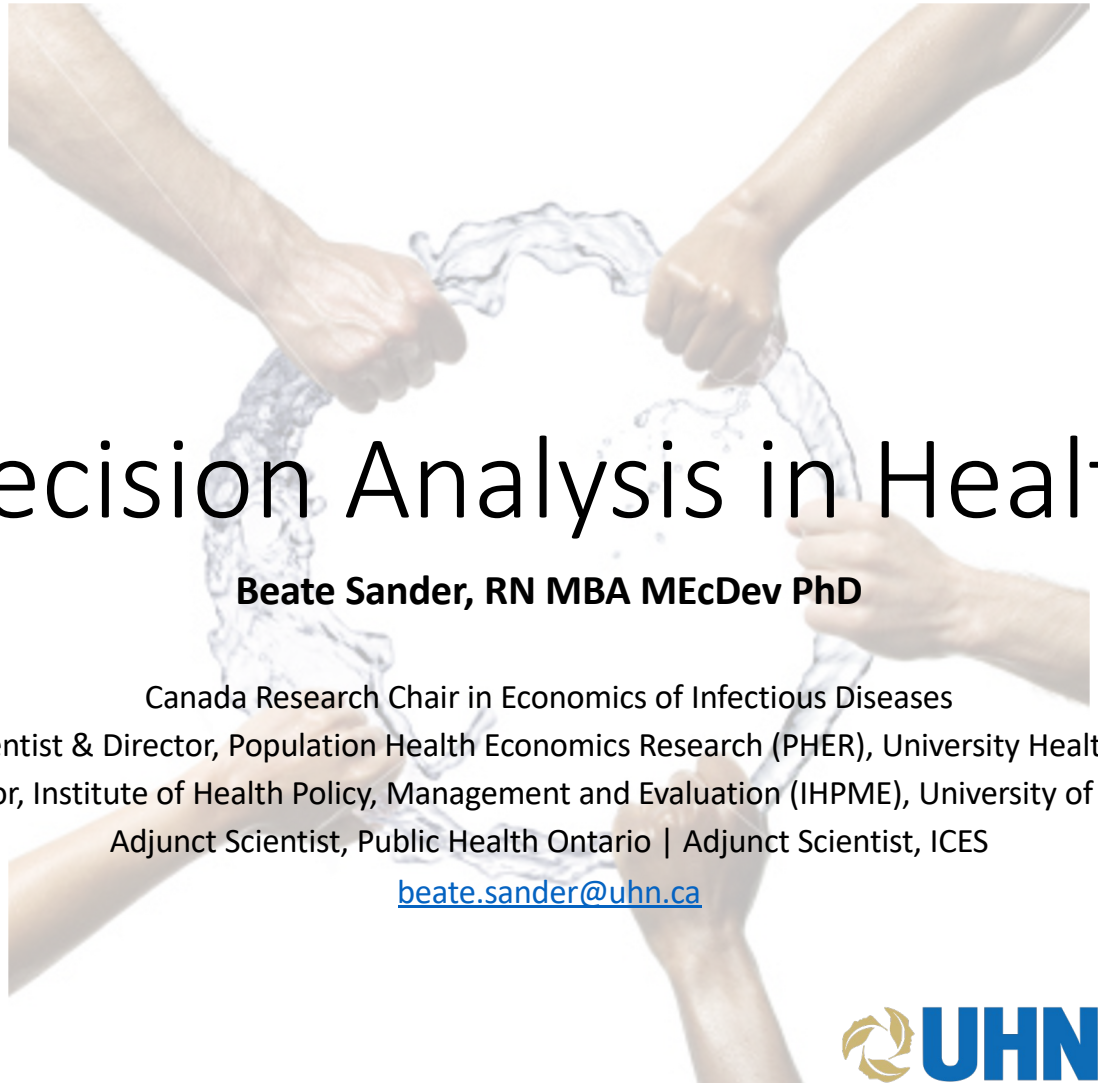

Decision Analysis in Health

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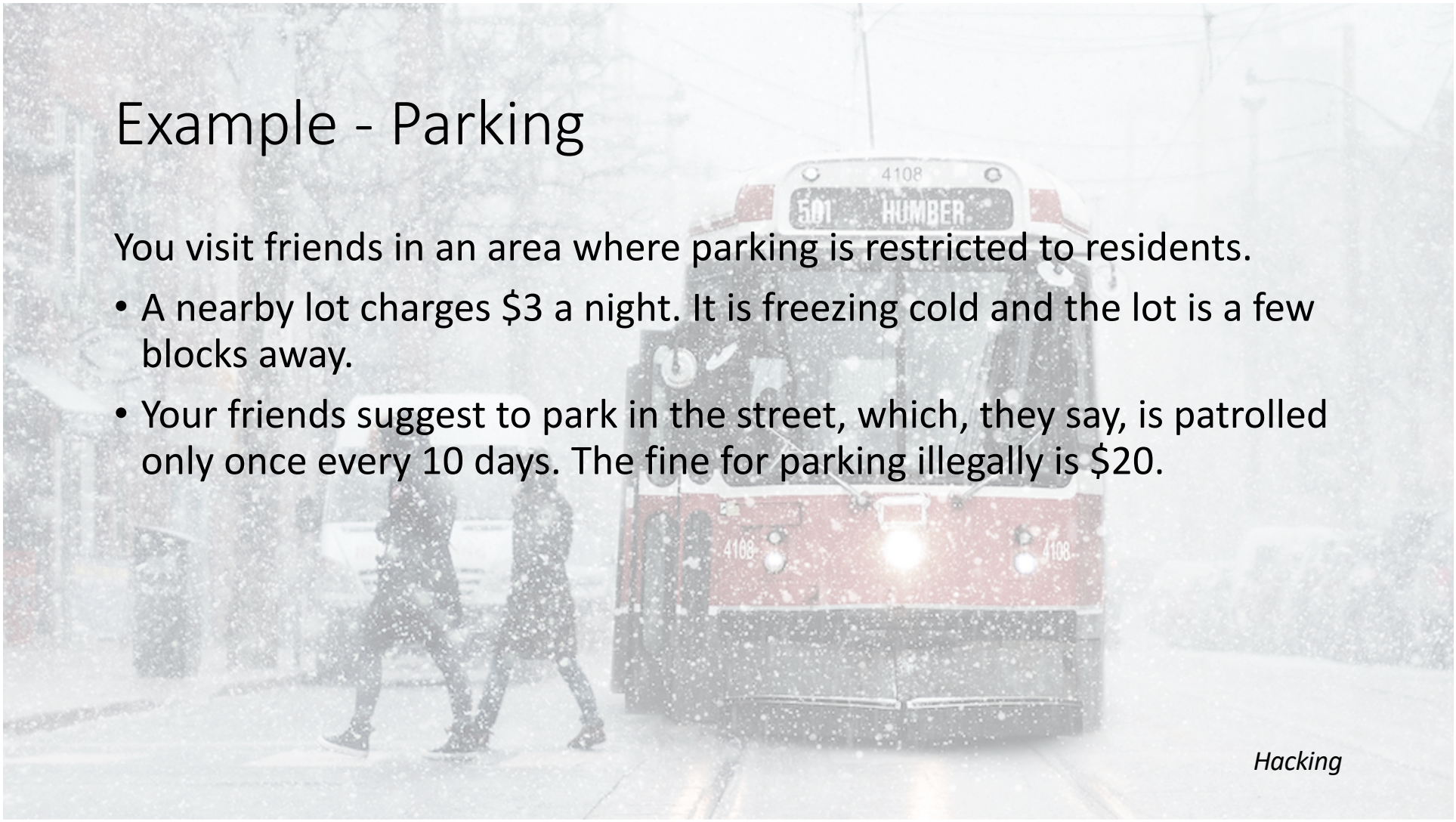
Example - Parking

