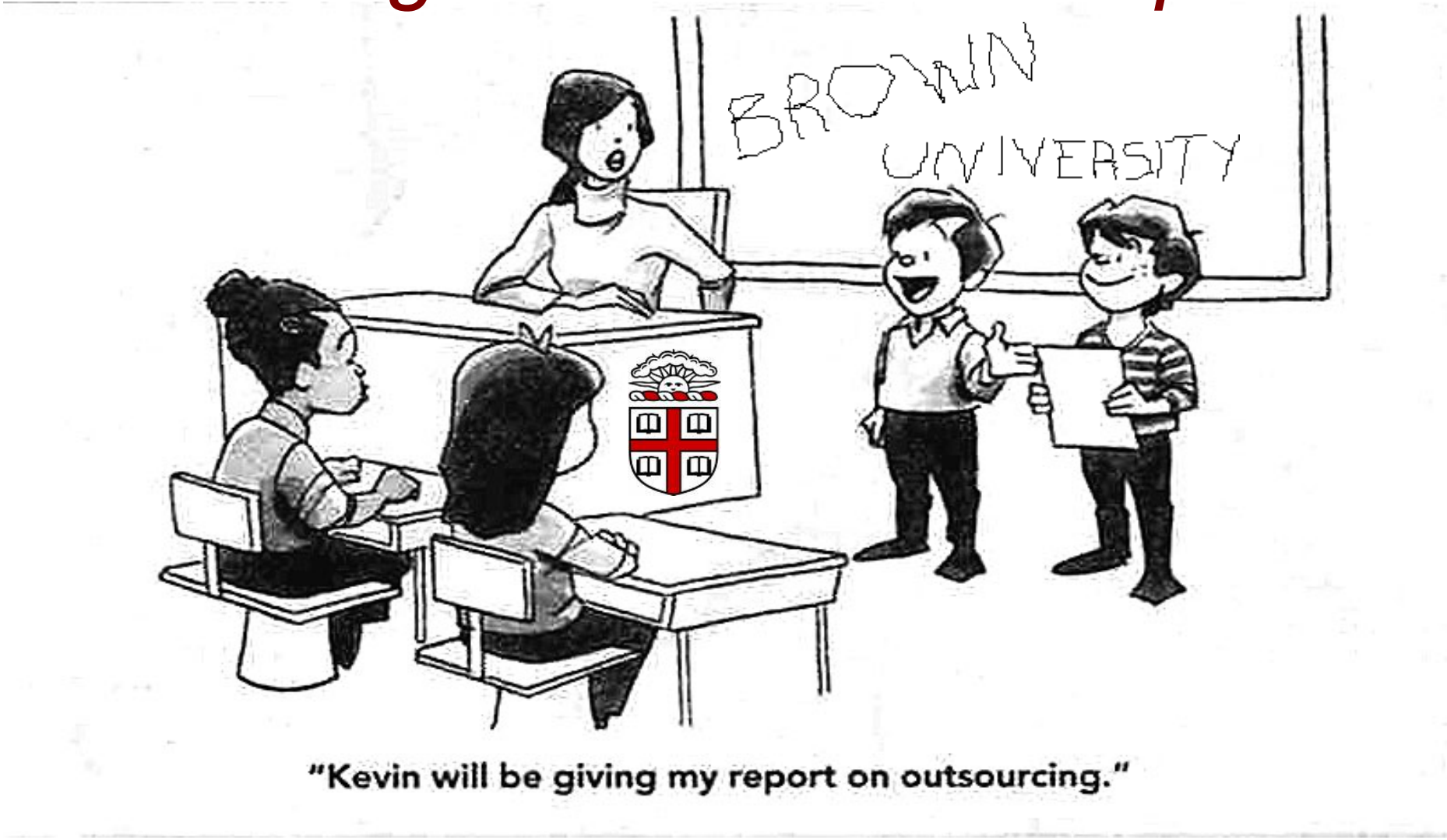
Incentivizing Outsourced Computation



"Kevin will be giving my report on outsourcing."

