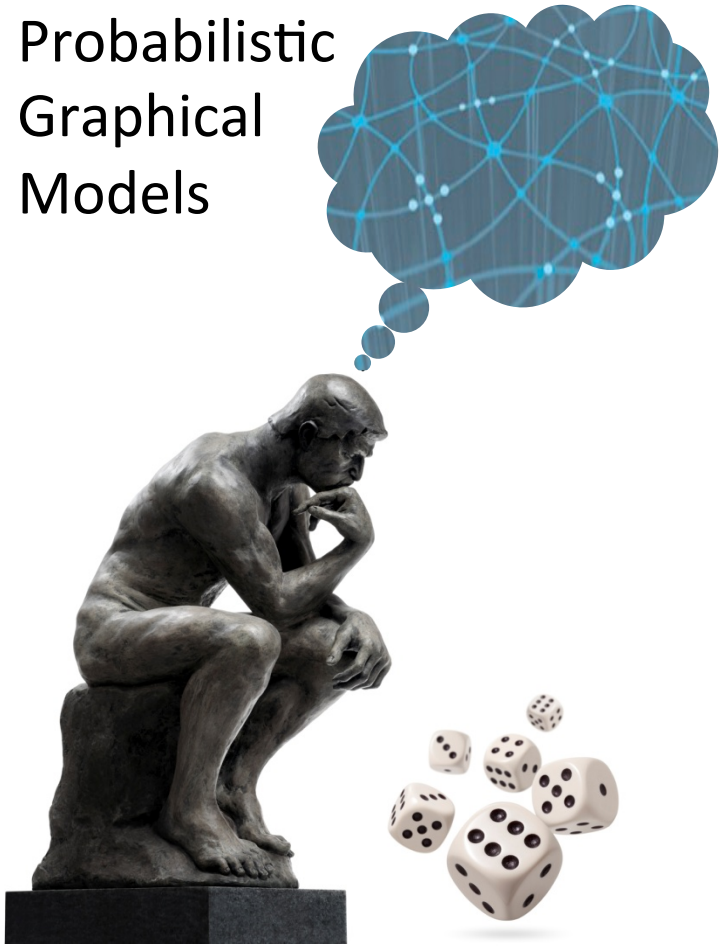
Probabilistic Graphical Models



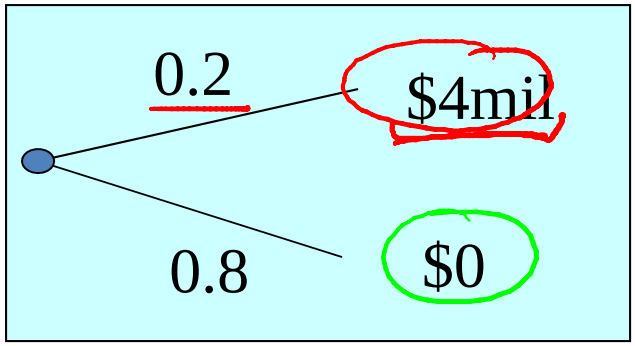
Acting

Decision Making

Utility Functions

Utilities and Preferences

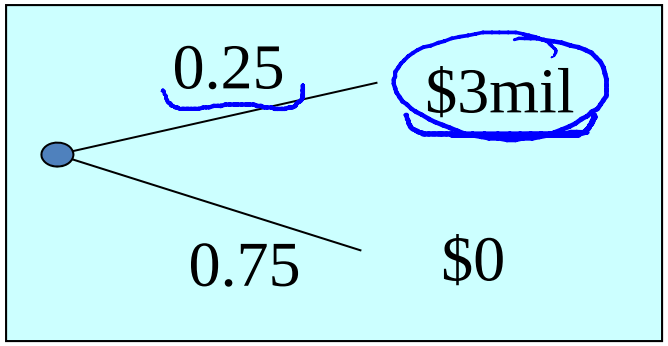
Lotteries



$\succ$

$\sim$

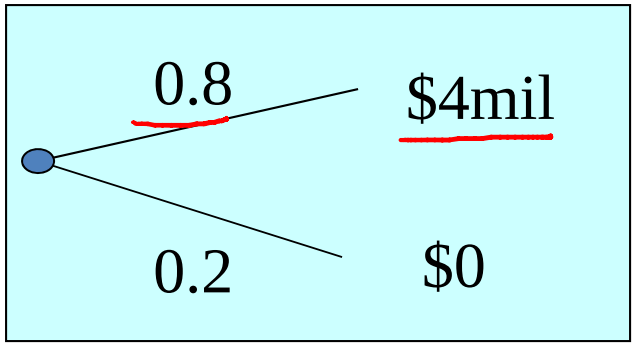
$\approx$



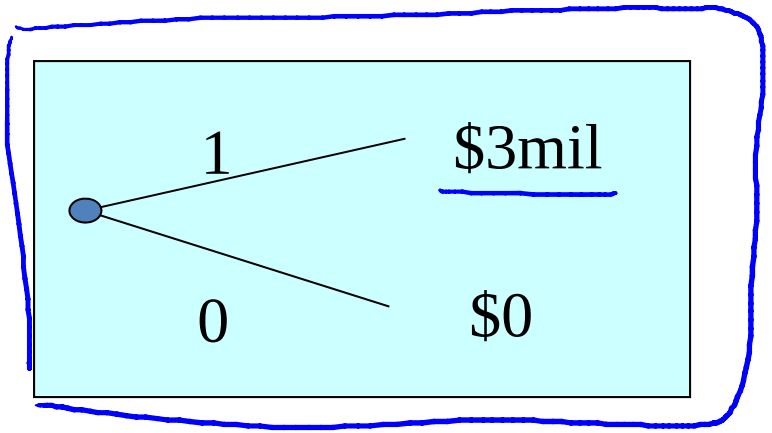
$0.2 \cdot u(4) + 0.8 u(0)$

$0.25 u(3) + 0.75 u(0)$

Utility = Payoff?



