

# Lecture 2

## - human decision making -

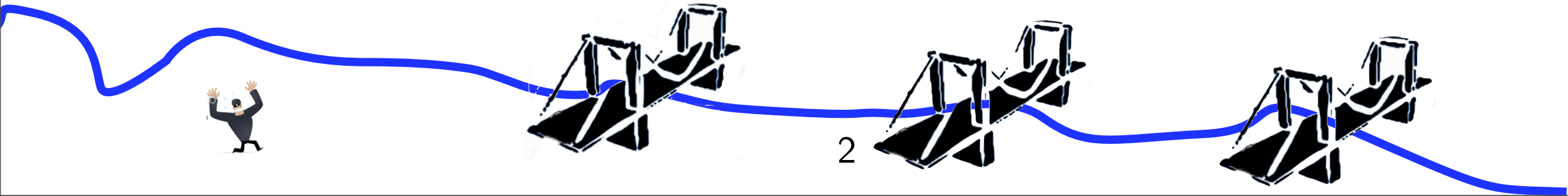
# Review

|          |    |     |     |
|----------|----|-----|-----|
| distance | d  | 2d  | 3d  |
| danger   | 0% | 20% | 10% |

safe!

snakes!

rocks!



2

# Review

- Decision theory: nonstrategic, parametric

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2



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- **Uncertainty!**
- Classical game theory: strategic, nonparametric

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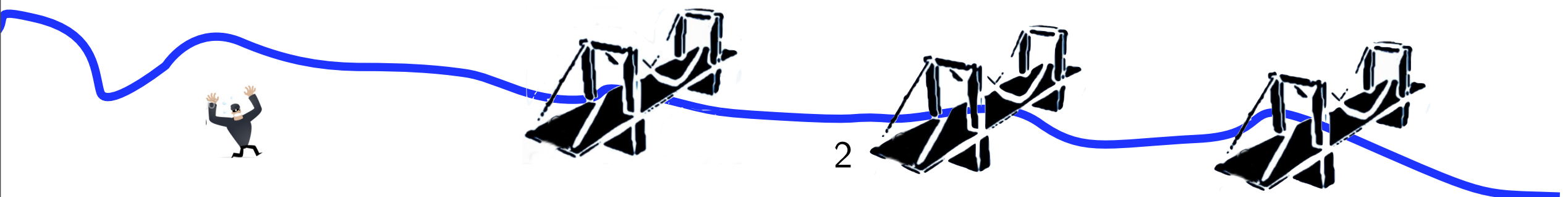
- Decision theory: nonstrategic, parametric
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- **No such notion in most natural sciences!**
- Central to understanding the dynamics of humans

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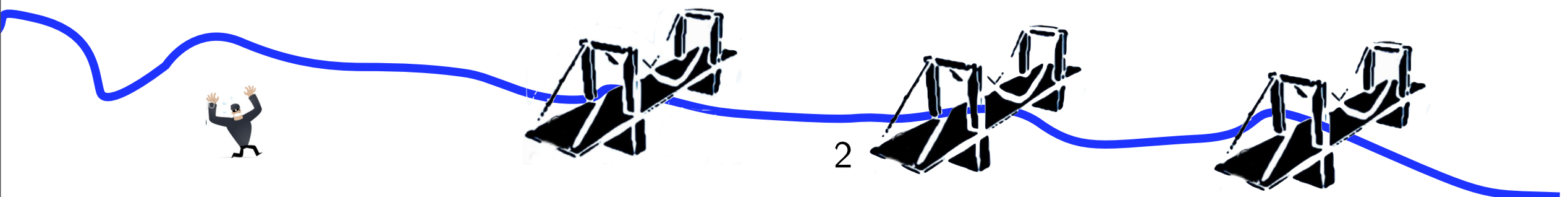
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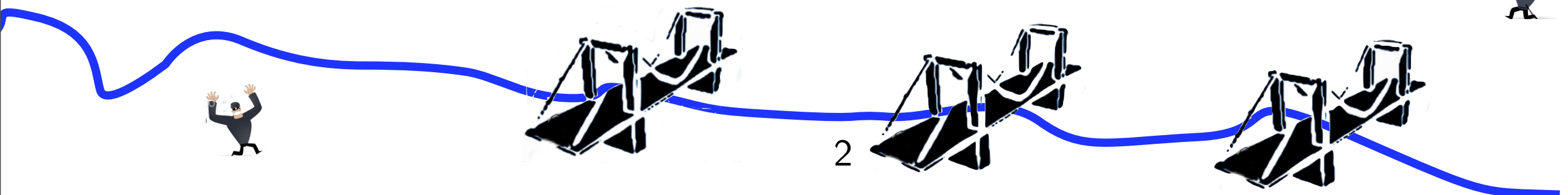
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# WEB 2.0 Landscape

Widget/  
component



CONTENT  
SHARING



Rating/  
Tagging

SOCIAL NETWORK

WEB APPLICATION



Aggregation/  
recombination

RECOMMENDATIONS/  
FILTERING



Collaborative  
filtering



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# WEB 2.0 Landscape

Widget/  
component



WEB APPLICATION

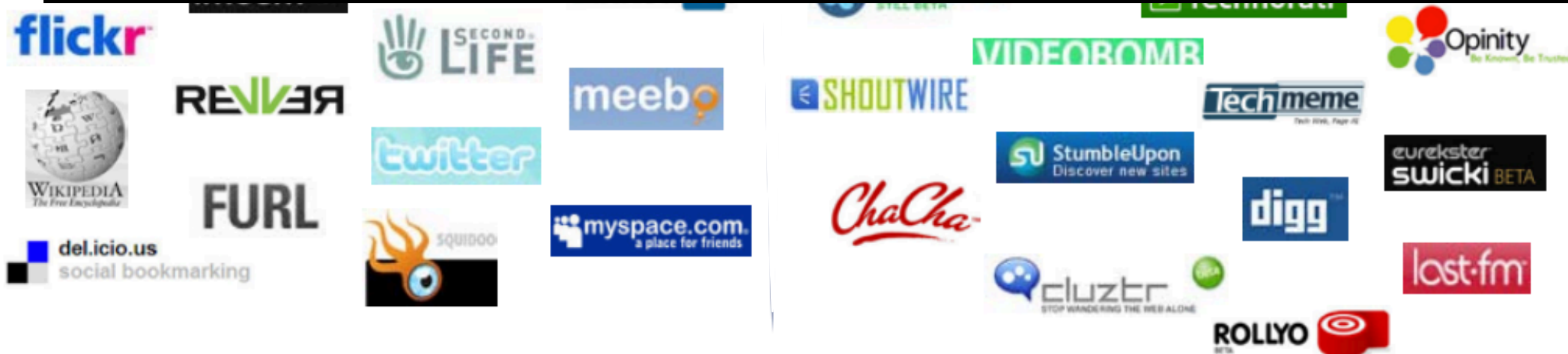


Aggregation/  
recombination

CONTENT  
SHARING

Large datasets on human dynamics,  
human interactions, and social  
network structures