Mira Belenkiy, Melissa Chase, Chris Erway,
John Jannotti, Alptekin Küpçü, Anna Lysyanskaya

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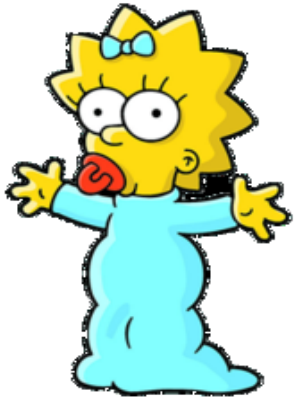
Scenario



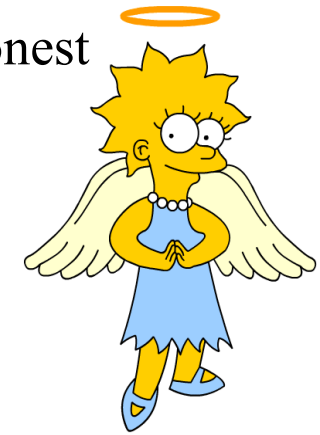





Scenario

Marge (Boss): trusted

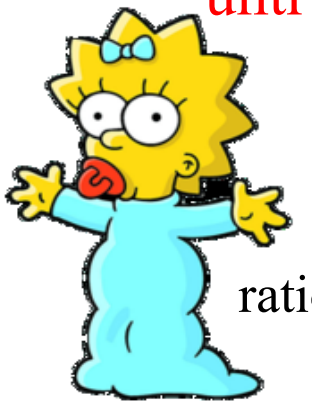
Vacuum clean the house (Job): algorithm + input



honest

lazy

Simpsons (Contractors): untrusted



rational

malicious

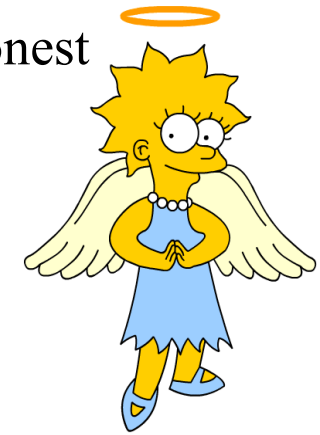
Scenario

Marge (Boss): trusted

Vacuum clean the house (Job): algorithm + input

Goal: Make sure the house is cleaned throughly

honest



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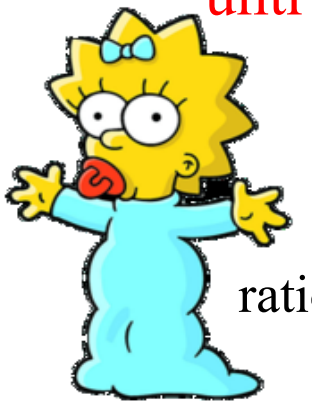