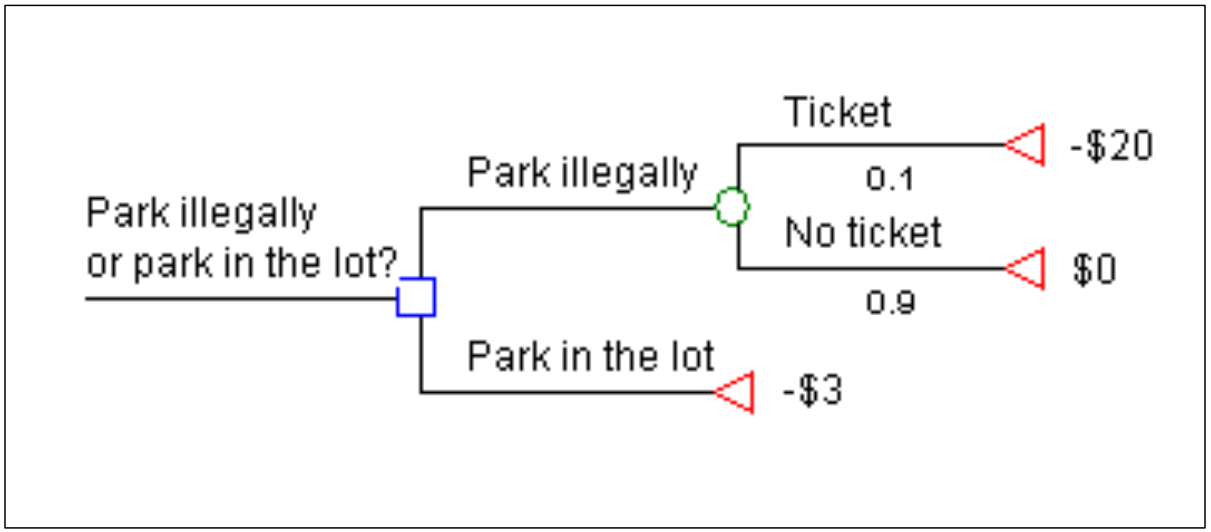


You visit friends in an area where parking is restricted to residents.

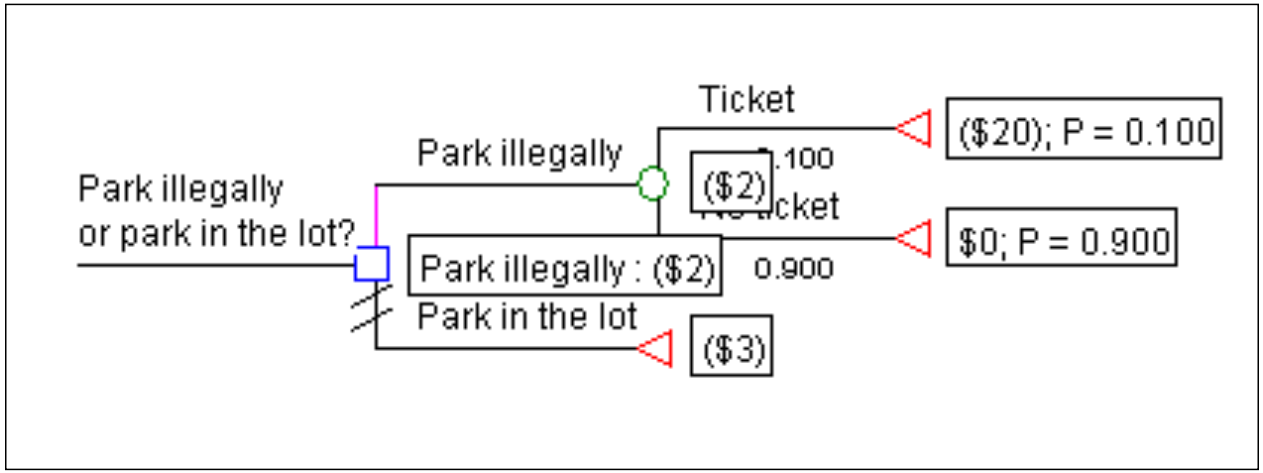
- A nearby lot charges $3 a night. It is freezing cold and the lot is a few blocks away.
- Your friends suggest to park in the street, which, they say, is patrolled only once every 10 days. The fine for parking illegally is $20.

Hacking

Parking – Tree Diagram



Parking – Expected Value



Exp (Park illegally) = (0.1)(-$20) + (0.9)($0) = -$2

Health policy decision-making: Choices

"The first lesson of economics is scarcity: there is never enough of anything to fully satisfy all those who want it.
The first lesson of politics is to disregard the first lesson of economics."
(Thomas Sowell 1993)

Roadmap

- Reasons why a decision may be difficult
- Decision analysis

Difficult Decisions

Difficult Decisions

- What makes a clinical/public health/policy decision difficult?
- Think back to a recent difficult decision you had to make
- Clinical, public health-related, policy or personal
- *Why* was it difficult?

Discuss a difficult decision

7 Reasons Why a Decision May Be Difficult

1. Lack of Knowledge
2. Inherent Risk
3. Inherent Uncertainty
4. Conflicting Values
5. Heuristics and Biases
6. Individualizing Risks and Benefits
7. Difficulty Synthesizing Components

Other reasons not discussed today:
Fear of Retribution (lawsuits, CPSO), Difficult Communication, Challenging Patients

1. Lack of Knowledge

Lack of Knowledge

- Ignorance & information overload
- “I don’t know what’s going on”
- Personal ignorance (“I skipped that lecture!”) – fix is easy
- Complex (medical) problems: large body of literature / evidence
- Difficult to stay up-to-date
- Unusual presentations
- Emerging disease (SARS, Zika, COVID-19)

2. Inherent Risk

Example: Estimating Absolute and Relative Risk

Scenario	MD Estimate	Computer Estimate	Ratio
High risk male patient	42.2 (23.2)	9.5	4.4 (2.4)
Average 40 year old Canadian man	24.0 (19.0)	3.6	6.7 (5.3)
Relative Risk	2.6 (2.0)	2.6	1.0 (0.8)

Perhaps better at thinking about *relative* rather than absolute risks.