RECOMMENDATIONS/  
FILTERING



Rating/  
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Collaborative  
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SOCIAL NETWORK



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- Behavioral game theory and complex networks



# Today



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- Beliefs, preferences, and constraints



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- Utility functions

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- Beliefs, preferences, and constraints
  - Utility functions
  - First step to understand strategy spaces, payoffs and environmental changes
- non-strategic setting

# Beliefs, preferences, and constraints

- Behavioral properties
- Notation
- Preference ordering
  - completeness
  - transitivity
  - independence of irrelevant alternatives
- Preference function
  - represents binary relation (Theorem 1.1)
  - uniqueness of preference functions (Theorem 1.2)

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# Consistency of preferences (experimental tests)



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3 choices

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| Web + Print | 84% |

Preferences consistent?





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Preferences consistent?

Choice set:

- $X = \{x_1, x_2, x_3\}$ ,  $x_1$ : "web",  $x_2$ : "print",  $x_3$ : "web+print"

$x_1 \succcurlyeq x_3 \succcurlyeq x_2$  seems to contradict  $x_3 \succcurlyeq x_1 \succcurlyeq x_2$



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SALE!

Preferences consistent?

Choice set:

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$x_1 \succcurlyeq x_3 \succcurlyeq x_2$  seems to contradict  $x_3 \succcurlyeq x_1 \succcurlyeq x_2$

- $X = \{(x_1, y_1), (x_2, y_1), (x_3, y_2), (x_3, y_2)\}$ ,  
 $y_1$ : "not on sale",  $y_2$ : "apparently on sale"

$(x_3, y_2) \succcurlyeq (x_1, y_1) \succcurlyeq (x_3, y_1) \succcurlyeq (x_2, y_1)$

# Rational action (experimental tests)

## NOTES AND COMMENTS

### GIVING ACCORDING TO GARP: AN EXPERIMENTAL TEST OF THE CONSISTENCY OF PREFERENCES FOR ALTRUISM

BY JAMES ANDREONI AND JOHN MILLER<sup>1</sup>

#### ALLOCATION CHOICES

| Budget | Token<br>Endowment | Hold<br>Value | Pass<br>Value | Relative<br>Price of Giving |
|--------|--------------------|---------------|---------------|-----------------------------|
| 1      | 40                 | 3             | 1             | 3                           |
| 2      | 40                 | 1             | 3             | 0.33                        |
| 3      | 60                 | 2             | 1             | 2                           |
| 4      | 60                 | 1             | 2             | 0.5                         |
| 5      | 75                 | 2             | 1             | 2                           |
| 6      | 75                 | 1             | 2             | 0.5                         |
| 7      | 60                 | 1             | 1             | 1                           |
| 8      | 100                | 1             | 1             | 1                           |

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| 1      | 40                 | 3             | 1             | 3                           | 8.0                      |
| 2      | 40                 | 1             | 3             | 0.33                        | 12.8                     |
| 3      | 60                 | 2             | 1             | 2                           | 12.7                     |
| 4      | 60                 | 1             | 2             | 0.5                         | 19.4                     |
| 5      | 75                 | 2             | 1             | 2                           | 15.5                     |
| 6      | 75                 | 1             | 2             | 0.5                         | 22.7                     |
| 7      | 60                 | 1             | 1             | 1                           | 14.6                     |
| 8      | 100                | 1             | 1             | 1                           | 23.0                     |