rational

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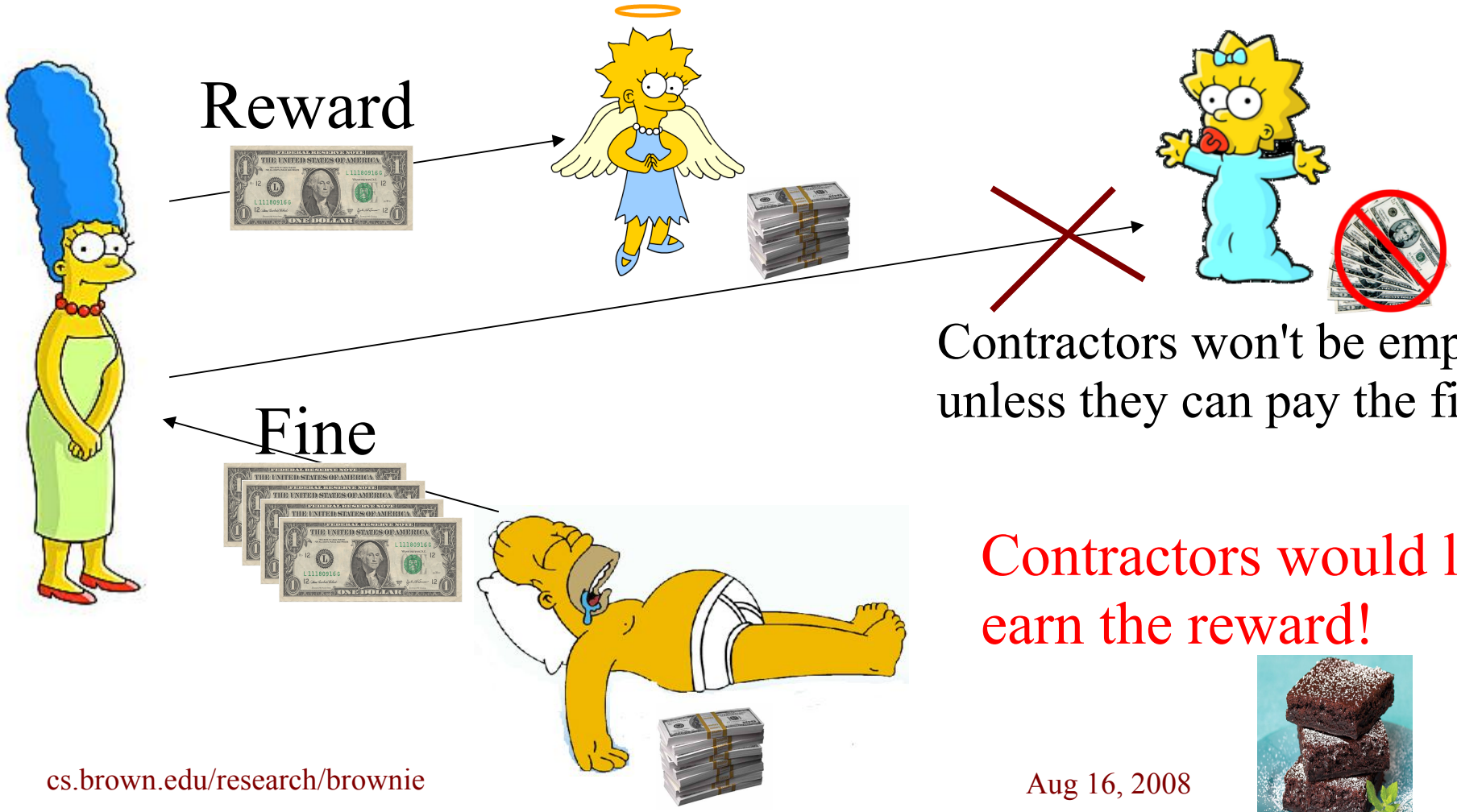
Model

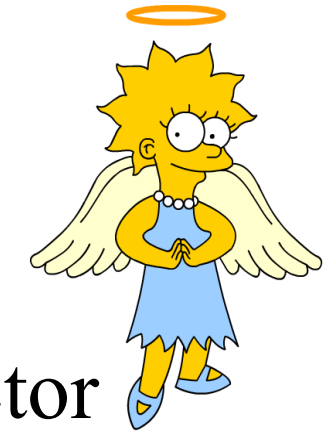

Reward
Fine
Contractors won't be employed unless they can pay the fine
Contractors would like to earn the reward!

Why do the job at all?

Reward 

Fine 

cost of vacuuming the house: cost(1)



utility of an honest contractor
util(1) = reward – cost(1) > 0

participation constraint

Why perform the job correctly?