$\succ$
$\succ$
$\approx$



$4mill × 0.8=
$3.2mill

$3mill

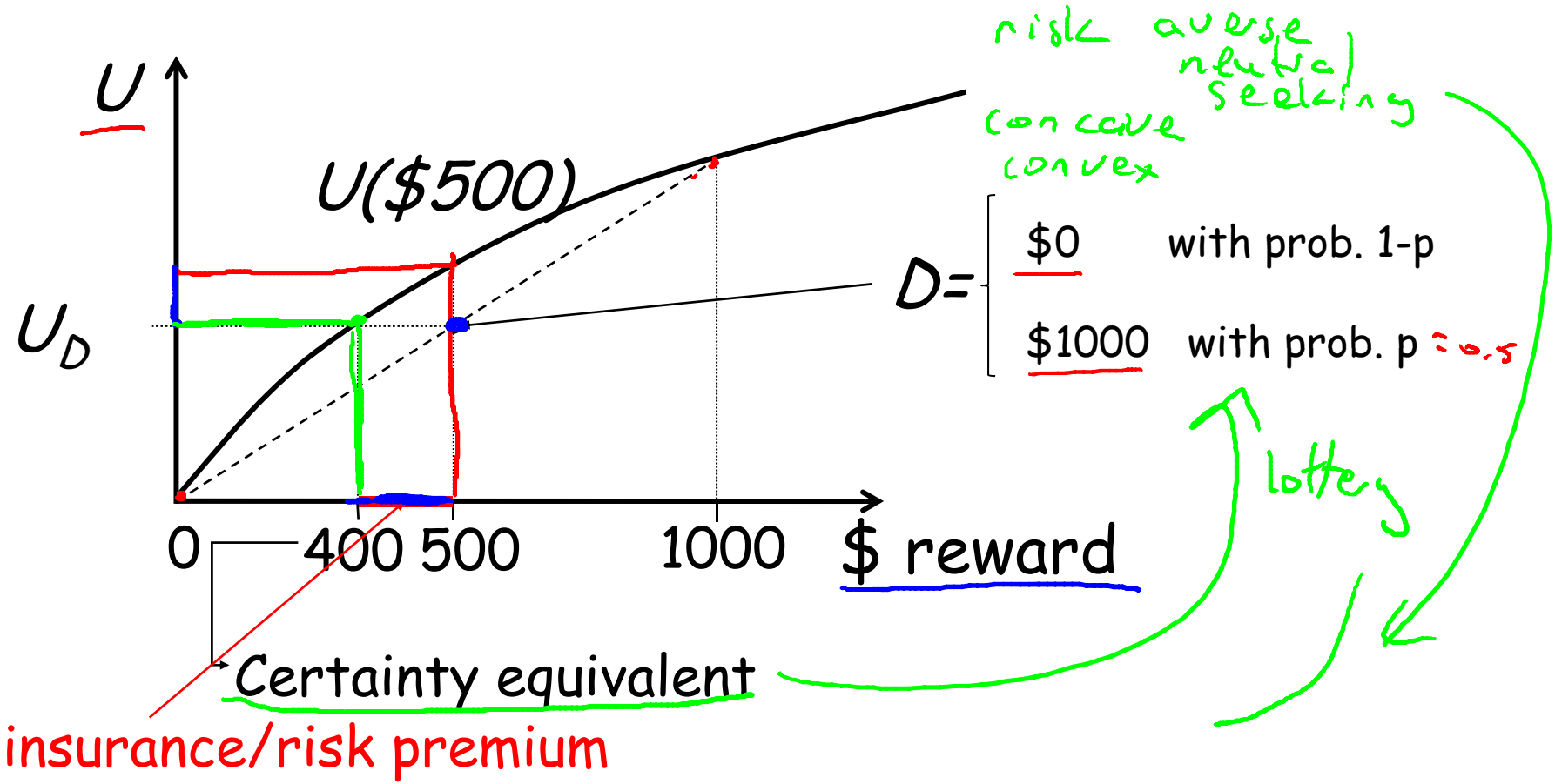
St. Petersburg Paradox

- Fair coin is tossed repeatedly until it comes up