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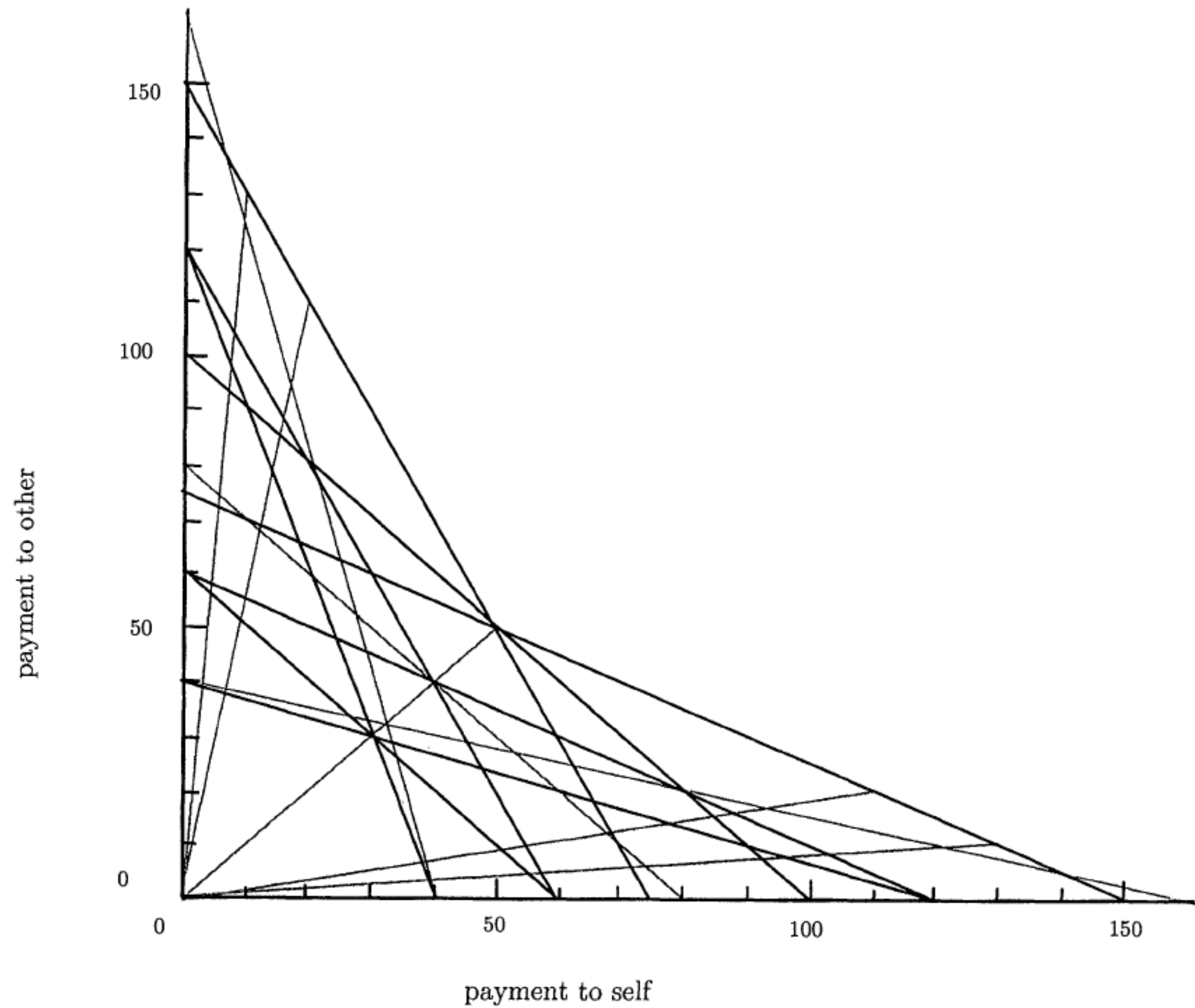
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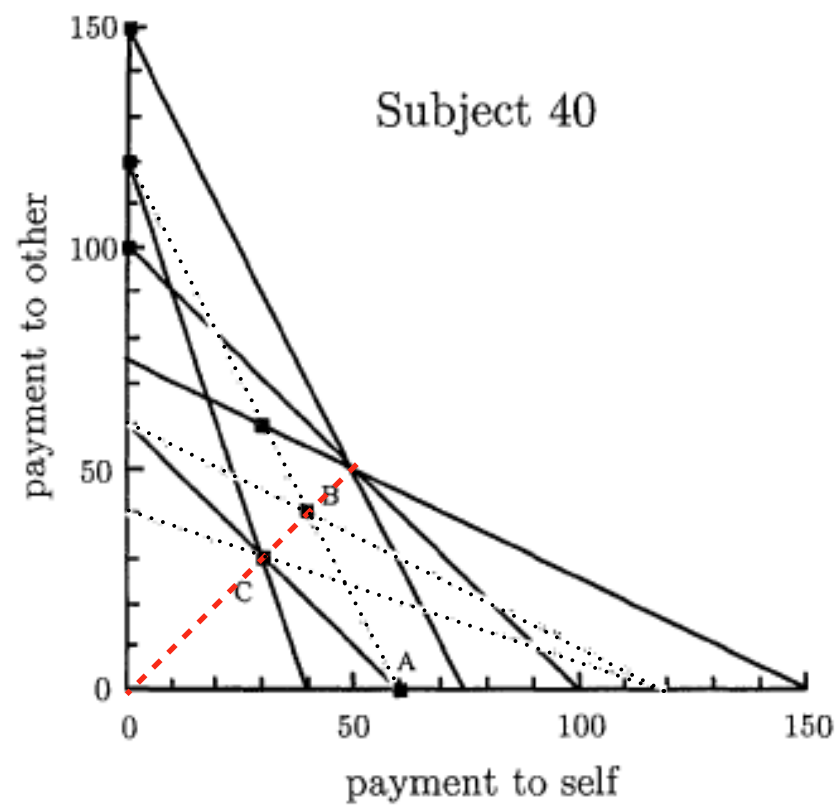
23%