- Lazy contractors (Homer) can use broom instead of vacuum
- Broom does the job correctly with probability $q < 1$
  - But has lower cost
  - $0 \leq \text{cost}(q) < \text{cost}(1)$

Guaranteed Accuracy

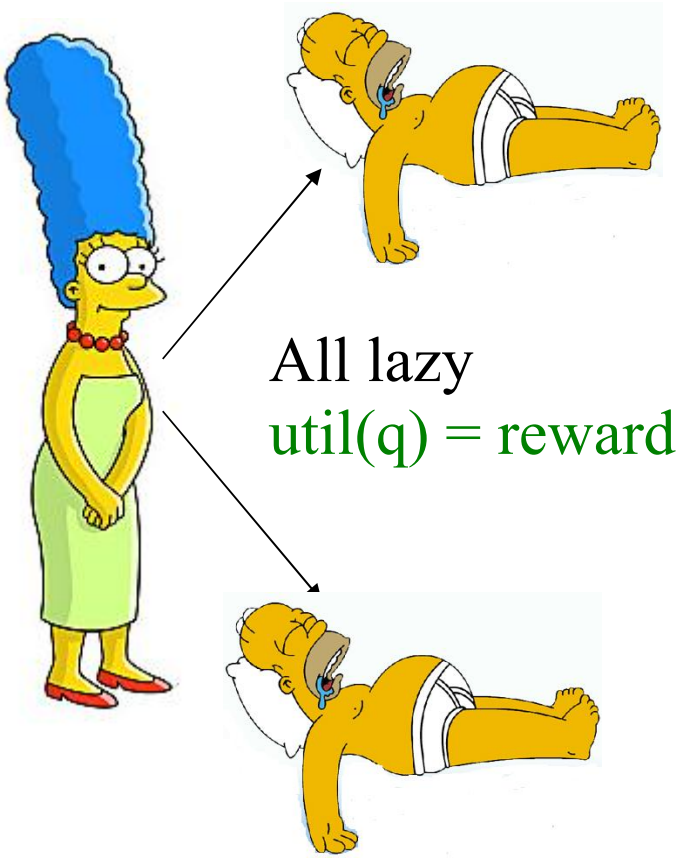
Ideally, everyone should use vacuum instead of broom

Solution: Require hash of intermediate steps (will be different for broom and vacuum) (e.g., plug into electricity)

Employ Multiple Contractors

- Marge needs to make sure the house is really clean, and ready for Christmas
- Give the same job to multiple people
- Marge double-checks the result only when the contractors return different results.

Problem: Two Equilibria

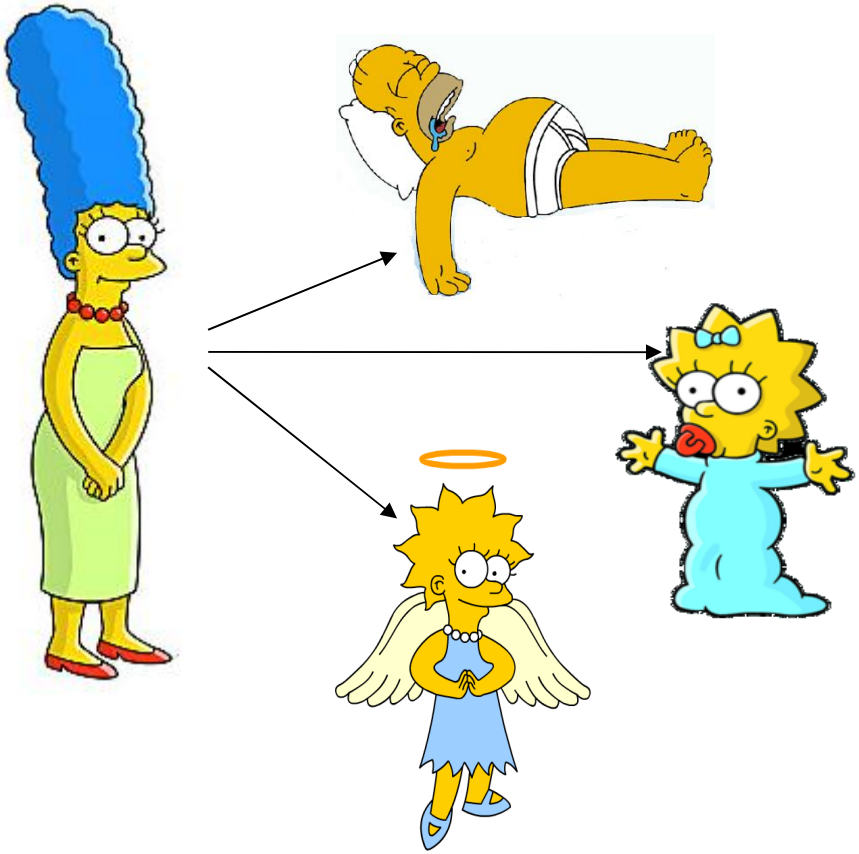


All lazy
util(q) = reward – cost(q)