Grover SA et al. Do doctors accurately assess coronary risk in their patients? Preliminary results of the coronary health assessment study. BMJ 1995;310:975-978

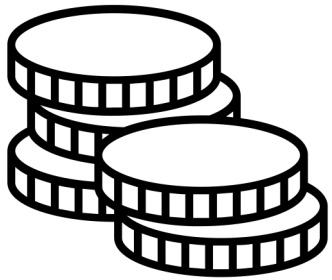
Risk

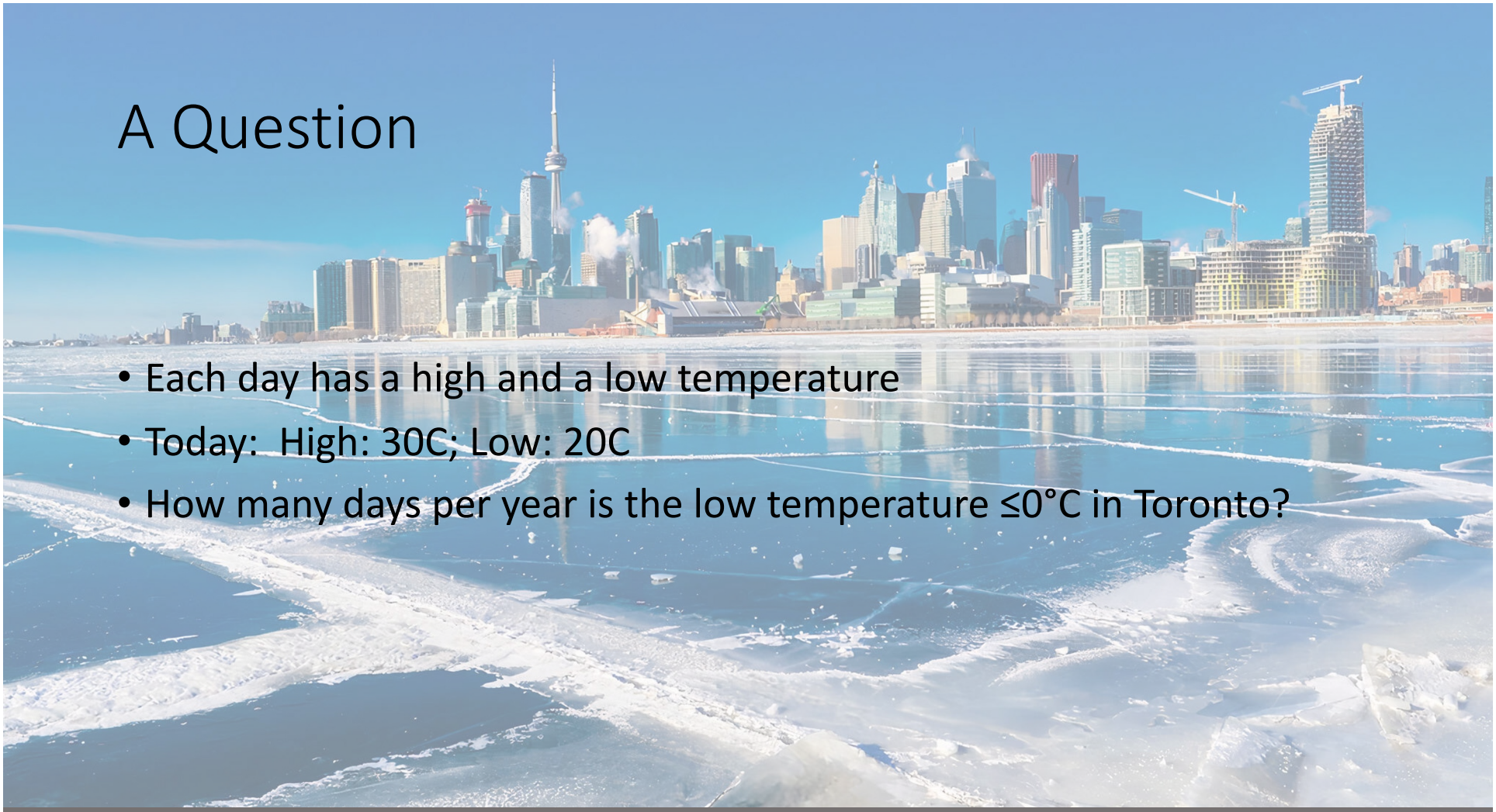
- Two problems with risk
  - Estimation
  - Comprehension
- For physicians, patients, policy makers
- Often difficult to think probabilistically
- Especially difficult to think about small risks

3. Inherent Uncertainty

Uncertainty

- Distinct from risk
- How certain are you about your estimate?
- Experts often overestimate their certainty, i.e., often don’t include the “correct” value in their ranges





A Question

- Each day has a high and a low temperature
- Today: High: 30C; Low: 20C
- How many days per year is the low temperature ≤0°C in Toronto?

A bet

- I will offer you a bet
- The odds of me winning (you losing) are 9:1
- You should only bet if you are 90% or more confident in winning
- We are betting on the number of days with the low temperature ≤0°C in Toronto (mean 1981-2010)
- The "bet" on the table is 130 to 170 days
- If the true value is
  - Inside this range ➔ you win $10
  - Outside this range ➔ I win $10
- Would you take the bet?

- What is your "90% confidence interval"?

Poll

A bet … the answer

- How many days per year is the low temperature below zero degrees Celsius in Toronto?

https://climate.weather.gc.ca/climate_normals/index_e.html

4. Conflicting Values

Values

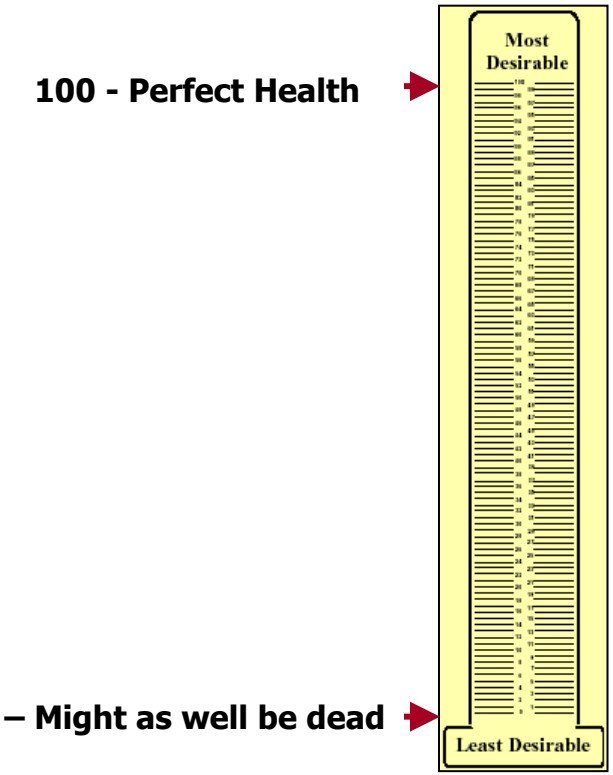
- Public/Patient values often vary
- May not be well characterized
- “I would rather fall and die at home than have to leave and be admitted to a nursing home.”
- One major way of valuing health: Quality-Adjusted Life Years

Quality-Adjusted Life Years

- Basic Principle
  - 1 Year of life in good health is not equal to 1 Year of life in poor health
- Utility
  - Utility is a measure of preference for a health state expressed on a 0 -1 scale (death – perfect health)
  - Used to calculate quality adjusted life years (QALYs)

