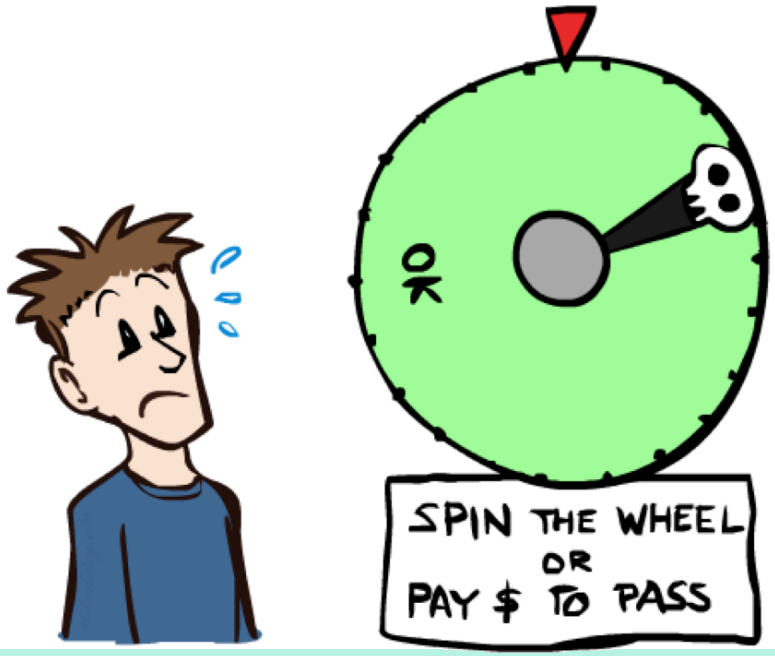
# Advanced Topics in AI

## Human Utilities




Instructor: Prof. Dr. techn. Wolfgang Nejdl
Leibniz University Hannover

Co-financed by the Connecting Europe Facility of the European Union

[These slides were created by Dan Klein and Pieter Abbeel for CS188 Intro to AI at UC Berkeley. All materials are available at http://ai.berkeley.edu.]

# Utility Scales

- Normalized utilities: $u_+ = 1.0$, $u_- = 0.0$
- Micromorts: one-millionth chance of death, useful for paying to reduce product risks, etc.
- QALYs: quality-adjusted life years, useful for medical decisions involving substantial risk
- Note: behavior is invariant under positive linear transformation

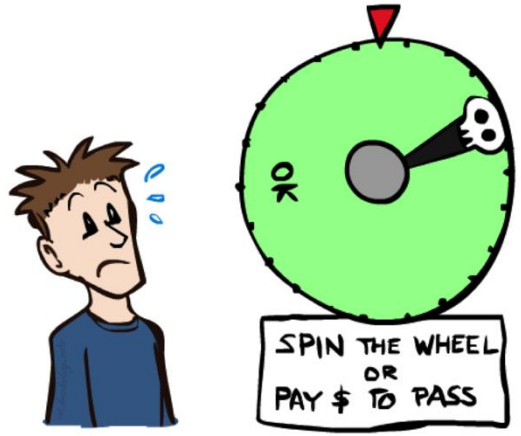
$$U'(x) = k_1 U(x) + k_2 \text{ where } k_1 > 0$$

- With deterministic prizes only (no lottery choices), only ordinal utility can be determined, i.e., total order on prizes

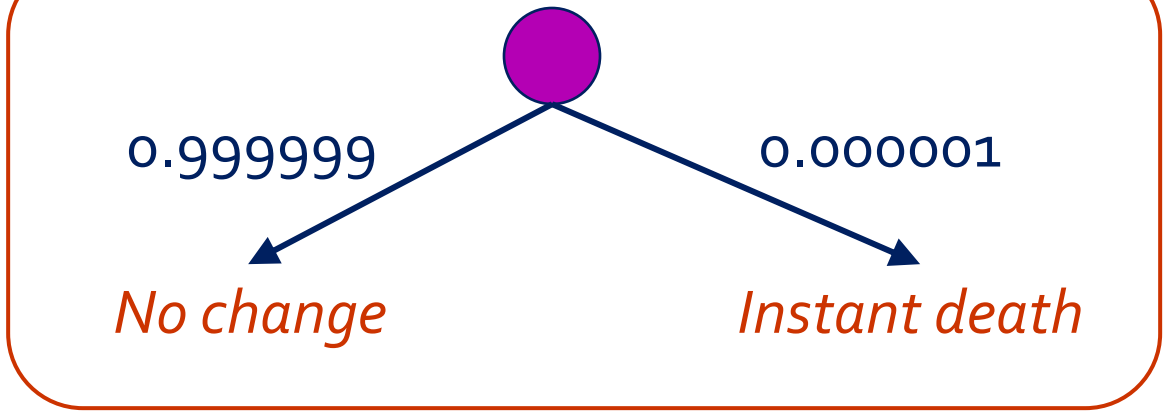
Co-financed by the Connecting Europe Facility of the European Union