All honest
util(1) = reward – cost(1)

Clearly util(q) > util(1)

Method 1: Using Honest Contractors to Incentivize Rational Contractors



- If some fraction of contractors are honest
- Set fine/reward using
  - Pr[honest contractor exists in group]
- Then all rational contractors will behave honestly

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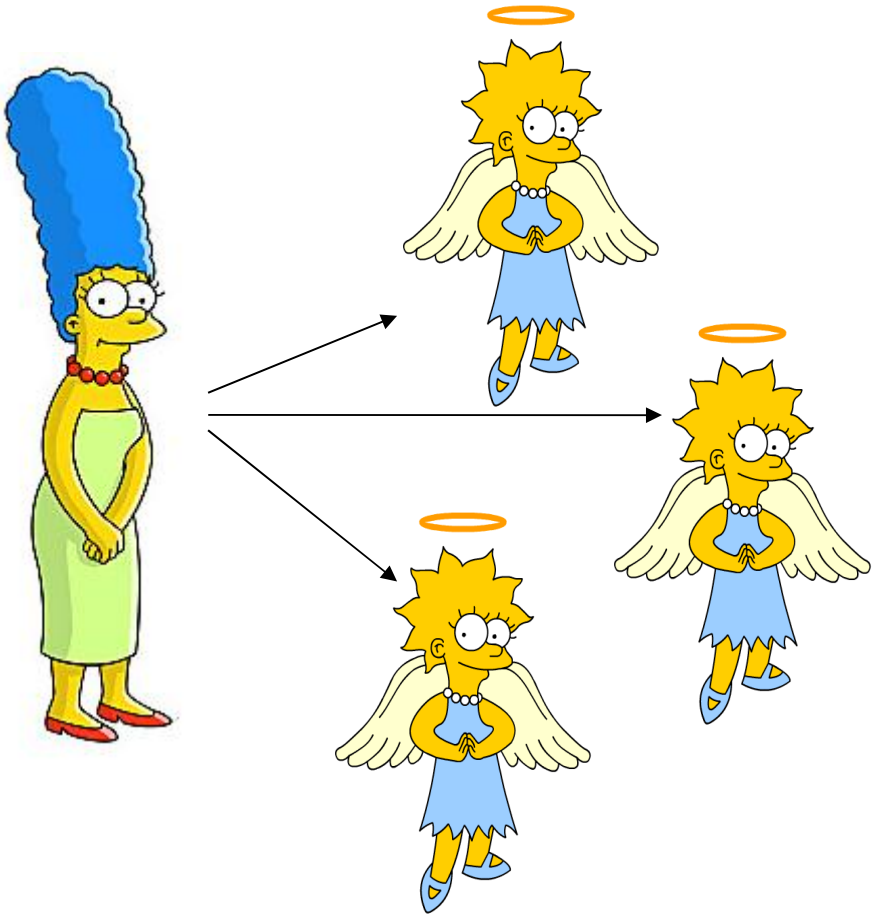

