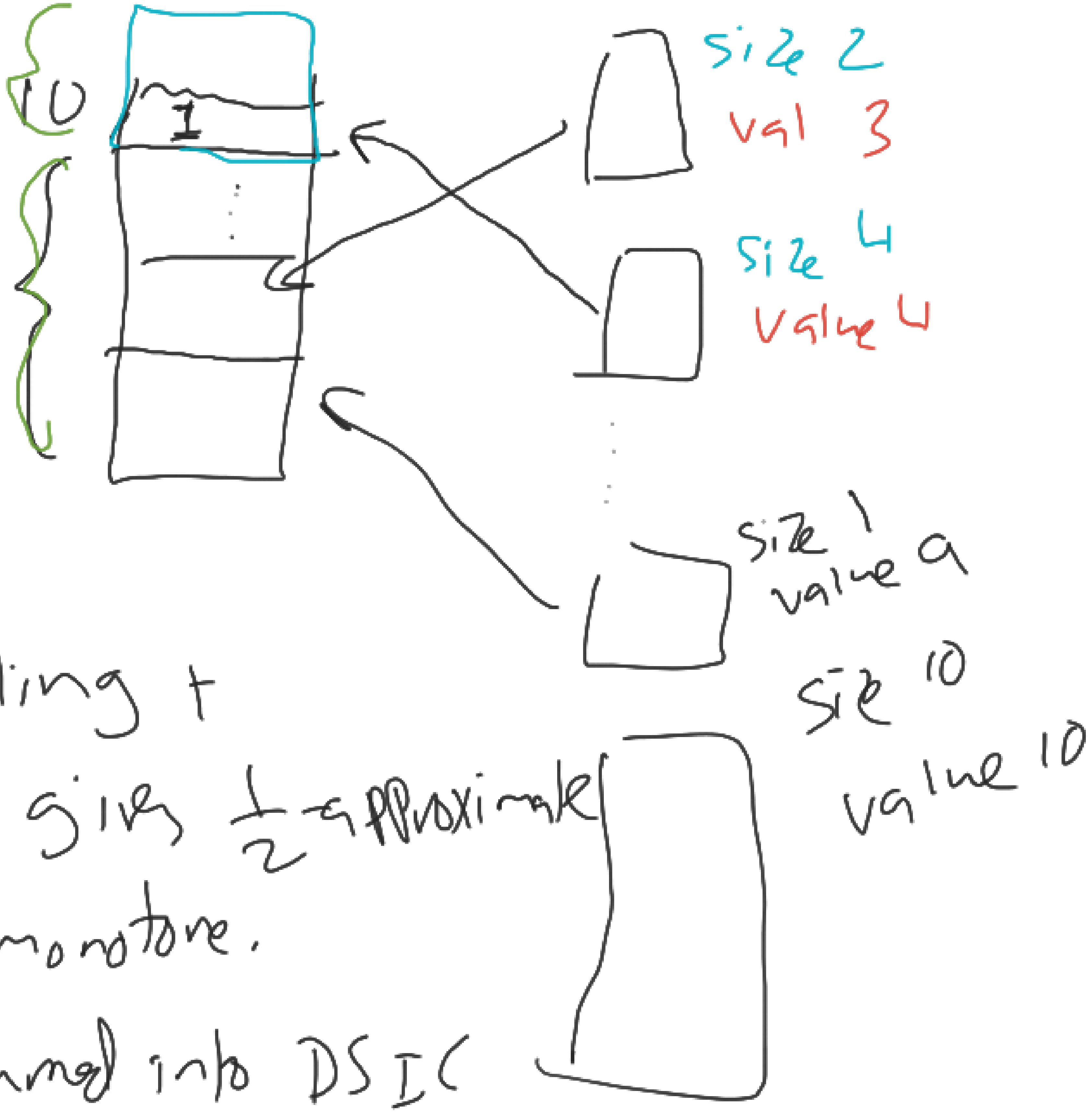