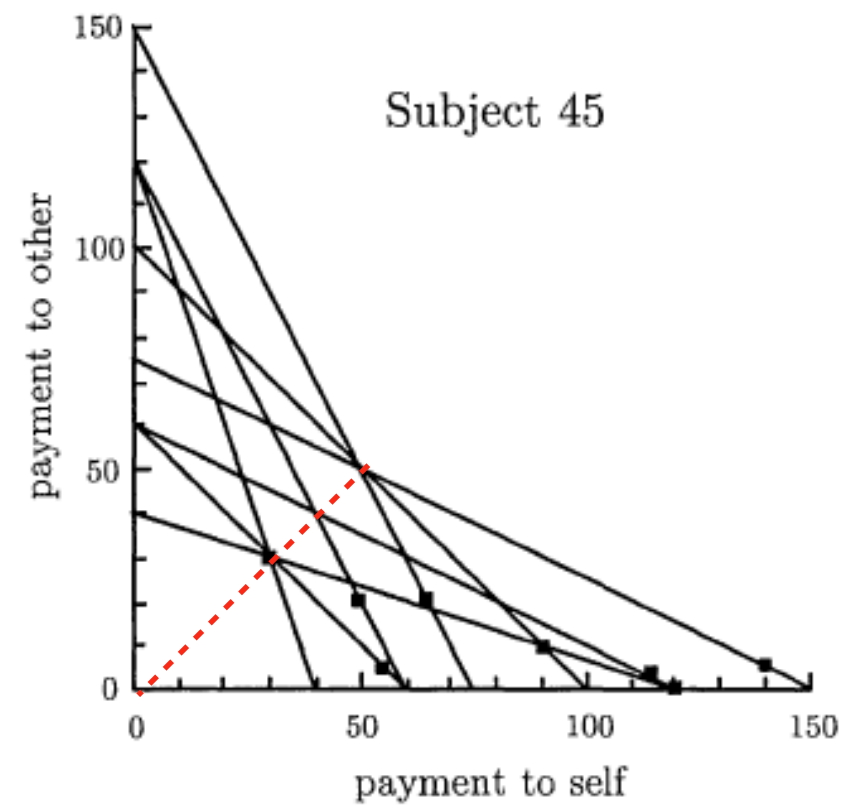




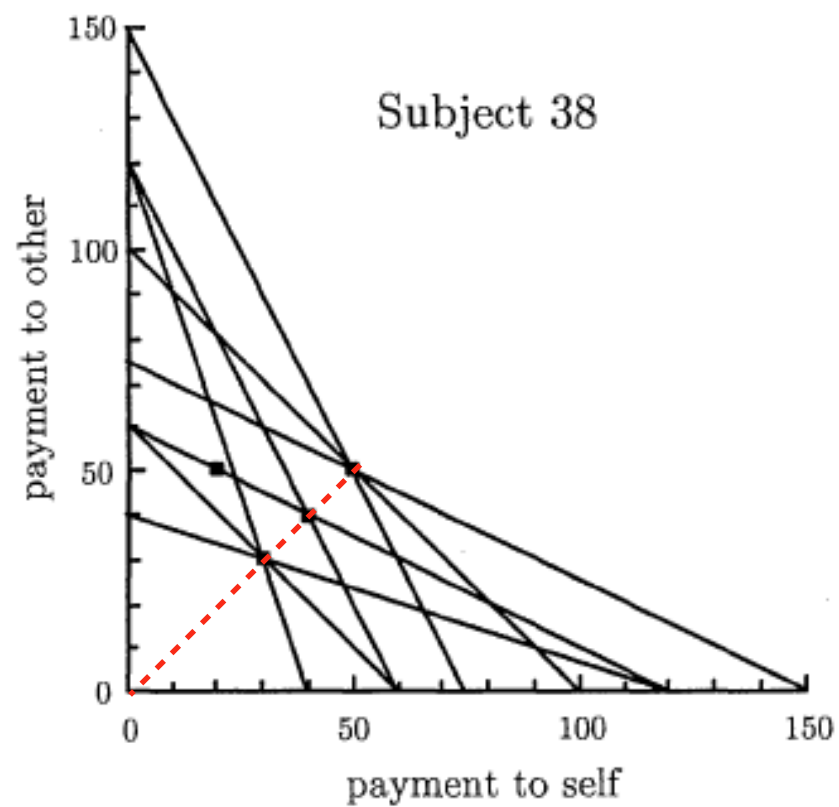




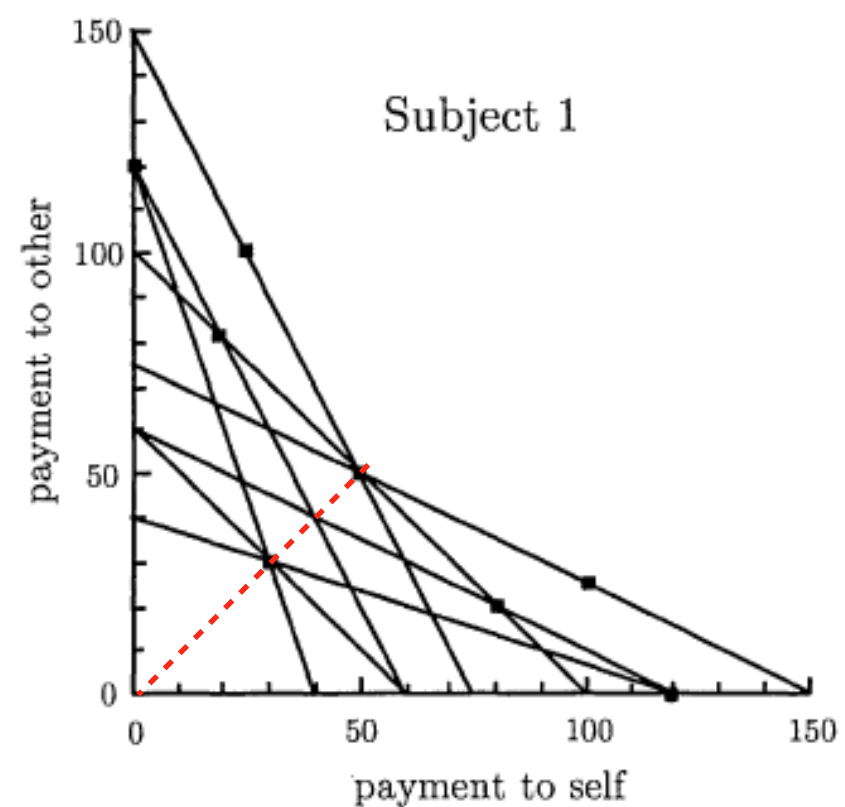
a. Violations of GARP