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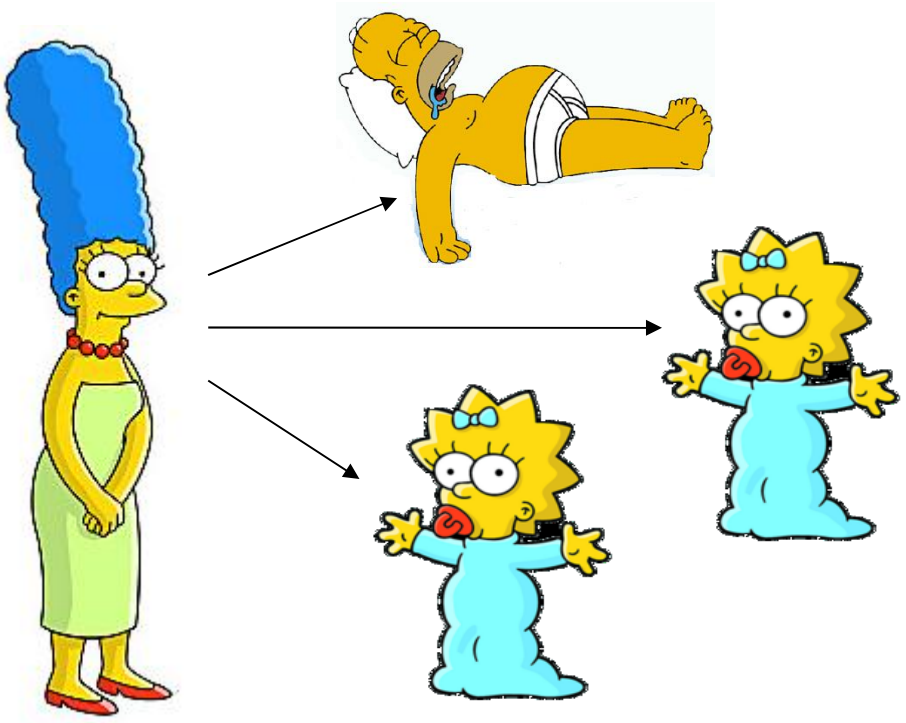
Method 2: Using Bounties to Incentivize Rational Contractors



utility when you catch a cheater
util(1) = reward – cost(1) + bounty

- Offer extra reward (bounty) to whoever catches a cheater
- If cheating gives advantage adv then set
  bounty ≥ reward · adv
- Then all rational contractors will act honestly

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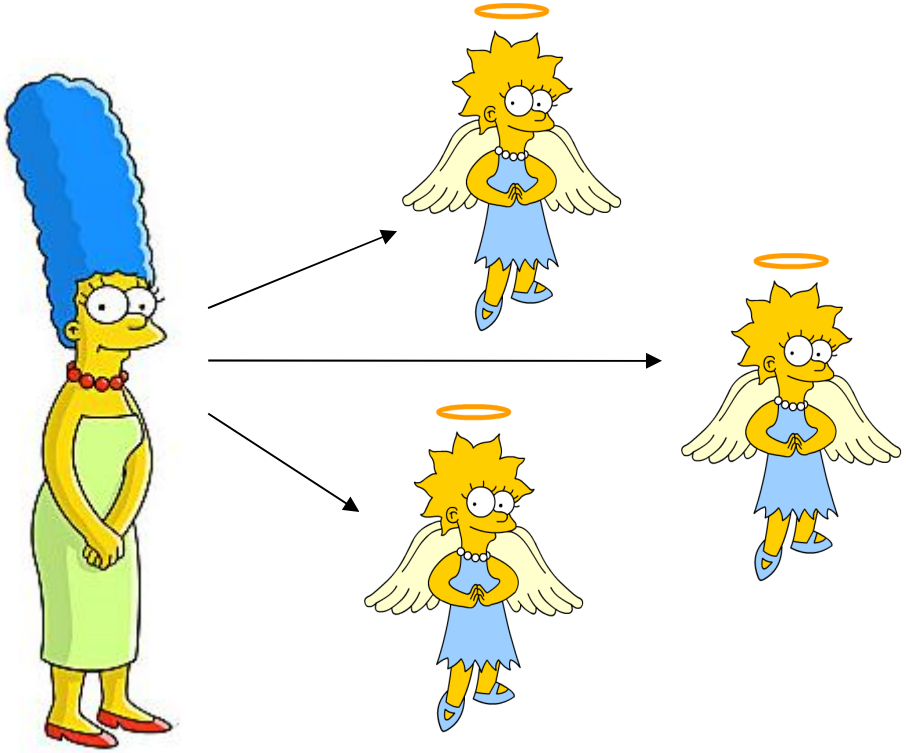

