

Making Decisions under Risk
An Overview of Structured Decision Making

Module I — Making Decisions under Risk

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This module is about making decisions in the face of uncertainty, which necessarily involves risk. How do we perceive risk, evaluate risk, and make sound decisions in the presence of risk?

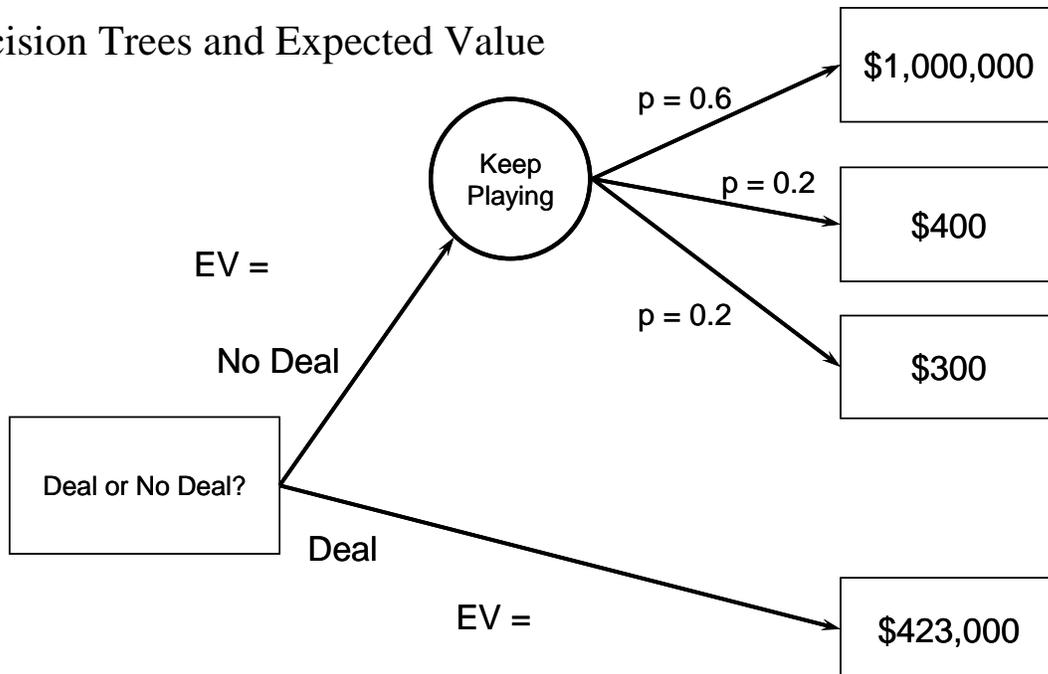
Deal or No Deal?

In the October 29, 2008 episode of “Deal or No Deal”, Tomorrow Rodriguez was trying to win \$1,000,000. In the sixth round, she had eliminated all but 5 cases, and those contained:

- \$1,000,000
- \$1,000,000
- \$1,000,000
- \$400
- \$300

The banker offered her \$423,000 to stop playing. What should she have done? What would you have done?

Decision Trees and Expected Value



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Module Outline

- Human intuition and risk
- What do we do in the face of uncertainty?
 - Make decisions anyway
 - Approaches to risk
 - Utility
 - In a later module...*
 - Conduct research to reduce uncertainty (then make a decision later)
 - Value of Information
 - Both, simultaneously
 - Adaptive management

Human Intuition and Risk

Human intuition

- One of the first challenges with decision making in the face of uncertainty:
 - We don't understand probability very well
 - We have a lot of inherent tendencies toward biased estimation of probability
- The second challenge of course,
 - Is that even if we can quantify the risks, we don't know what to do in response

Expression of Uncertainty

Assign a numerical probability to the following phrases:

Phrase	Numerical Probability	Range
High Probability		
Not very probable		
Seldom		
Quite Likely		
Rare		
Rather Likely		
Good Chance		
Uncertain		

S. Lichtensten & J. R. Newman. 1967. Empirical scaling of common verbal phrases associated with numerical probabilities. *Psychonomic Science* 9:563-564.