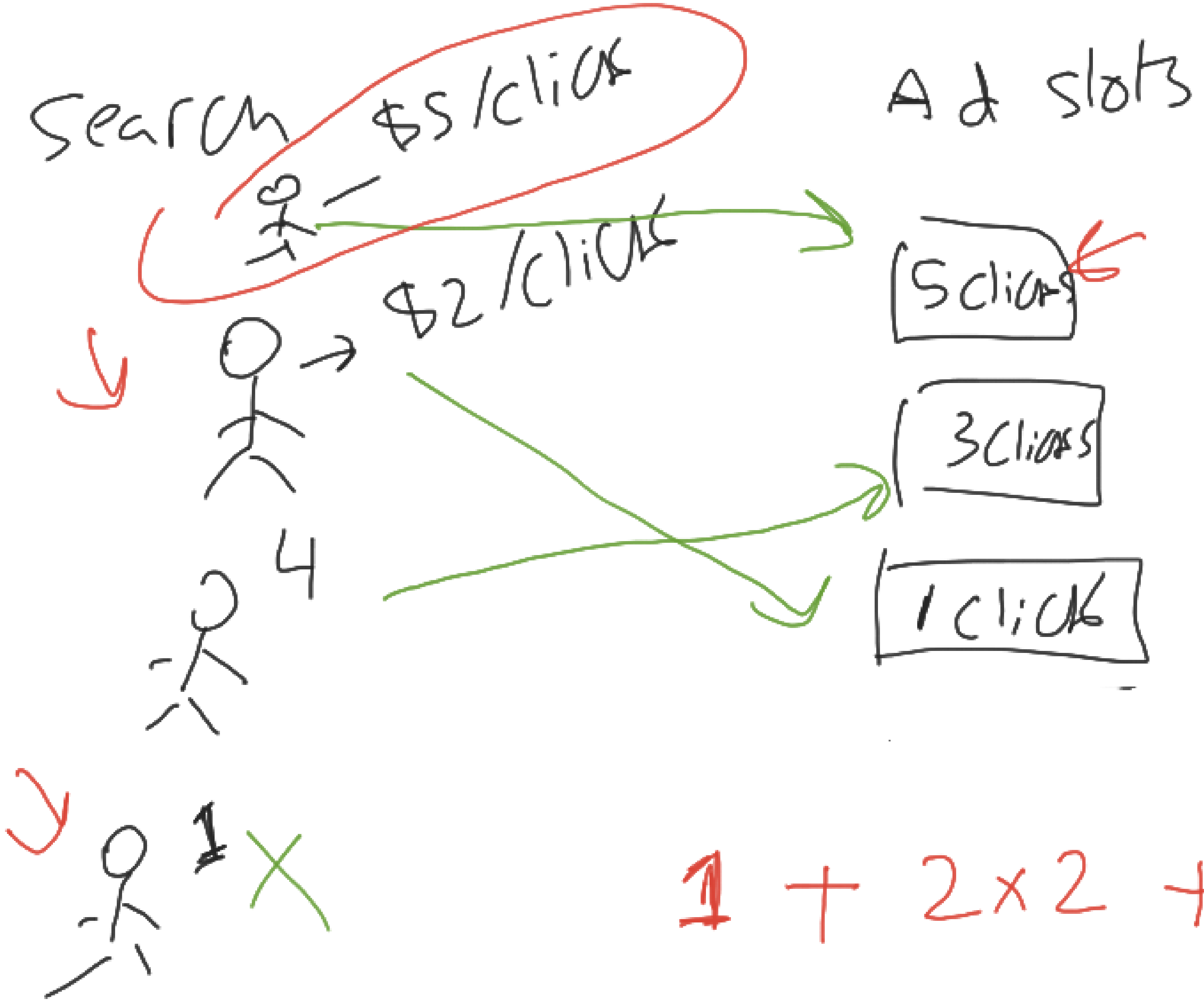