Measuring Utilities: Rating Scale

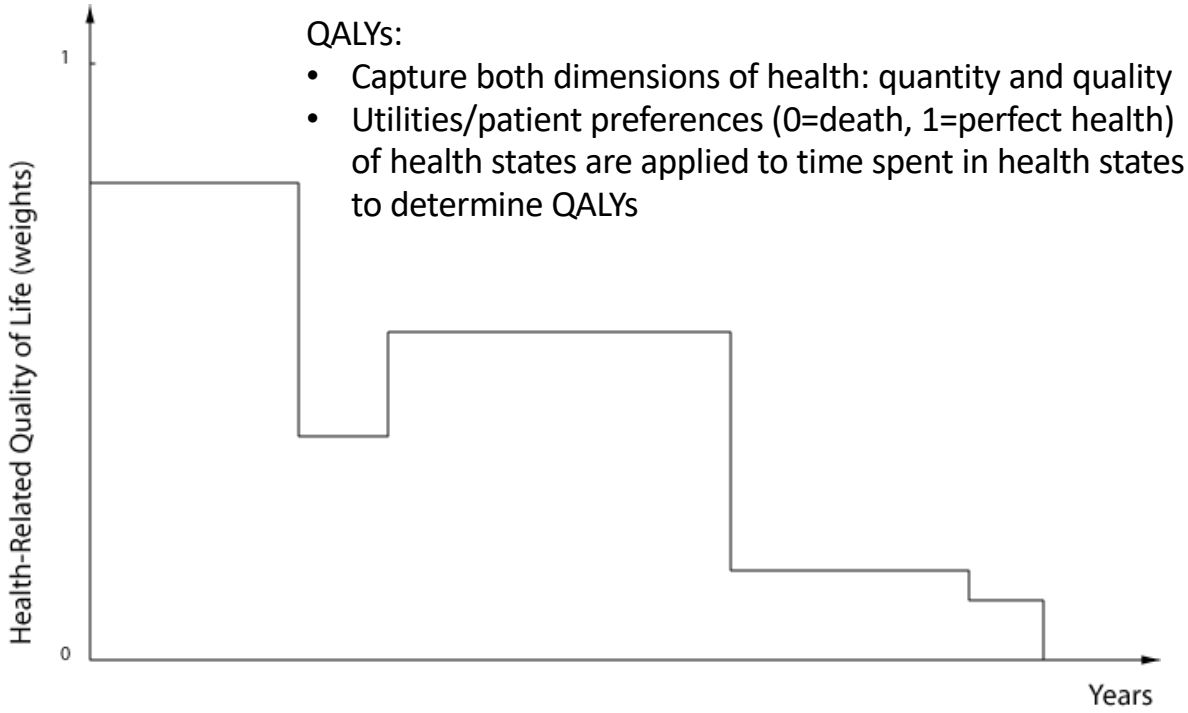
- How would you rate
  - Stay as is
  - Surgery
    - Successful?
    - Failure?



Methods to Elicit Values

- WHO? Patients vs. general public
- WHAT? Own health vs. standardized health
- HOW?
  - Direct vs. indirect measurement
  - Rating Scale, Time Trade-off, Standard Gamble (gold standard), Discrete Choice Experiments
  - Interviewer vs. paper vs. computer

QALYs



QALYs:

- Capture both dimensions of health: quantity and quality
- Utilities/patient preferences (0=death, 1=perfect health) of health states are applied to time spent in health states to determine QALYs

Concern: "A QALY is a QALY is a QALY."

5. Heuristics and Biases

Heuristics and Biases

- Heuristics: "rules of thumb" in situations where a judgment or prediction is necessary ("short cuts" or intuitive procedures)
  - Advantage: save time and convert the complex task of assessing probabilities into a simple judgment procedure
  - Disadvantage: can lead to systematic errors in judgment → cognitive biases
- Use of heuristics and tendency toward biased assessments is not limited to the scientifically naive lay public. People with extensive research and statistical training are prone to the same biases when they think intuitively.

- Examples:
  - Representativeness Heuristic
  - Availability Heuristic
  - Confirmatory Bias

Representativeness Heuristic

- Judge feature representative of a condition to indicate membership in a group
  (resemblance is used as a means of assessing likelihood)
- Example: a person with a stethoscope and a pager is probably a doctor
- Can yield accurate results when representativeness correlates with likelihood
- But can be a problem when over-reliance on “representative” features yields false conclusions

Representativeness Heuristic: Example

1945, New York City children evaluated for tonsillitis

- Experts examined 389 children
  Recommended tonsillectomy for 174 (45%)
- 2nd group examined other 215 children
  Recommended tonsillectomy for 99 (46%)
- 3rd group examined other 115 children
  Recommended tonsillectomy for 51 (44%)

Problem: Expectation that each group represents the overall populations

6. Individualizing Risks and Benefits

Individualizing Information

- Patients may not resemble patients in clinical trials
- Even if they resemble the typical patient, individualized risks may be important
- For example, blood pressure or cholesterol levels

[similar concerns when parameterizing models]

Approaches for Determining Individual Risk

- Subgroups of clinical trials
  - But often underpowered or not pre-specified hypotheses
- Population-based data
  - Level of detail may not be sufficient
- Clinical prediction rules
  - But often not validated
- Clinical judgment
  - Recall study suggests MDs good at estimating relative risk

7. Synthesis

Synthesis

- Decisions are rarely difficult because of only one reason
  i.e., must synthesize risk, uncertainty, values, and sometimes ignorance
- Difficult for patients, providers, policy makers
- From cognitive, emotional, and value perspectives

Decision Analysis

Difficult Decisions → Decision Analysis

- Uncertainty and tradeoffs: common in clinical decision making
  - Effect size and duration
  - Benefits/harms; benefits/costs
  - Values

- Ignorance
- Risk
- Uncertainty
- Values
- Biases
- Synthesis

Decision Analysis

- A systematic, quantitative and explicit approach to analyzing difficult clinical decisions
- Based on expected utility theory
- "The only well-developed prescriptive framework for choice under uncertainty"

DA is widely used in health and medicine

- Clinical decision-making
  - Individual
  - Guidelines
- Policy decision-making (model-based economic evaluations)
  - Drugs
  - Vaccines
  - Technologies
  - Other

https://www.cadth.ca/about-cadth/what-we-do/products-services/cdr/reports
https://www.hqontario.ca/Evidence-to-Improve-Care/Health-Technology-Assessment/Reviews-And-Recommendations