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Risk and the ESA

- What do these phrases mean?
 - "...in danger of extinction..."
 - "...likely to become endangered..."
 - Can you assign a probability to them?
-
-
-
-

Some hope: Odds

- Familiar to think of odds (betting, sports, etc.)
 - 100:1 chance
 - 100 losses for every 1 win
- Translating to probability
 - 101 total chances
 - $\text{Pr}(\text{loss}) = 100/101 = 0.99$
 - $\text{Pr}(\text{win}) = 1/101 = 0.01$
- Benefit of thinking in terms of probability
 - Rich theory and set of tools
 - Easier to work with quantitatively

Quick Exercise

- Translate the following odds into probability of success
 - 4:1 (against) _____
 - 19:1 _____
 - 2:5 _____

- Translate the following probabilities (of success) into odds (against)
 - 0.50 _____
 - 0.25 _____
 - 0.75 _____
 - 0.10 _____

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Decisions in the face of Uncertainty: Utility

Choose a game to play

- Game 1: Win \$30 with probability 0.5
 Lose \$1 with probability 0.5

- Game 2: Win \$2000 with probability 0.5
 Lose \$1900 with probability 0.5

Approach to Risk

- The decision-maker's approach to risk is a values decision
 - In our context, this is often a public value
- Who decides the approach to risk
 - Legal mandates (e.g., ESA)?
 - Western science (5% p-values)?
 - Other?

Dealing with Risk

- Optimization
 - Maximize (or minimize) expected value of objective function
 - Actual performance can be less, owing to uncertainty

- Mini-max, Maxi-min
 - Minimizes maximum loss, or maximizes minimum gain

- Satisficing and robustness
 - Focus on attaining a minimum performance requirement
 - Beyond that, seek a solution that guarantees minimum performance over greatest range of uncertainty

- Utility
 - Translate return into a utility scale that expresses risk attitude

- These alternatives differ essentially in the decision maker's attitude toward risk

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Expected Value, Maximin, & Robustness

Action	Outcome				EV	Min	P>15
	0	10	20	30			
A	.25	.25	.25	.25	15	0	50%
B	.00	.25	.50	.25	20	10	75%
C	.10	.20	.00	.70	23	0	70%
D	.20	.00	.80	.00	16	0	80%

Risk Attitude

- Consider the following wager
 - Win \$500 with prob 0.5, or lose \$500 with prob 0.5
- Would you pay to get out of this wager? How much?
- Would you pay to get into this wager? How much?
- Draw a decision tree to represent your decision for the first question (would you pay to get out of this wager?)

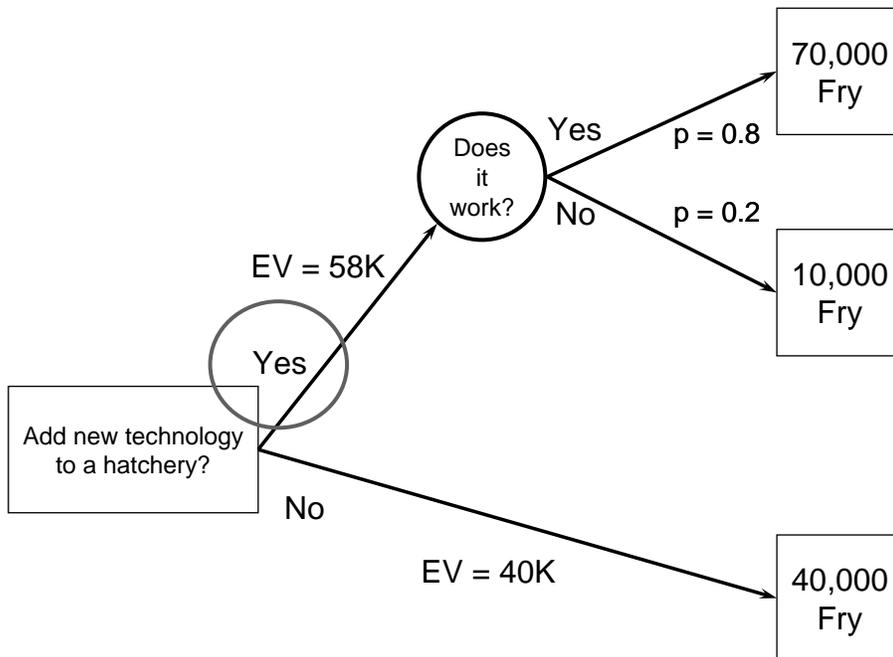
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Risk Attitude

- Risk-averse
 - You would trade a gamble for a sure amount that is less than the expected value of the gamble
 - e.g., buying insurance