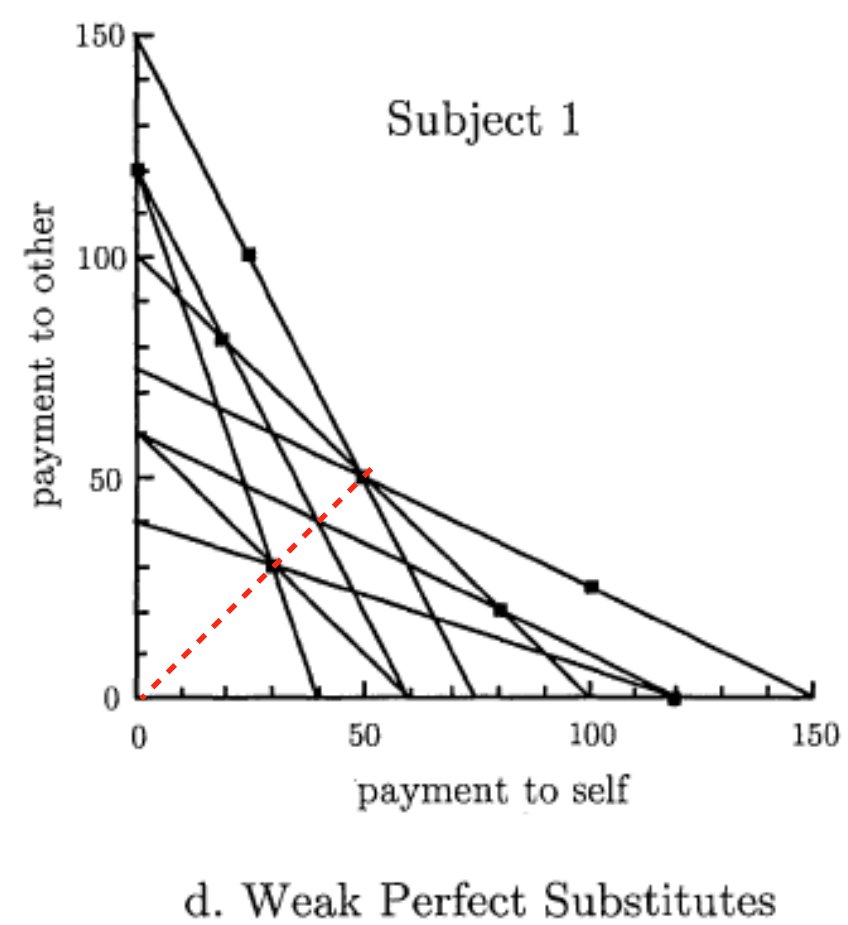
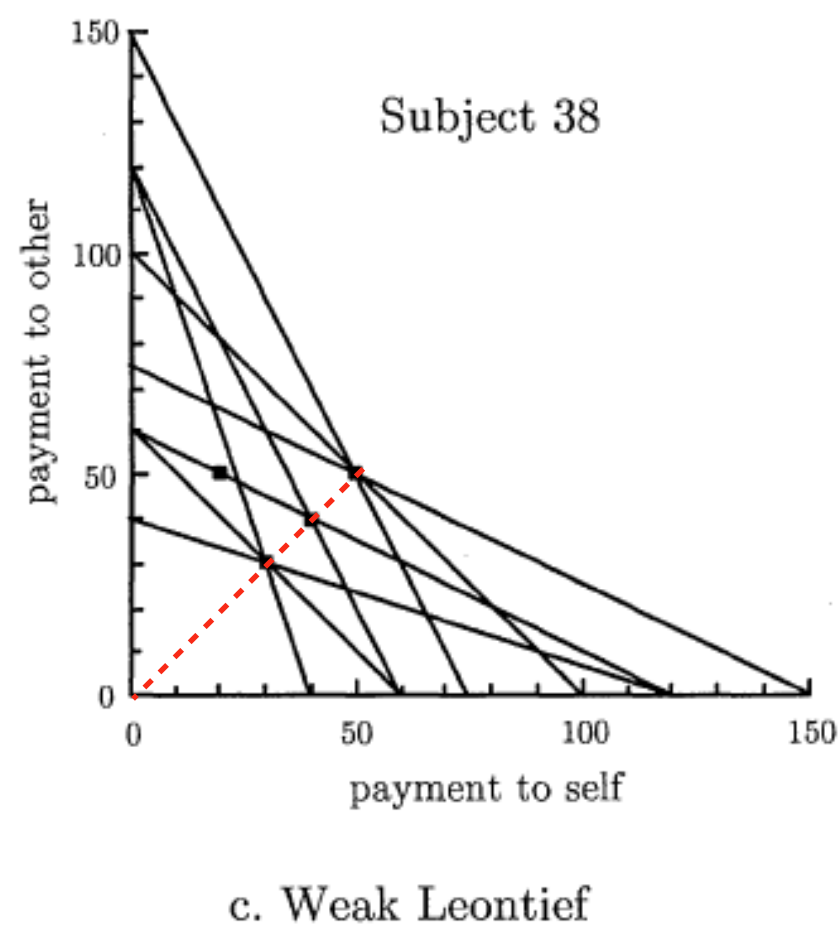
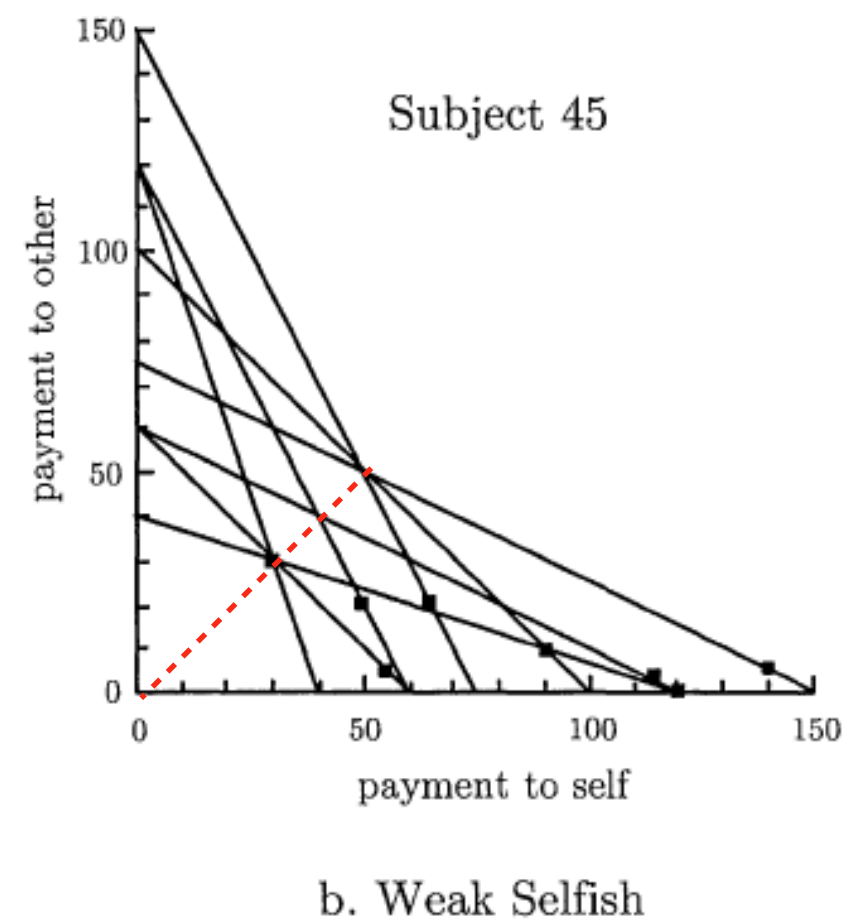
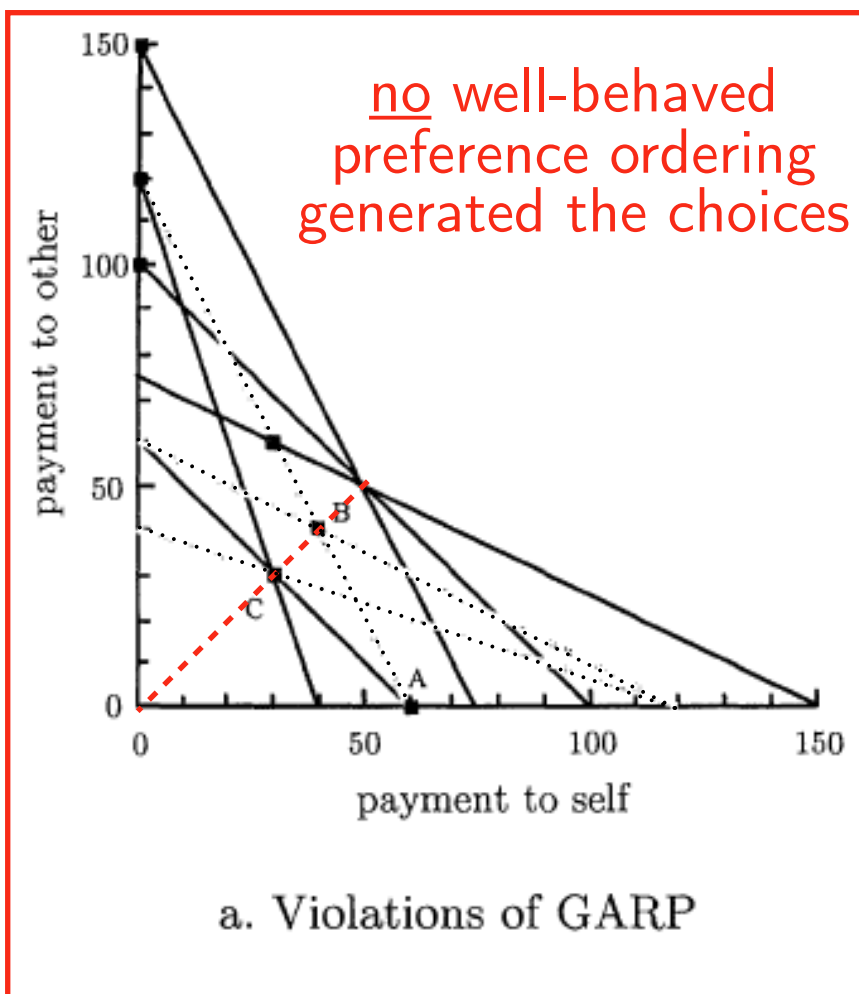
b. Weak Selfish