# Human Utilities

- Utilities map states to real numbers. Which numbers?
- Standard approach to assessment (elicitation) of human utilities:
  - Compare a prize $A$ to a standard lottery $L_p$ between
    - "best possible prize" $u_+$ with probability $p$
    - "worst possible catastrophe" $u_-$ with probability $1-p$
  - Adjust lottery probability $p$ until indifference: $A \sim L_p$
  - Resulting $p$ is a utility in $[0,1]$




*Pay $30* ~

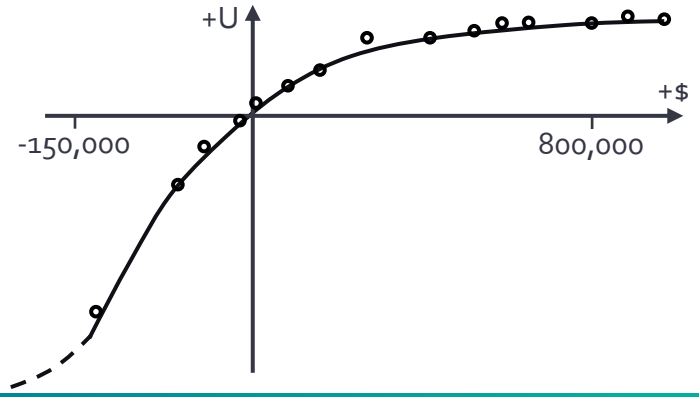



Co-financed by the Connecting Europe Facility of the European Union

xAIM

# Money

- Money does not behave as a utility function, but we can talk about the utility of having money (or being in debt)
- Given a lottery: $L = [p, \$X;\ (1-p), \$Y]$
  - expected monetary value: $EMV(L) = pX + (1-p)Y$
  - $U(L) = pU(\$X) + (1-p)U(\$Y)$
  - Typically: $U(L) < U(\ EMV(L)\ )$
  - In this sense, people are risk-averse
  - When deep in debt, people are risk-prone

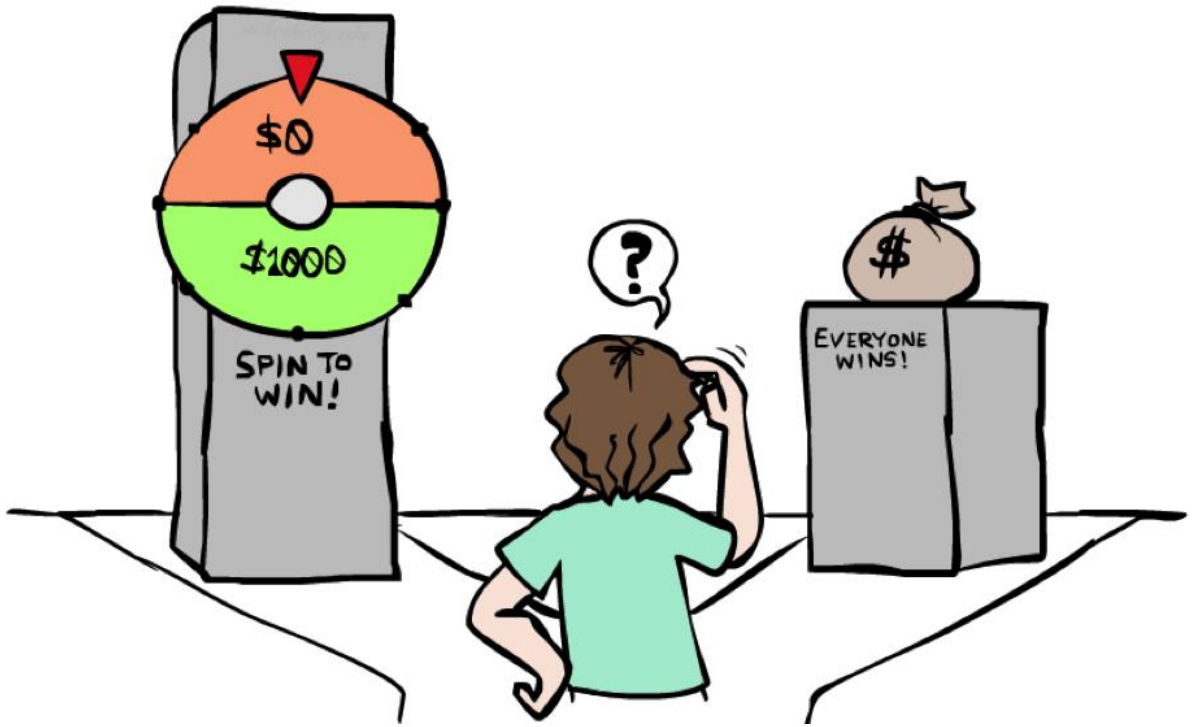




Co-financed by the Connecting Europe Facility of the European Union

xAIM

# Example: Insurance




- Consider the lottery: $[0.5, \$1000;\ \ 0.5, \$0]$
  - What is its expected monetary value? ($500)
  - What is its certainty equivalent?
    - Monetary value acceptable in lieu of lottery
    - $400 for most people
  - Difference of $100 is the insurance premium
    - There's an insurance industry because people will pay to reduce their risk
    - If everyone were risk-neutral, no insurance needed!
  - It's win-win: you'd rather have the $400 and the insurance company would rather have the lottery (their utility curve is flat and they have many lotteries)