heads, say on the n^{th} toss
- Payoff = $\$2^n$

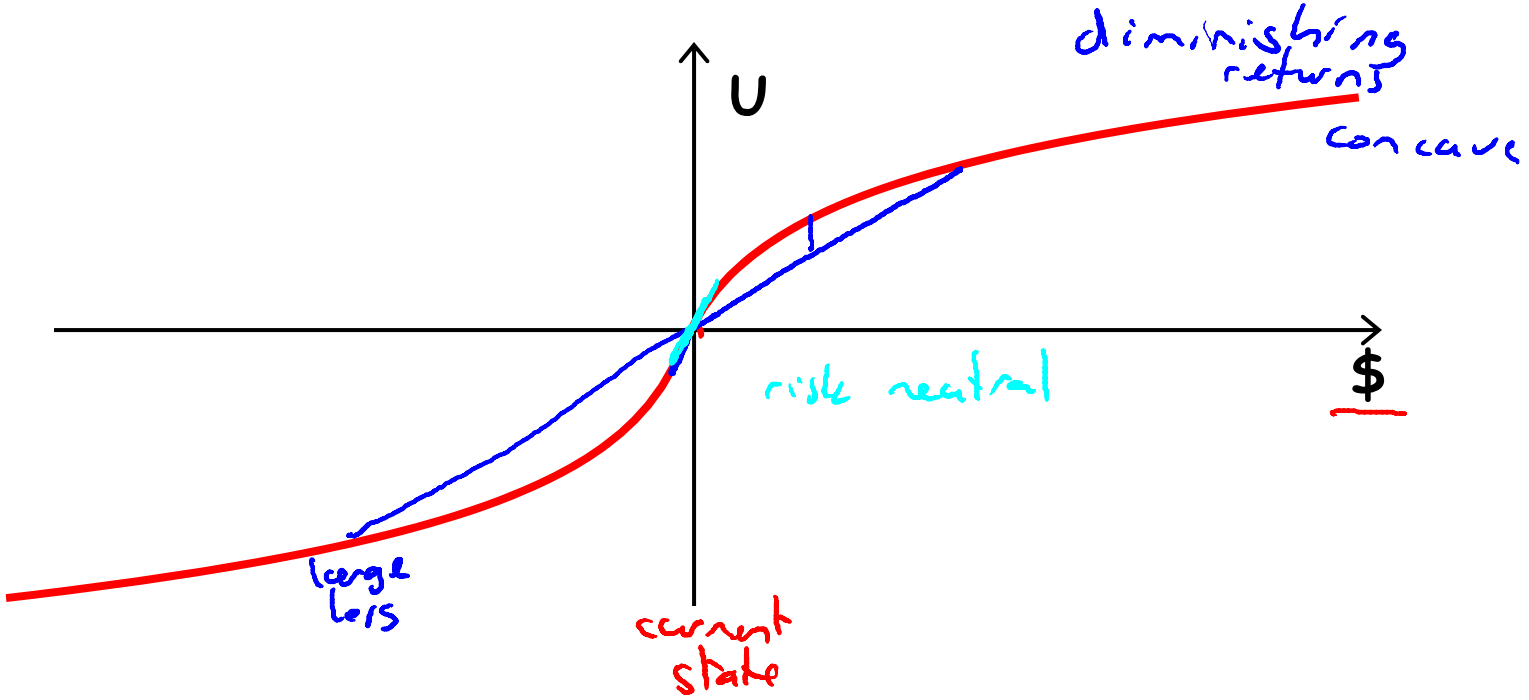
$\frac{1}{2} \times 2 + \frac{1}{4} \times 4 + \frac{1}{8} \times 8 + \ldots = \infty$