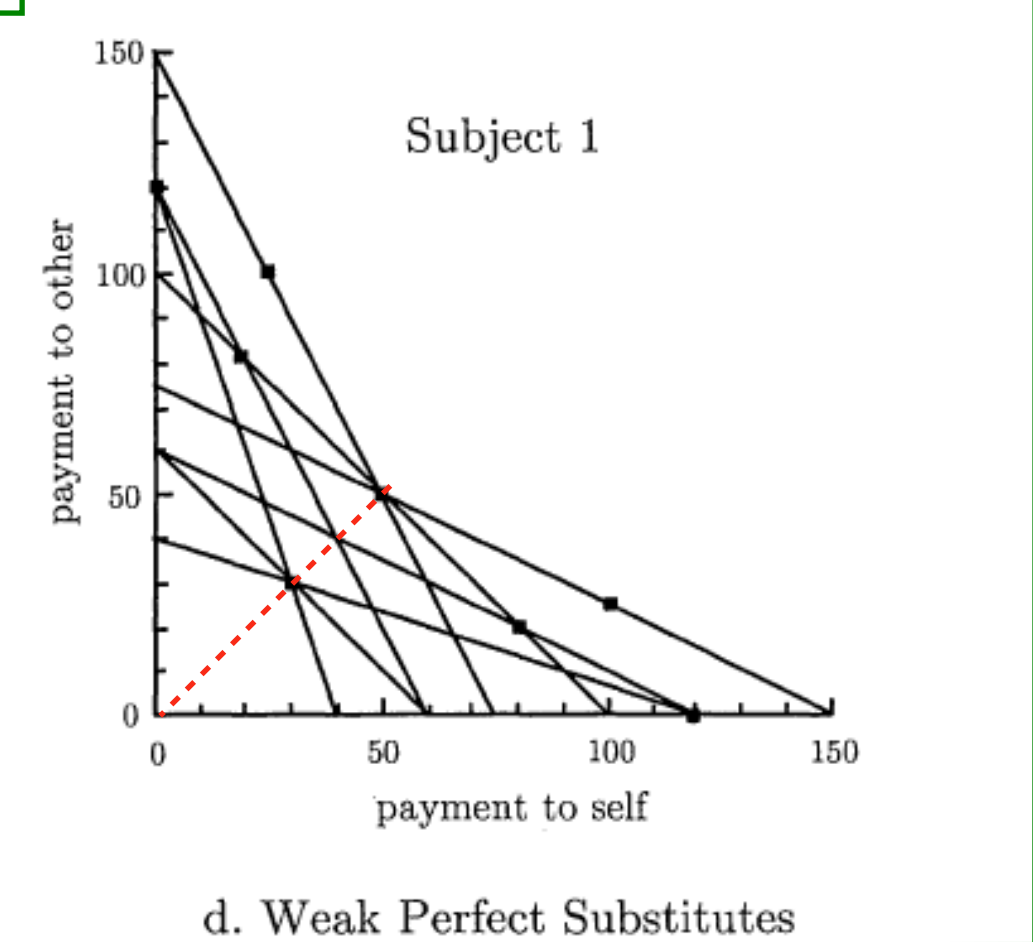
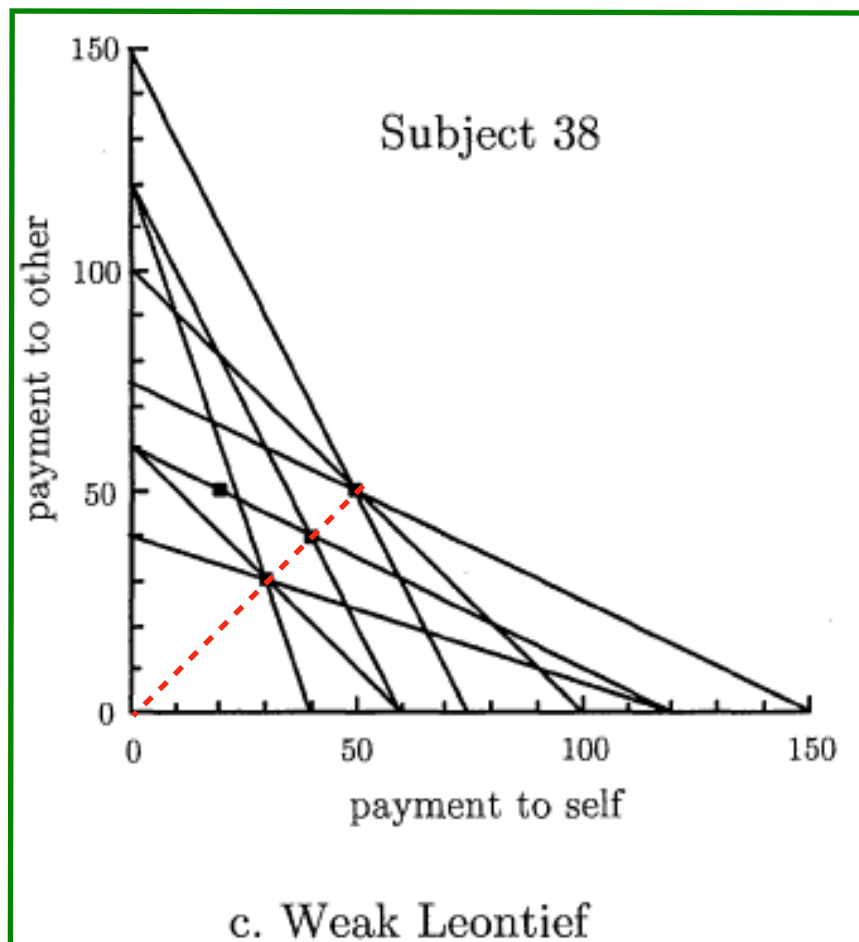