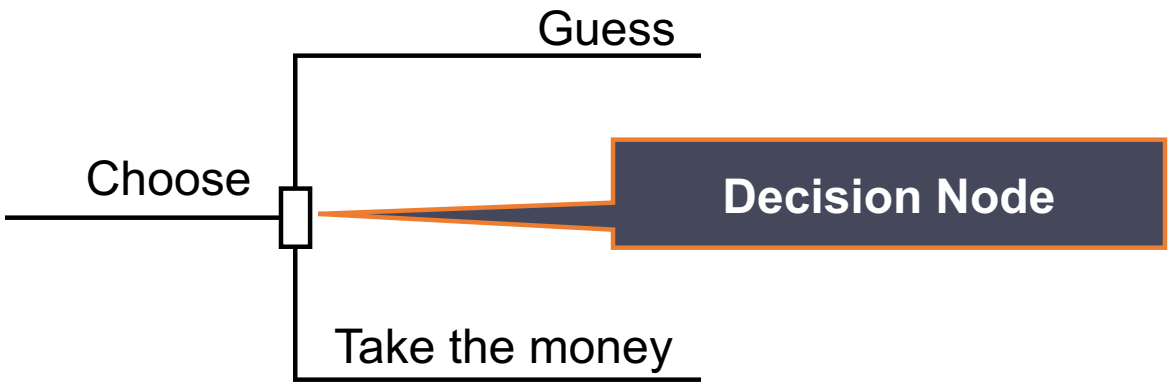
Elements of Decision Analysis

- Strategies
- Probabilities
- Outcomes (e.g., health outcomes, quality of life, cost)

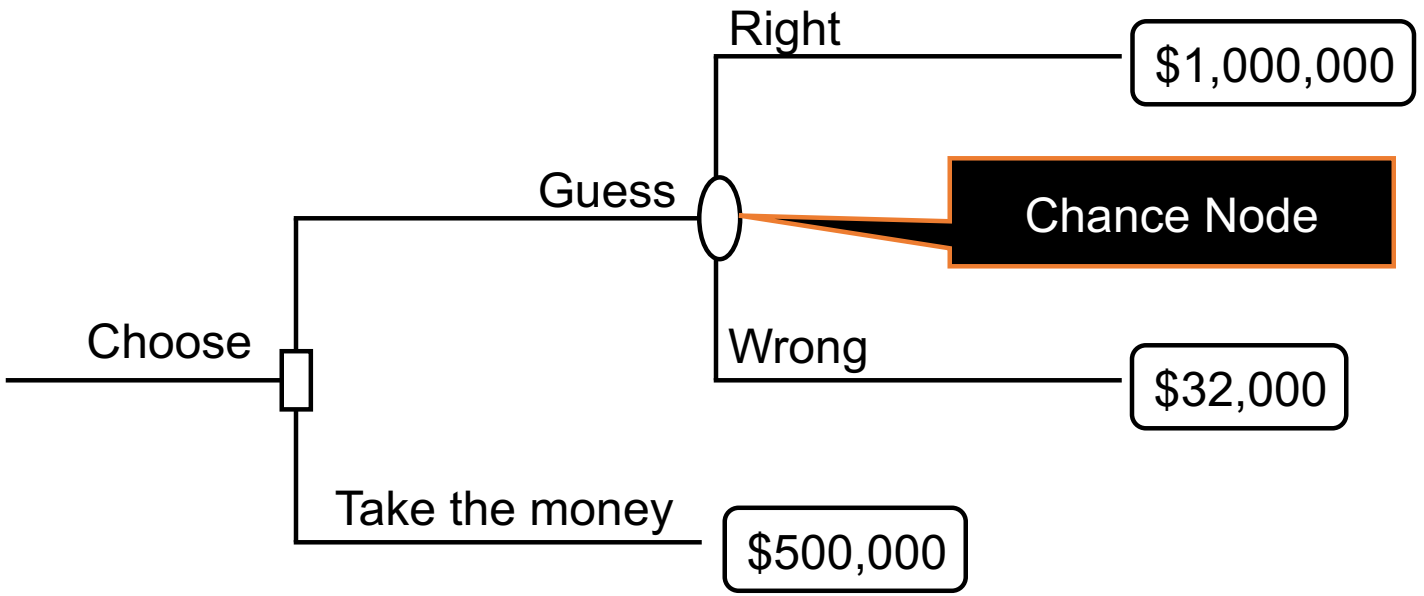
The Scenario

- “Who wants to be a Decision Maker”
- Could win a $1,000,000 grant
- Already won $500,000
- Assured at least $32,000
- No Lifelines left