Greedy waterfilling +
Case analysis gives $\frac{1}{2}$-approximate solution, and is monotone.

Therefore, can be turned into DSIC by charging critical values

More General: Single-parameter Settings

E.g. Sponsored search

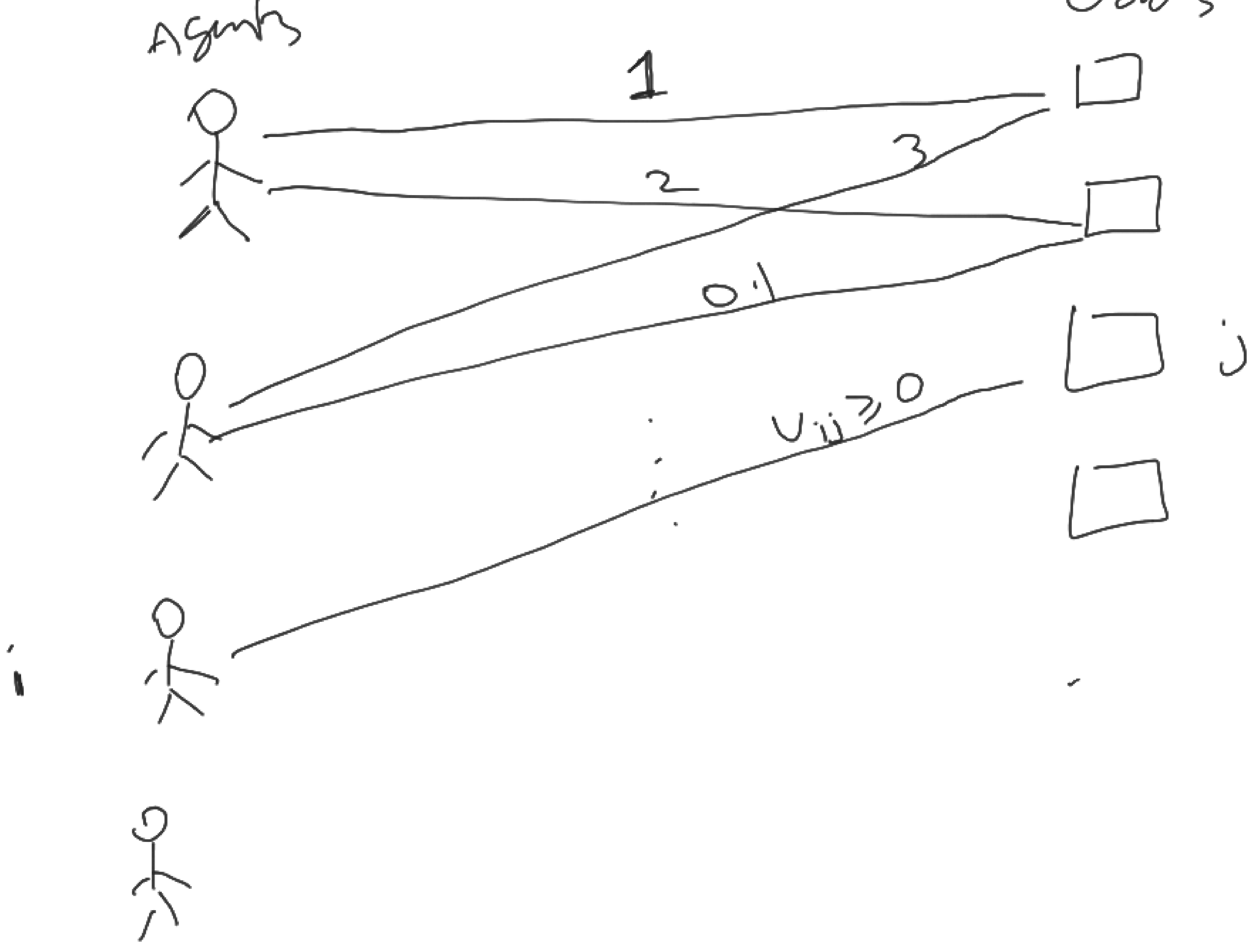


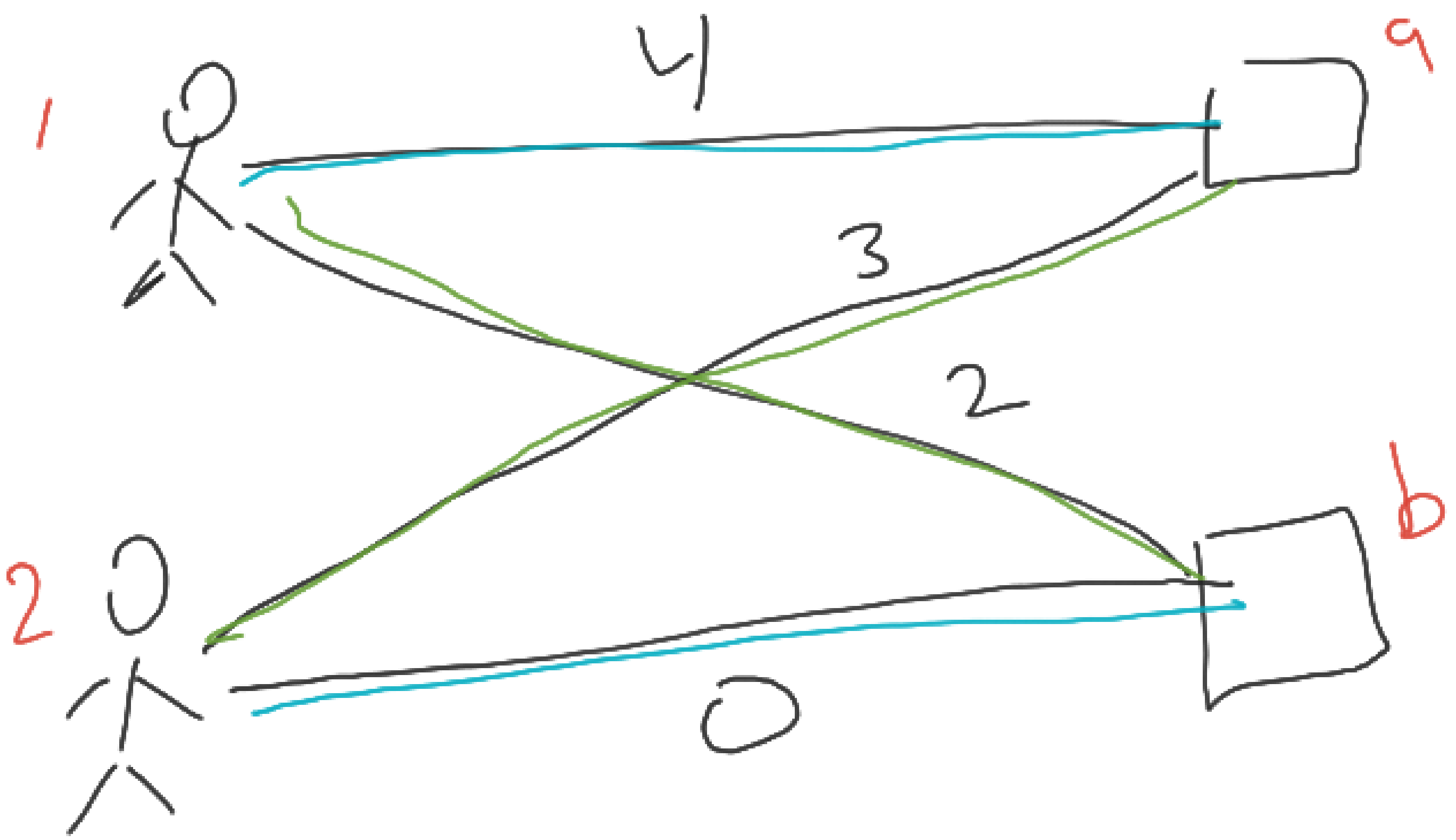
$1 + 2 \times 2 + 4 \times 2$

$= 13$


stuff
$v_i = b_i$
bid

Mech. Design: Multiparameter settings



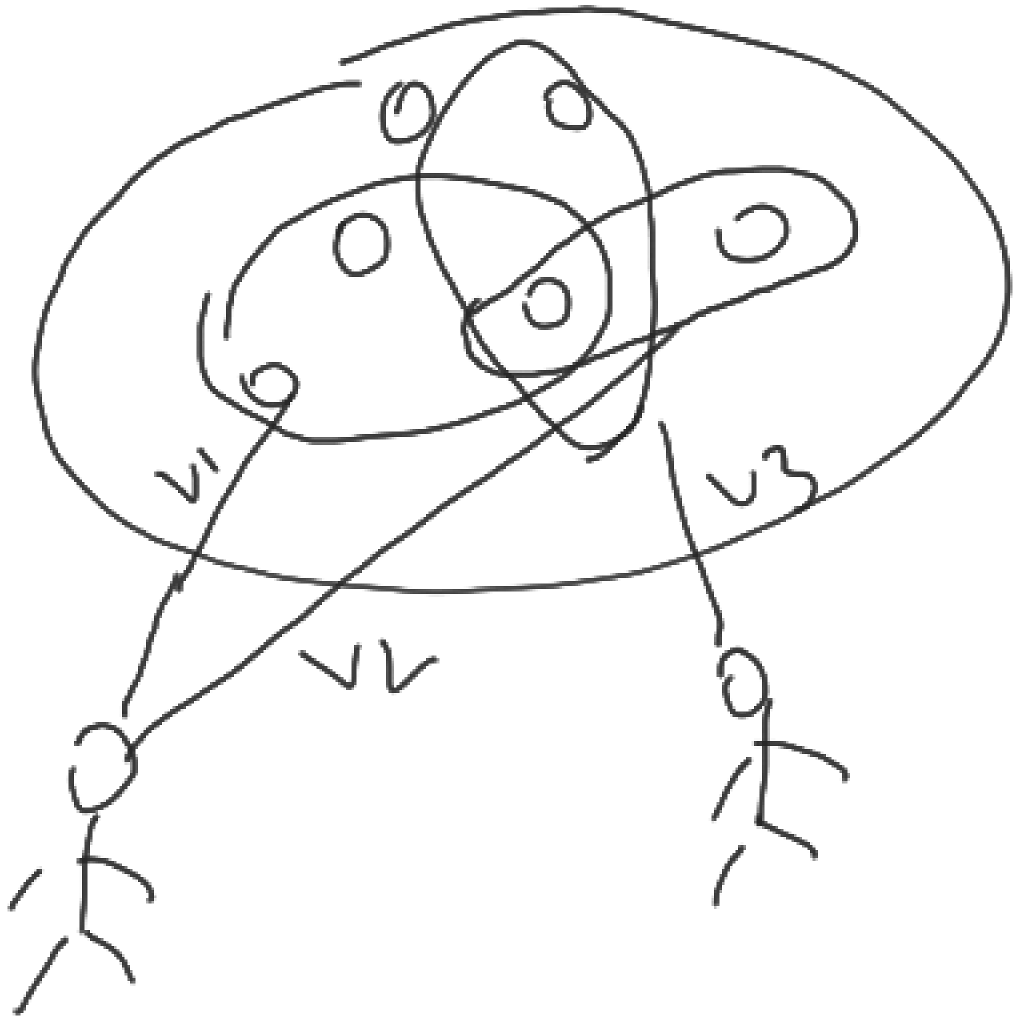


Max-weight bipartite matching.

Externality (i) = How much he reduces other's utility by participating.