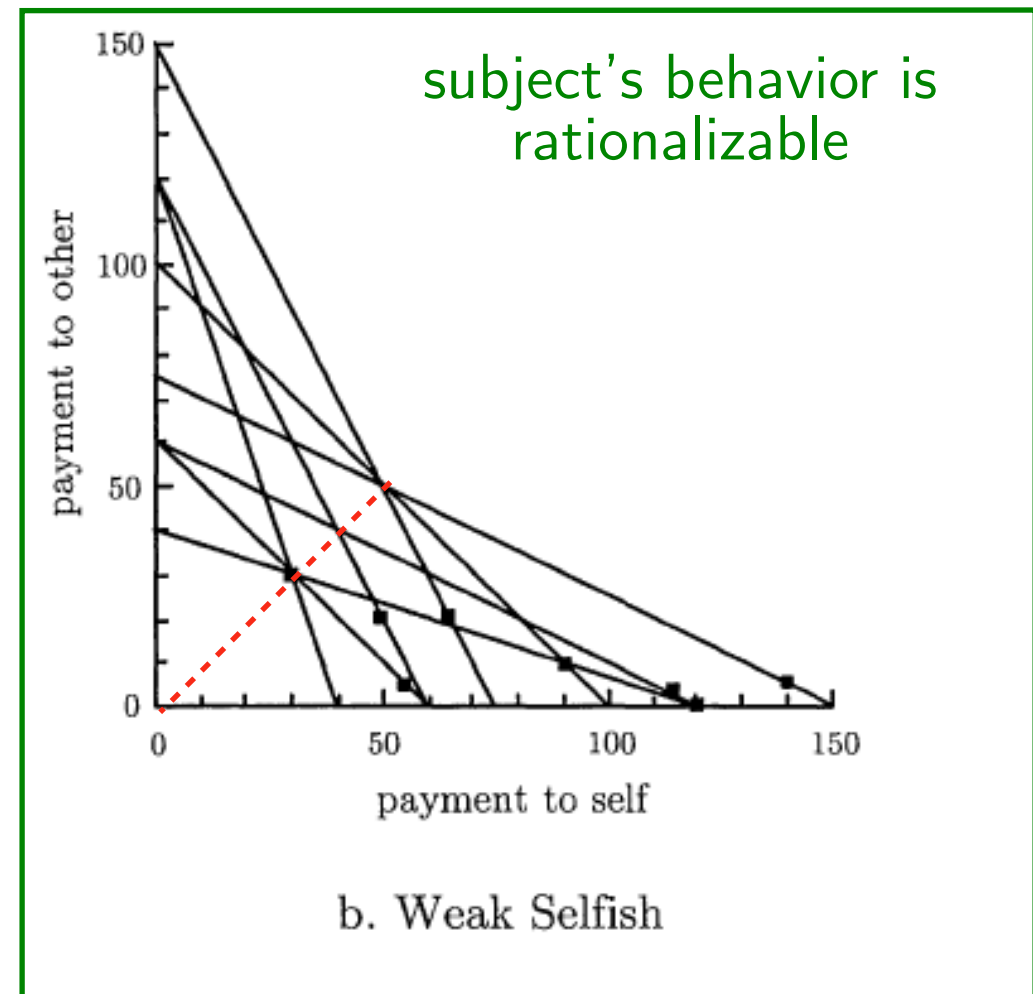
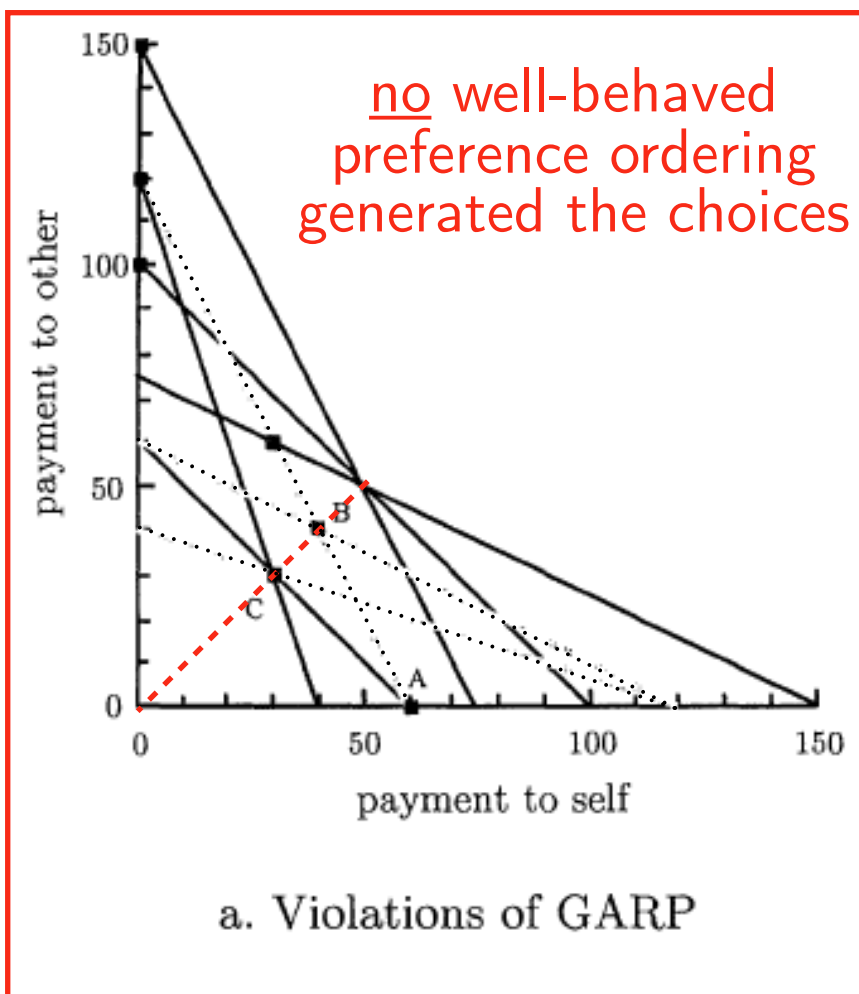