Strategies



The Decision in Tree Format

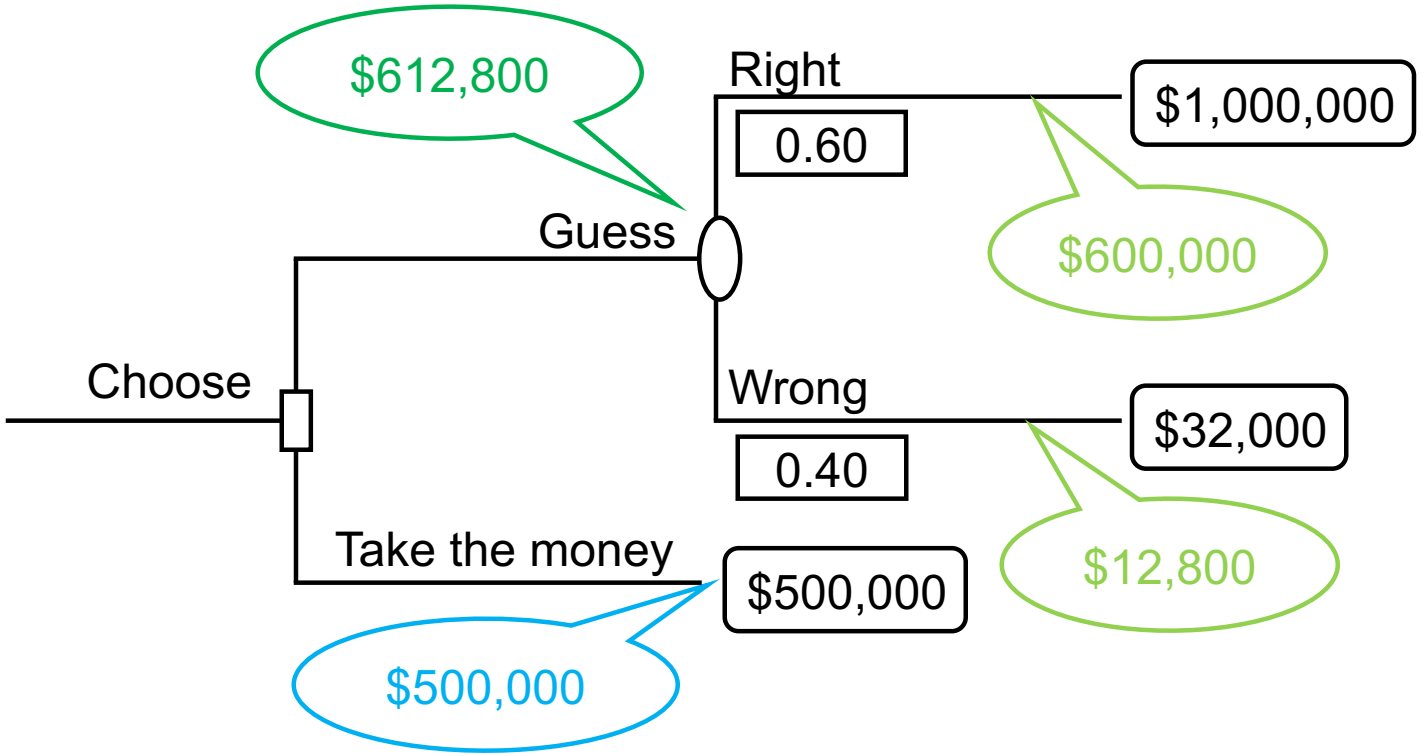


Put in Probabilities

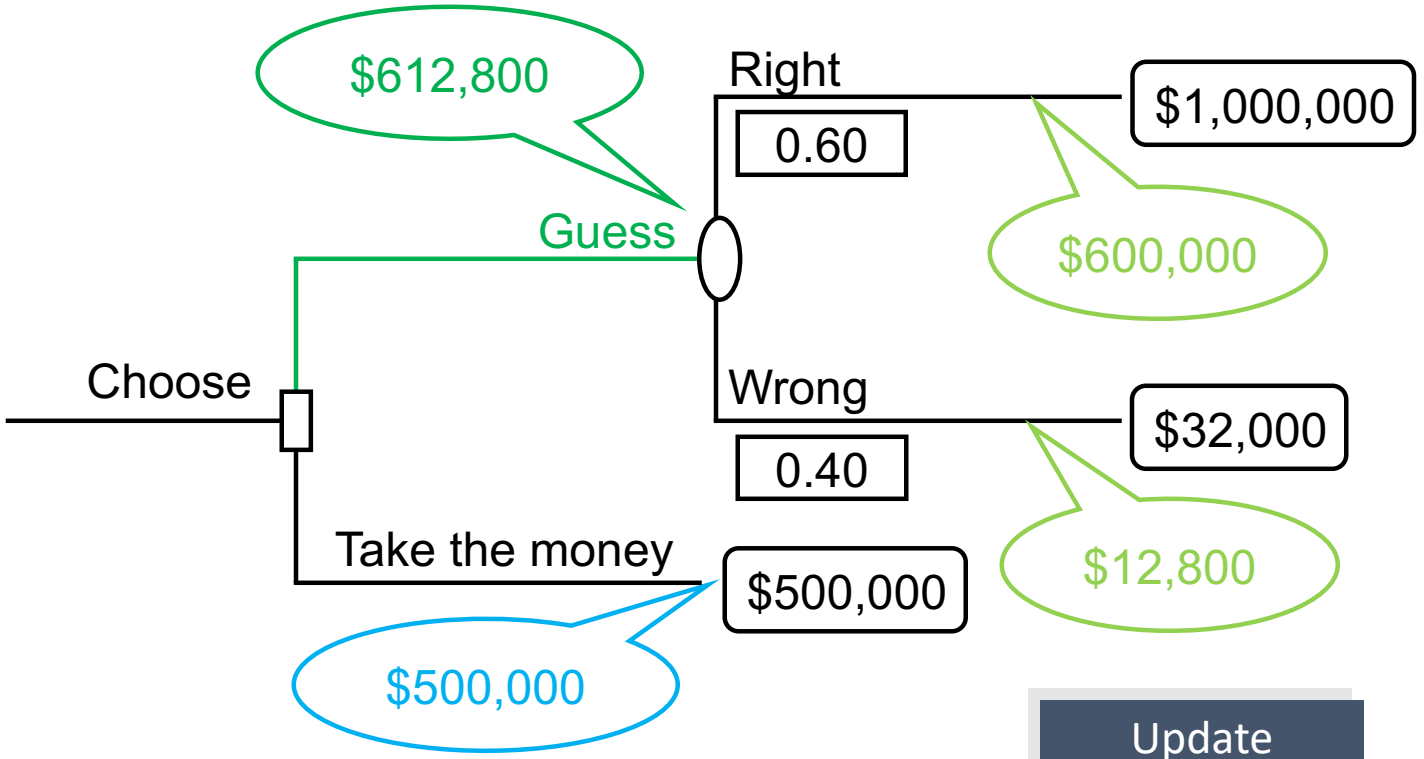
Poll

$p = 0.4$, $p = 0.8$

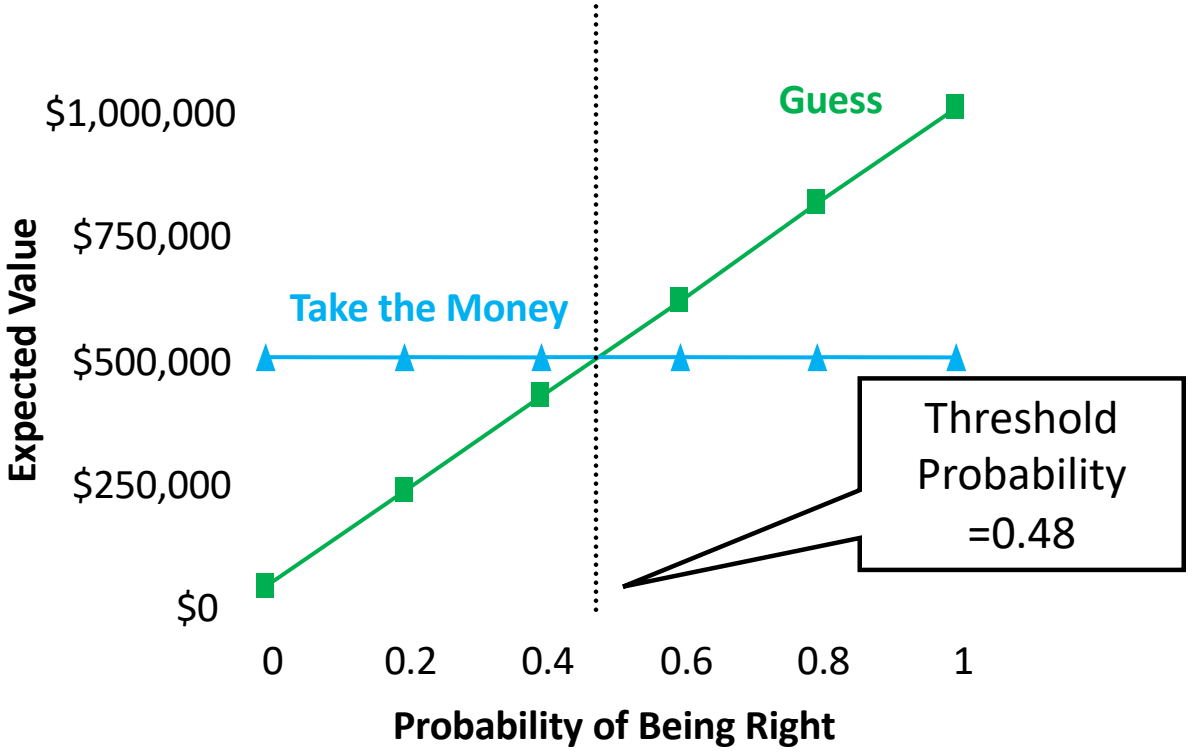
The Decision in Tree Format



Put in Your Own Probabilities



Sensitivity Analysis



Utilities

- Reflect preference for outcomes
- Consider:
  - $32,000 gain if
    - net worth is $5,000
    - net worth is $500,000
- Or
  - 6 month extended life if
  - Life expectancy is
    - 1 year
    - 25 years