most people value x $\$2$

Daphne Koller


U
U($500)
U_D
0
400 500
1000
$ reward
Certainty equivalent
insurance/risk premium
risk averse
neutral
seeking
concave
convex
D=
$0 with prob. 1-p
$1000 with prob. p
lottery

Typical Utility Curve



Multi-Attribute Utilities

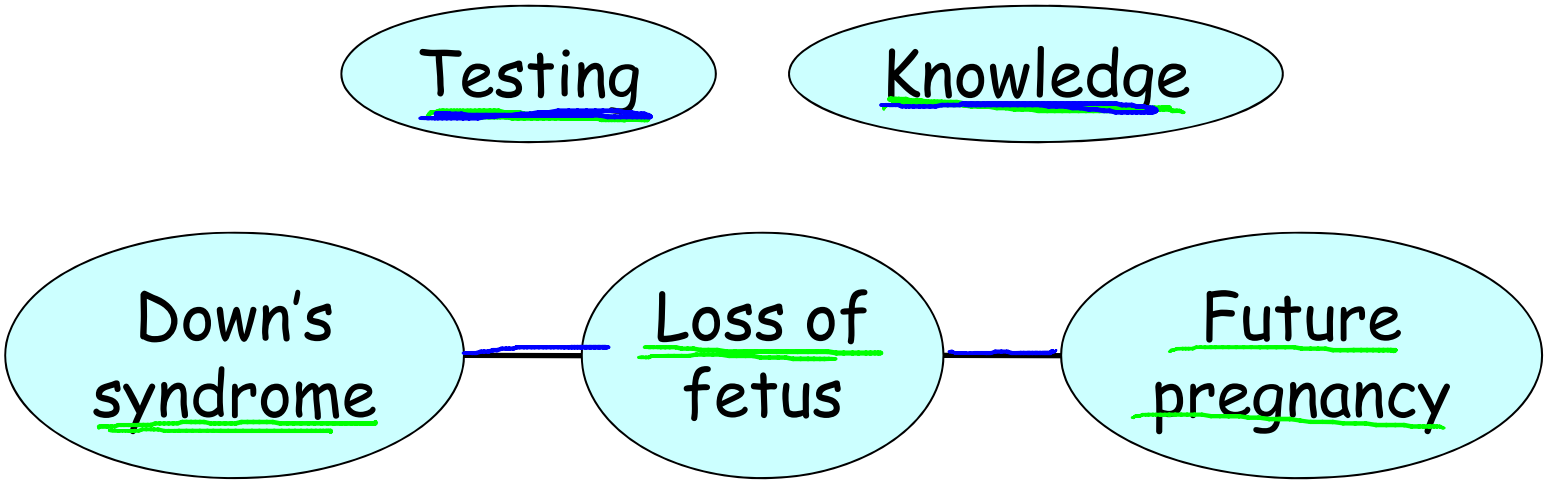
- All attributes affecting preferences must be integrated into one utility function

money, time, pleasure, ..

- Human life
  - Micromorts 1/1000000 chance of death ≈ $20 1930
  - QALY (quality-adjusted life year)

Example: Prenatal diagnosis

$$U_1(T) + U_2(K) + U_3(D,L) + U_4(L,F)$$



Summary

- Our utility function determines our preferences about decisions that involve uncertainty
- Utility generally depends on multiple factors
  - Money, time, chances of death, …
- Relationship is usually nonlinear
  - Shape of utility curve determines attitude to risk
- Multi-attribute utilities can help decompose high-dimensional function into tractable pieces