c. Weak Leontief



d. Weak Perfect Substitutes





# Utility function

TABLE III  
SUBJECT CLASSIFICATION BY PROTOTYPICAL UTILITY FUNCTION

| Utility Function    | Fit    |                   | Total        |
|---------------------|--------|-------------------|--------------|
|                     | Strong | Weak              |              |
| Selfish             | 40     | 43                | 83 (47.2%)   |
| Leontief            | 25     | 28.5 <sup>a</sup> | 53.5 (30.4%) |
| Perfect Substitutes | 11     | 28.5 <sup>a</sup> | 39.5 (22.4%) |

- Selfish:  $U(\pi_s, \pi_o) = \pi_s$
- Leontief:  $U(\pi_s, \pi_o) = \min\{\pi_s, \pi_o\}$
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Function of current state!

# Irrational action



# Irrational action

- Does not imply subjects do:
  - caring for others, sacrificing for a social ideal
  - believing in fairness
- Human decision not logical or reasonable:



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$x$  or  $y$ , choose  $x$

$y$  or  $z$ , choose  $y$

$x$  or  $z$ , choose  $z$

$x > y > z > x$  (intransitivity)

# Rational action

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  - Leontief (divide surplus)
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- Does not imply:
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  - Leontief (divide surplus)
  - Perfect substitutes
- Rational actor:
  - Altruistic choices consistent
  - Transitive preferences over outcomes
  - Reacts to environment in some conditional sense
  - Maximize preferences given their beliefs subject to constraints (BPC model)

# Time consistent decisions?

| $t=0$   | $t=365$ |
|---------|---------|
| $x > y$ | $y > x$ |

# Time consistent decisions?

- \$10 now or \$11 a week from now (+ 1 year)
- Systemic tendency to discount near future at higher rate

$x = \$10$  at time  $t$

$y = \$11$  at time  $t + 1$

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Are people time-consistent?

- Another choice space:

$x_0 = \text{"10 delivered immediately"}$

$x_t = \text{"10 delivered at time } t\text{"}$

$y_0 = \text{"11 delivered immediately"}$

$y_t = \text{"11 delivered at time } t\text{"}$



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| $t=0$       | $t=365$             |
|-------------|---------------------|
| $x_0 > y_7$ | $y_{372} > x_{365}$ |

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|-------------|---------------------|
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Explicitly models time  
between choice and delivery

17



Capture stream of choices!  
No contradiction!

# Utility function

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- Let  $u(z_t) = z / (t + 1)$
- Then:
  - $u(x_0) = u(10_0) = 10 / 1 = 10$
  - $u(y_7) = u(11_7) = 11 / 8 = 1.375$

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- Then:
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  - $u(y_7) = u(11_7) = 11/8 = 1.375$

$x_0 > y_7$

# Utility function

- Let  $z_t$  = “amount of money delivered  $t$  days from now”
- Let  $u(z_t) = z/(t+1)$
- Then:
  - $u(x_0) = u(10_0) = 10/1 = 10$
  - $u(y_7) = u(11_7) = 11/8 = 1.375$
  - $u(x_{365}) = 10/366 = 0.027$
  - $u(y_{372}) = 11/373 = 0.029$

$$\left. \begin{array}{l} u(x_0) = 10 \\ u(y_7) = 1.375 \end{array} \right\} x_0 > y_7$$



# Utility function

- Let  $z_t$  = “amount of money delivered  $t$  days from now”
  - Let  $u(z_t) = z/(t+1)$
  - Then:
    - $u(x_0) = u(10_0) = 10/1 = 10$
    - $u(y_7) = u(11_7) = 11/8 = 1.375$
    - $u(x_{365}) = 10/366 = 0.027$
    - $u(y_{372}) = 11/373 = 0.029$
- $x_0 > y_7$
- $y_{372} > x_{365}$



# Discount factors

$$x = x_0, x_1, \dots \quad (y = y_0, y_1, \dots)$$

$$U(x_0, x_1, \dots) = \sum_{k=0}^{\infty} \delta^k u(x_k)$$

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$$U(x_0, x_1, \dots) = \sum_{k=0}^{\infty} e^{-rk} u(x_k), \quad \delta = e^{-r}, \quad r > 0$$

$$U(x_0, x_1, \dots) = \sum_{k=0}^{\infty} \frac{1}{(1+r)^k} u(x_k), \quad \delta = 1/(1+r), \quad r > 0$$

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Individual prefers stream  $x$  over  $y$  if and only if  $U(x) > U(y)$

# Time consistency

- Time inconsistency exists!
- Time-dependent preference functions
- Consistency of the model being proposed

# Next class

- Bayesian Rationality
  - Savage's Axioms
  - Savage's Theorem
- Biases in decision-making
- Prospect Theory