Calculate Your Utilities

- Assume utility of having $1,000,000 = 1.0
- Assume utility of having $0 = 0

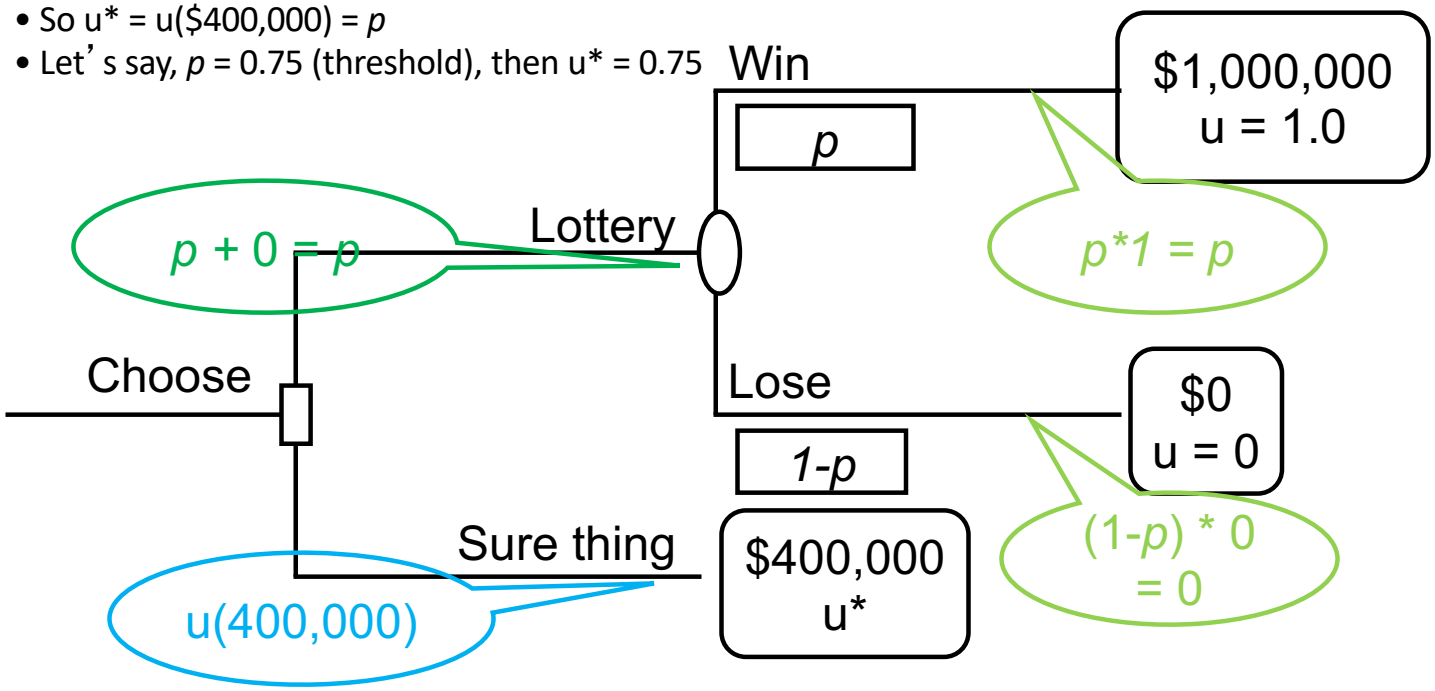
- Consider a lottery
  - 50% chance of winning $1,000,000 (nothing if you lose) OR
  - $400,000 gift

- Many would choose sure thing
- Even though it has less “expected value”

Utility calculator

At the threshold probability, *p*, the "Lottery" and "Sure thing" are equally desirable

- So u* = u($400,000) = *p*
- Let's say, *p* = 0.75 (threshold), then u* = 0.75



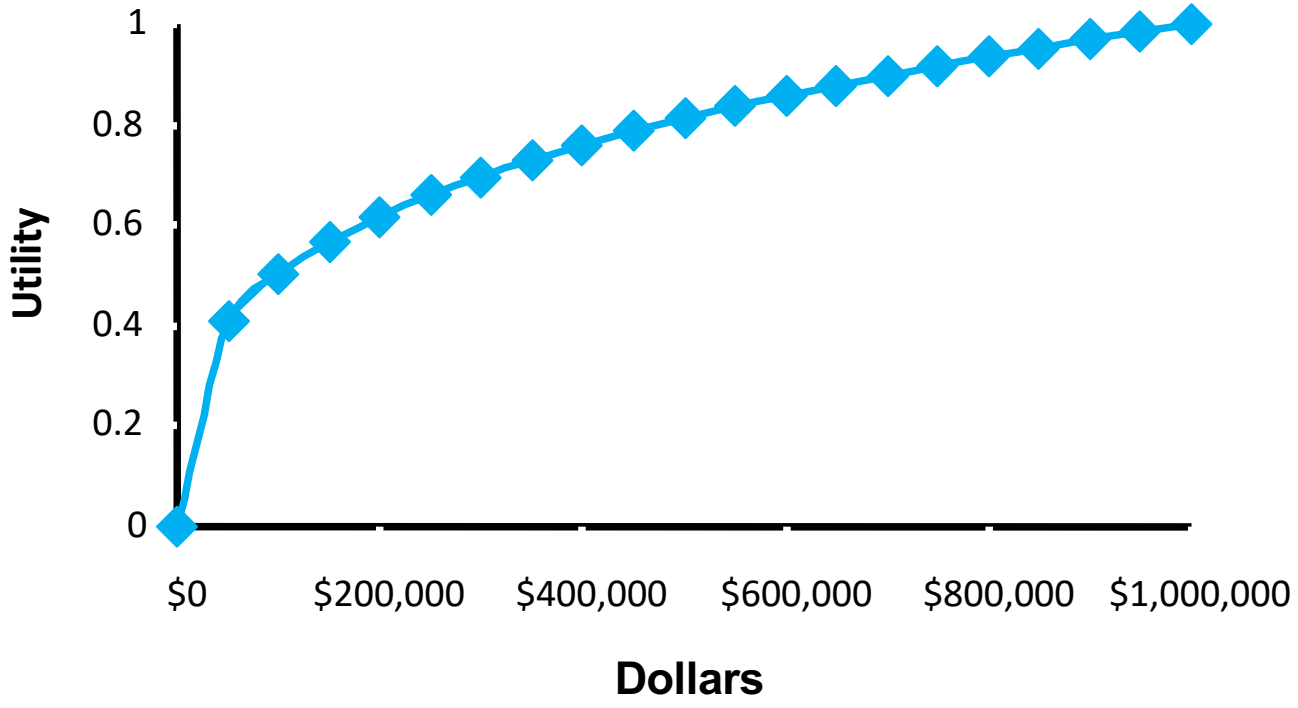
- What would you do if p=0.5? What if p=0.99?
- If you changed your mind, then there must be a "threshold" between 0.50 and 0.99