Externality (1) = 0

Externality (2) : 4-2 = 2



$$\text{util}(i) = v_i(\text{what happens}) - p_i$$

$$= v_i - \left(\max_{\text{outcome}} \sum_{j \neq i} v_j(\text{outcome}) - \sum_{j \neq i} v_j(\text{what happens})\right)$$

externality

= my value if I stay − (val of others if I leave − val of others if I stay)

⇓ total welfare

= my val if I stay + val of others if I stay

− val of others if I leave

cont of my control

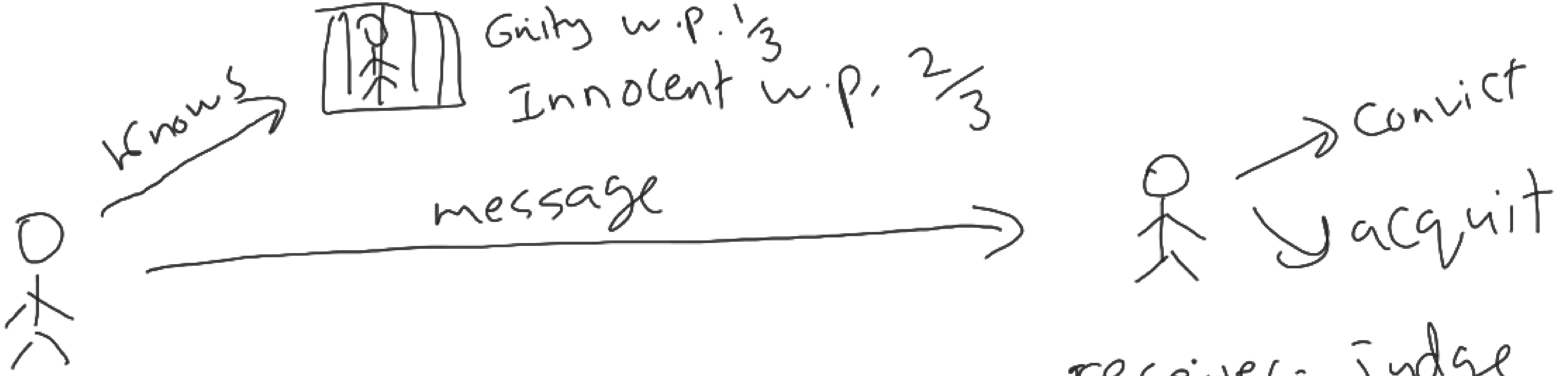
- This is called the Vickrey-Clarke-Groves mech.
- works very generally to maximize welfare in dominant strategies.
- Reduces MD to Algorithm design.
- Research Area: what if the Algorithmic problem is NP-complete, but we have a decent heuristic.
  - Tricky. Long story.

Other things to look at:

- Revelation principle
- other objectives: revenue, ...

Persuasion

Simplest setting : single-receiver (Bayesian persuasion)



sender: Prosecutor

util 1 if judge convicts
util 0 if judge acquits

receiver: judge

util 1 for "getting it right"
util 0 o.w.

Prosecutor's policy for sending messages is known to judge.