Co-financed by the Connecting Europe Facility of the European Union

# Example: Human Rationality?

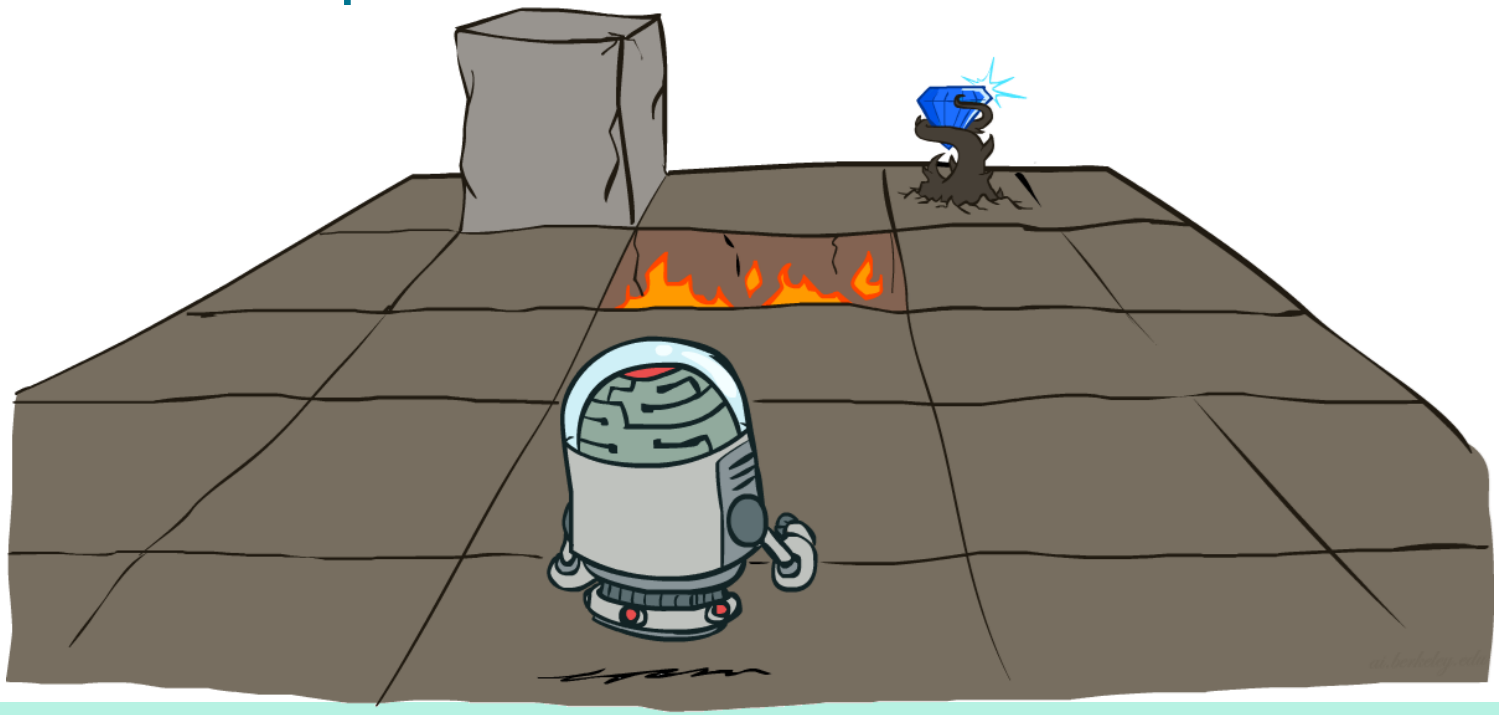
- Famous example of Allais (1953)
  - A: $[0.8, \$4k; 0.2, \$0]$
  - B: $[1.0, \$3k; 0.0, \$0]$
  - C: $[0.2, \$4k; 0.8, \$0]$
  - D: $[0.25, \$3k;\ 0.75, \$0]$
- Most people prefer $B \succ A, C \succ D$
- But if U($0) = 0, then
  - $B \succ A \Rightarrow U(\$3k) > 0.8\, U(\$4k)$
  - $C \succ D \Rightarrow 0.8\, U(\$4k) > U(\$3k)$


Co-financed by the Connecting Europe Facility of the European Union

xAIM

# Advanced Topics in AI

## Next topic: Markov Decision Processes



Instructor: Prof. Dr. techn. Wolfgang Nejdl

Leibniz University Hannover

Co-financed by the Connecting Europe Facility of the European Union

[These slides were created by Dan Klein and Pieter Abbeel for CS188 Intro to AI at UC Berkeley. All materials are available at http://ai.berkeley.edu.]