Utility Values

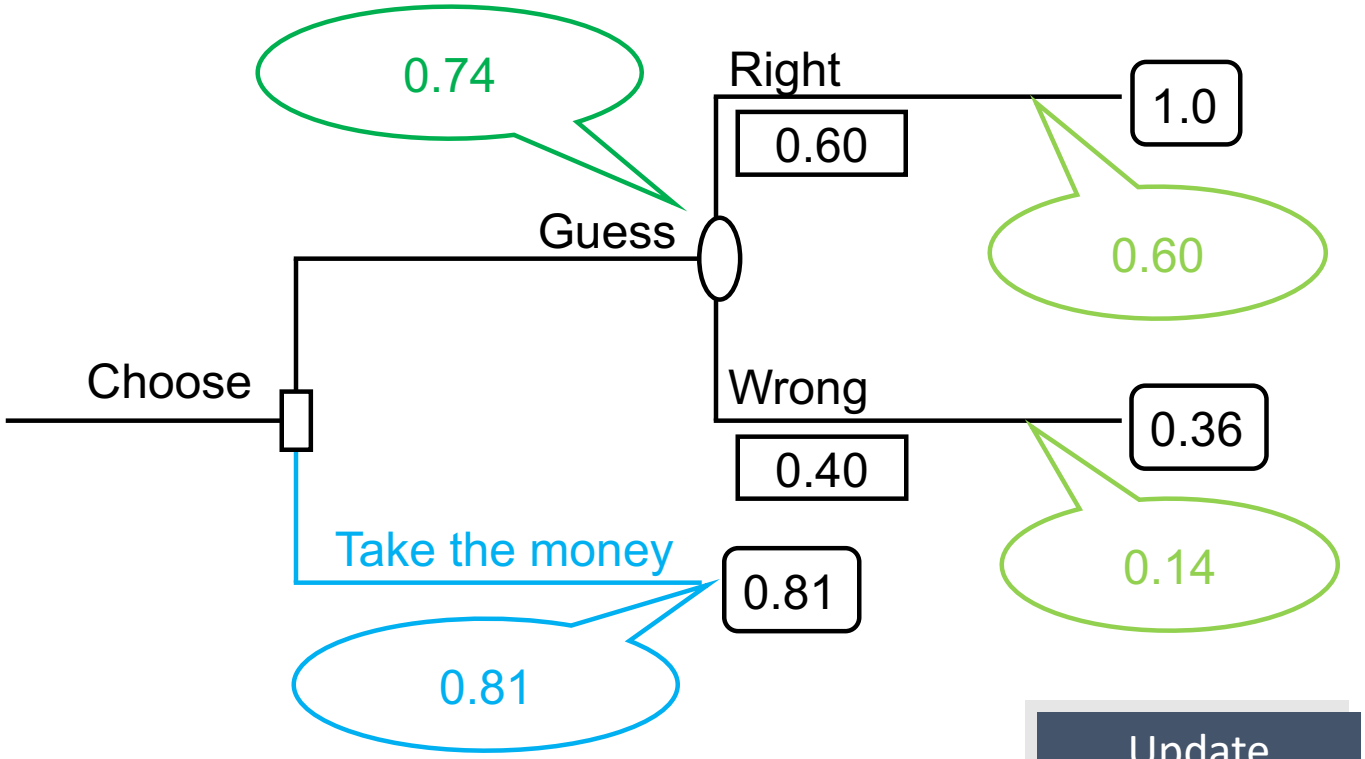
Repeat Several times

Dollars	Utility
$50,000	0.41
$100,000	0.50
$250,000	0.66
$500,000	0.81
$750,000	0.92

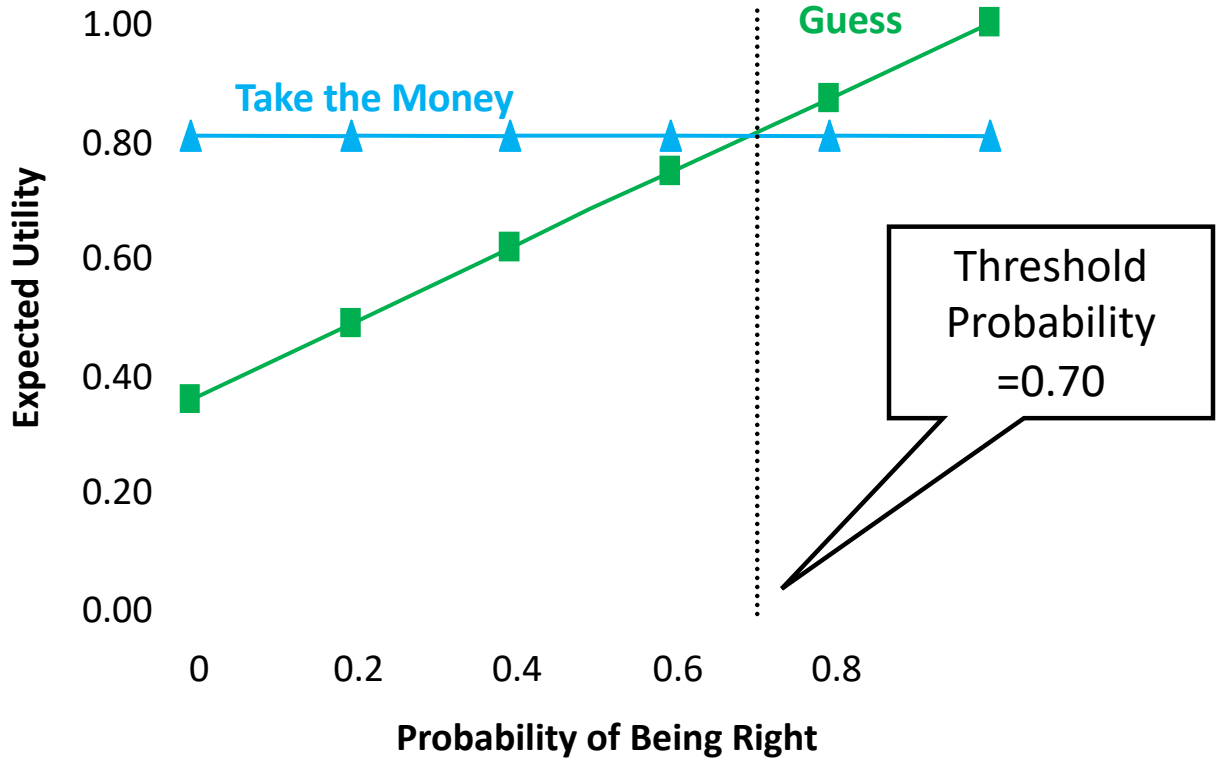
Graphically



Decision Tree with Utilities



Sensitivity Analysis with Utilities



Strengths of Decision Analyses

- Tradeoffs made explicit
- Insights from scenario and sensitivity analyses
- Examine multiple outcomes
- Incorporate Quality of Life

Weaknesses of Decision Analyses

- Black Box models
- Verisimilitude vs. Clinical Complexity
- Assumptions and Extrapolations
- Prescriptive/Descriptive Tension

Purpose of Decision Analysis

. . . is to assist in the comprehension of the problem and to give us insight into what variables or features of the problem should have a major impact on our decision.

Hunink