Some natural policies:

- Honesty: If Guilty say "convict"
  If Innocent say "acquit"

  $util(judge) = 1$

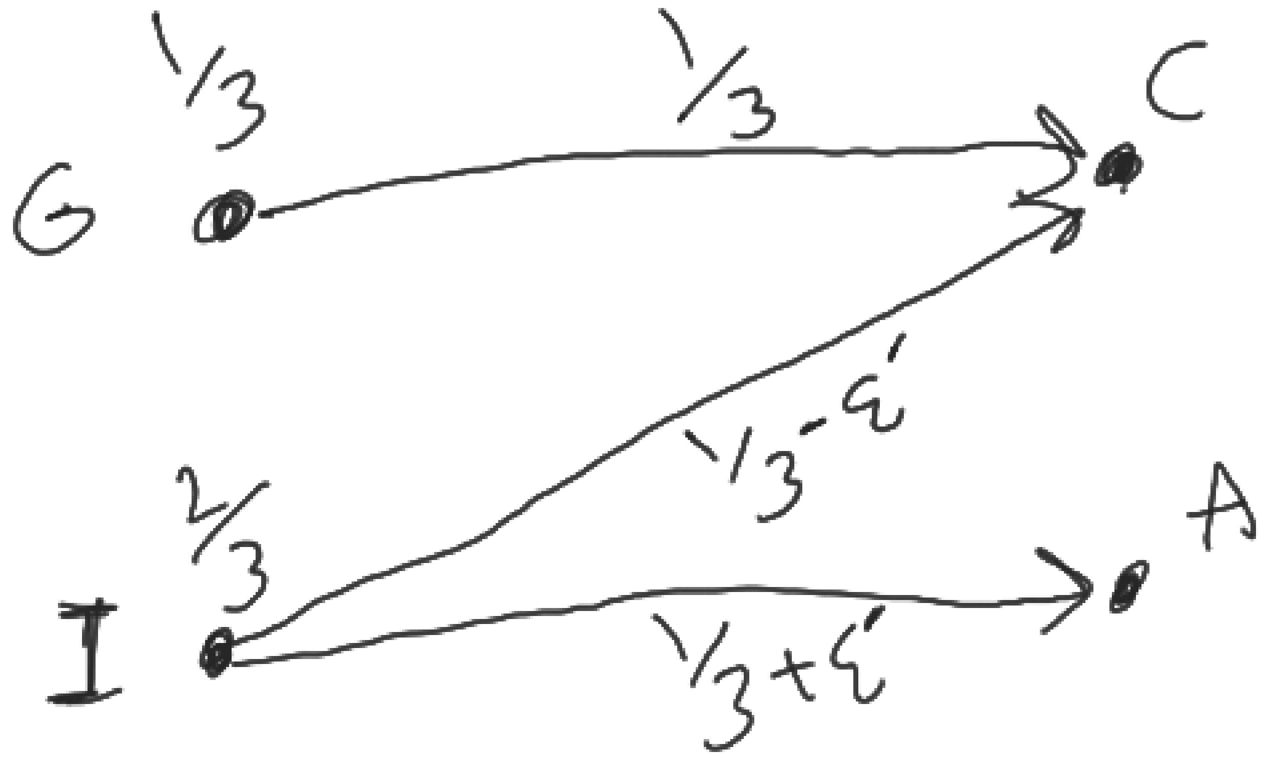
  $E[util(prosecutor)] = 1/3$

- Say nothing: Judge will always acquit
  always say "convict"

  $E[util(judge)] = 2/3$

  $util(prosecutor) = 0$

- Be selectively honest as follows: - If Guilty say "convict"
  - If Innocent, flip a slightly biased coin and
    - say "convict" w.p. $\frac{1}{2}-\varepsilon$
    - say "acquit" w.p. $\frac{1}{2}+\varepsilon$