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Malicious Contractors

- Malicious contractors are irrational
  - Bart will break the vases while cleaning
- Bart wants to
  - reduce accuracy of the job
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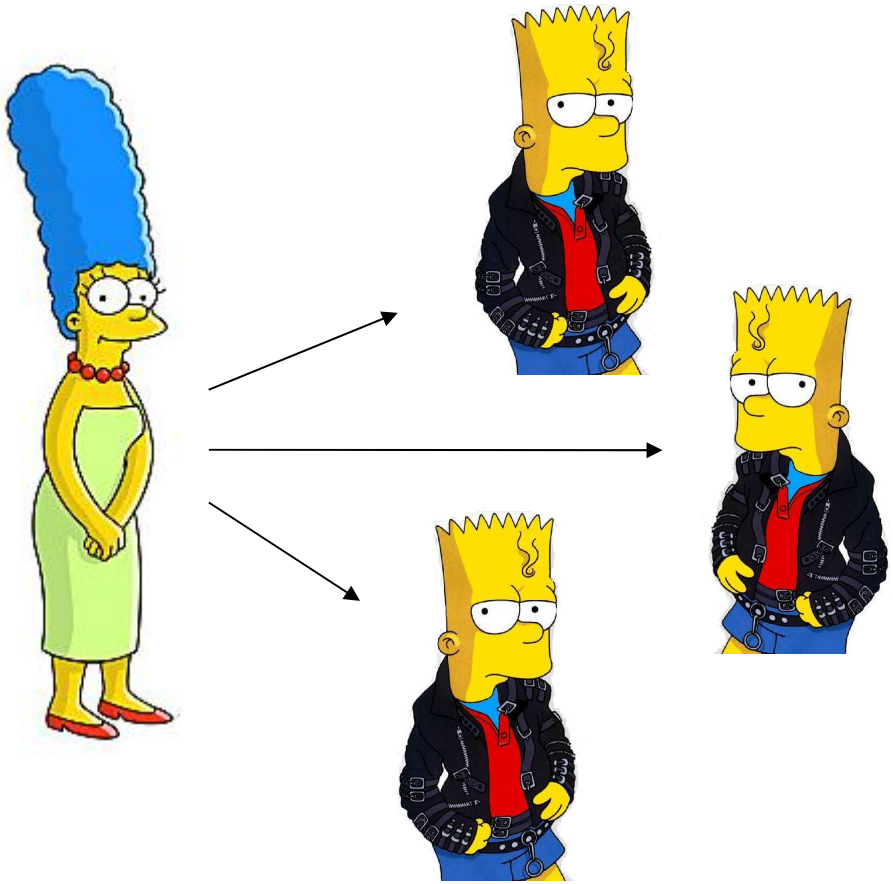
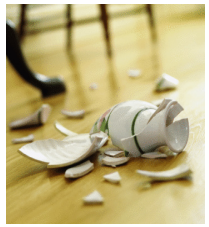
- Malicious contractors are irrational
  - Bart will break the vases while cleaning
- Bart wants to
  - reduce accuracy of the job
  - waste Marge's time
- Needs to keep non-negative balance
  - needs to stay in the system
  - will not be employed if cannot pay the fine

Limited Damage by Malicious Contractors



- We show the accuracy loss and wasted work caused by malicious contractors are very limited.
- Bart needs to clean the house many times so that he can pay the fine when he breaks the vase.



Conclusion

- Ways for Marge to employ untrusted family members to throughly clean the house using a vacuum
- Limit damage caused by malicious Bart, and force him to clean the house most of the time.
- Best of all, at Brown University, our Brownie group rewards its members who clean after the meetings with

Full presentation this Friday @ Seattle

NetEcon 08

cs.brown.edu/research/brownie

THANKS!