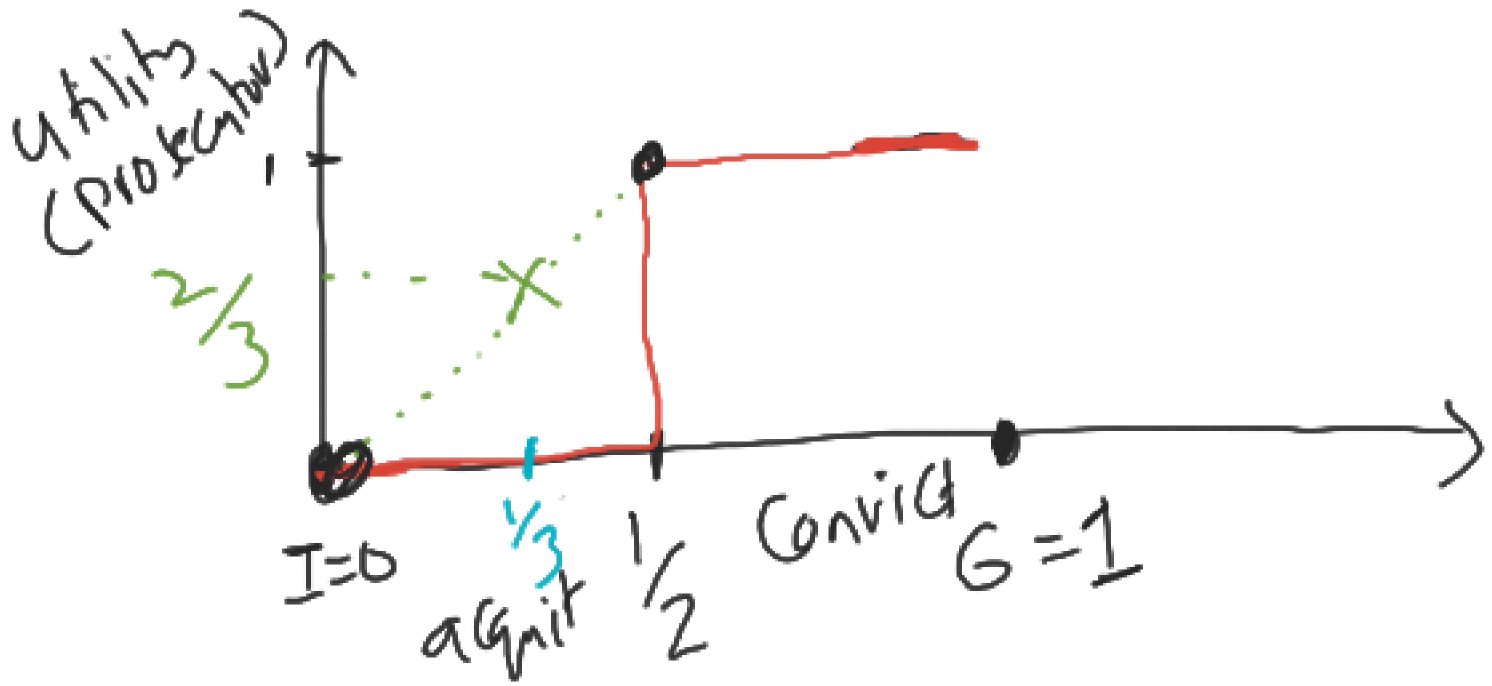
util(judge) $= \frac{2}{3}+\varepsilon'$

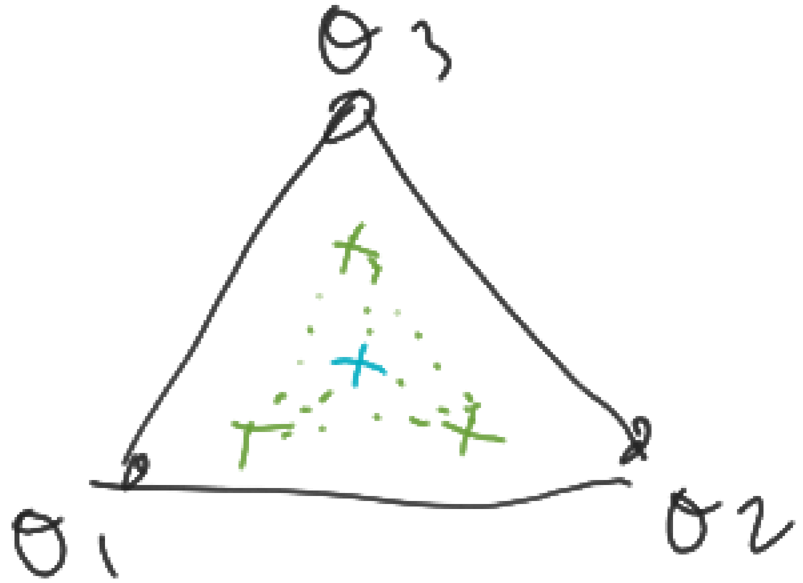
util(prosecutor) $= \frac{2}{3}-\varepsilon'$

If judge sees "convict": he concludes that defendant is more likely guilty than innocent, so I will actually convict

If sees "acquit": concludes definitely innocent, so will acquit.

whats really happening :





$$\frac{1}{3} = \frac{2}{3} \times \frac{1}{2} + \frac{1}{3} \times 0$$

prob of "convict"

prob[G | "convict"]

Pr(acquit)

Pr[G | "acquit"]

This works in general, can be turned into persuasion algorithm using linear programming.

More general persuasion settings: Multiple receivers

e.g. routing.

with multiple receivers, gets tricky. Status unsettled.

2-player Zero-Sum Games via security games

Each player's win is another's loss

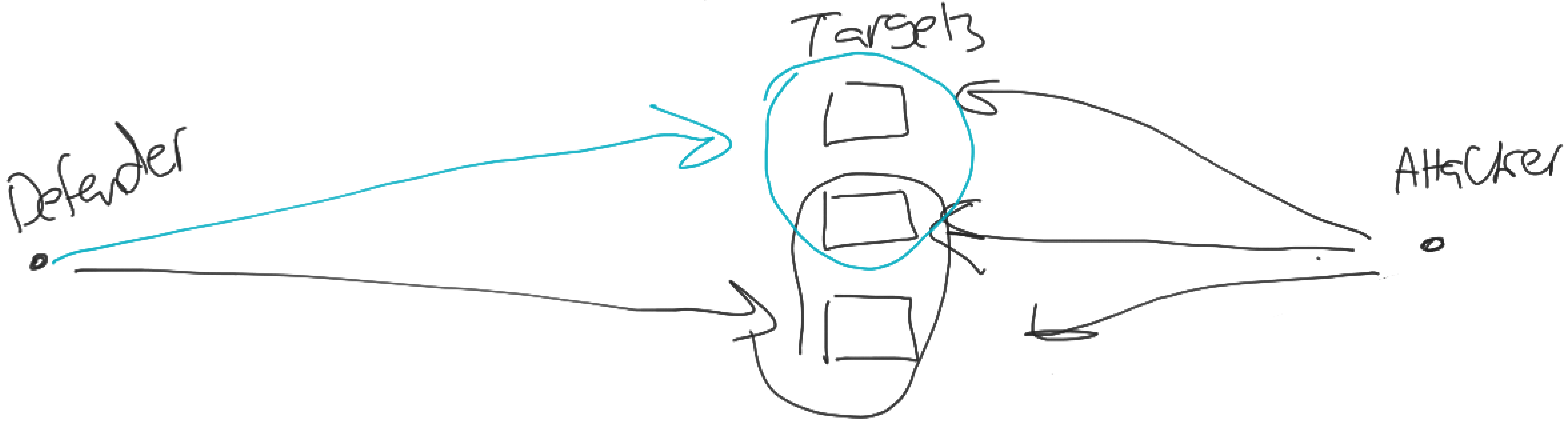
e.g. Rock paper scissors

	R	P	S
R	0,0	-1,1	1,-1
P	1,-1	0,0	-1,1
S	-1,1	1,-1	0,0

$\approx$

0	-1	1
1	0	-1
-1	1	0

security game example



Each target has different importance. There are two numbers for each target t

$u_d^+(t)$: utility of defender if t is attacked while protected

$\vee$

-ve → $u_d^-(t)$: " " " " " " " " unprotected.

Example: Three targets a, b, c.

$$u_d^+(a) = u_d^+(b) = u_d^+(c) = 0$$

$$u_d^-(a) = -2, \quad u_d^-(b) = u_d^-(c) = -1$$

Attacker

Defender	a	b	c
ab	0	0	-1
ac	0	-1	0
bc	-2	0	0

Guesses for attacker strategies

$(0, 0.5, 0.5)$

$(\frac{1}{2}, \frac{1}{4}, \frac{1}{4})$

$(\frac{1}{3}, \frac{1}{3}, \frac{1}{3})$

scenario 1:

Instead of assuming simultaneous move, lets suppose defender picks their mixed strategy first, attacker responds optimally. (Defender moves first)

let $x = (x_{ab}, x_{ac}, x_{bc})$ be probabilities for defender

$$x_{ab} + x_{ac} + x_{bc} = 1$$

$$x_{ab}, x_{ac}, x_{bc} \geq 0$$

If attacker attacks a, defender utility will be:

$$-2x_{bc}$$

If attacks b, defender util is $-x_{ac}$.

If attacks c

$$-x_{ab}$$

Three options: $-2x_{bc}$, $-x_{ac}$, $-x_{ab}$

picks the minimum!

we need to choose $\vec{x}$ to make all these numbers equal.

$$x^*_{bc} = \frac{1}{5} \qquad x^*_{ab} = x^*_{ac} = \frac{2}{5}$$

protecting door a w.p. $\frac{4}{5}$

protecting doors b, c, w.p $\frac{3}{5}$ each.

util of defender will be $-\frac{2}{5}$

Scenario 2: Attacker moves first

$$y = (y_a, y_b, y_c)$$

$$y_a + y_b + y_c = 1$$

$$y_a, y_b, y_c \geq 0$$

If defender protects ab, ~~their~~ defender util is: $-1 \cdot y_c$

" " " ac " " " : $-y_b$

" " " bc " " " " : $-2y_a$