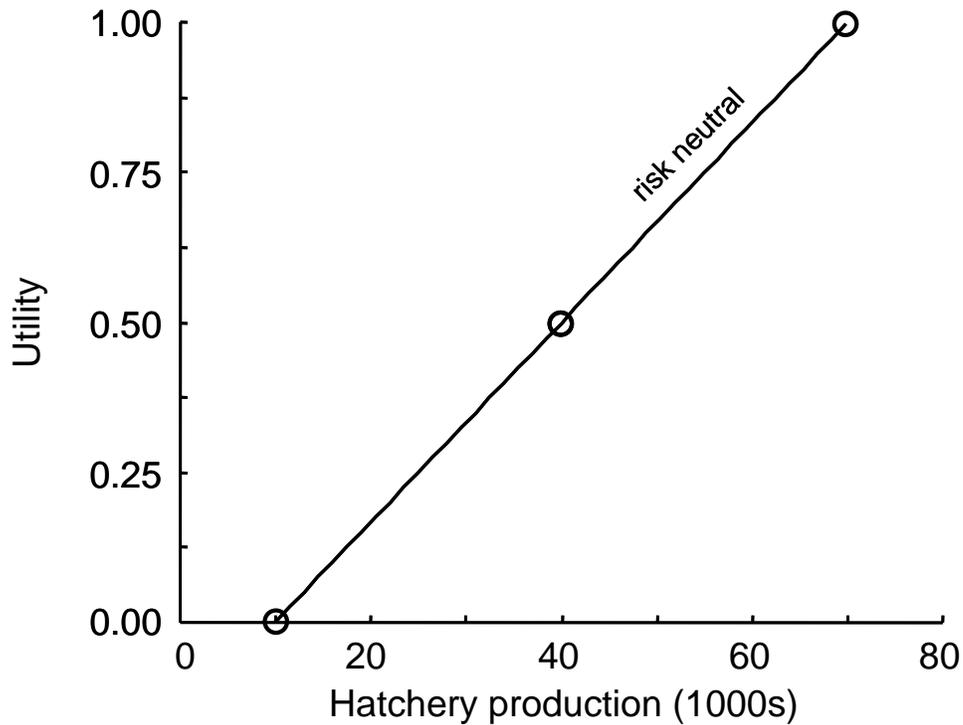
- Risk-seeking
 - You would trade a sure amount for a gamble that has a smaller expected value (but the chance of a larger payout)
 - e.g., buying lottery tickets

Decision Tree



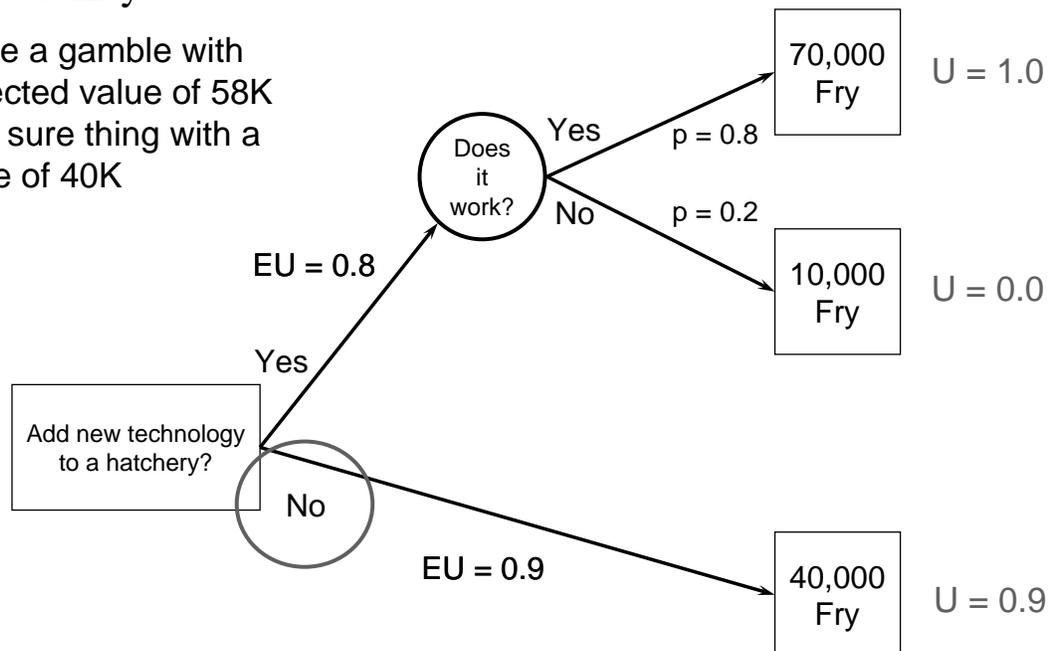
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Utility (you need to complete this graph)



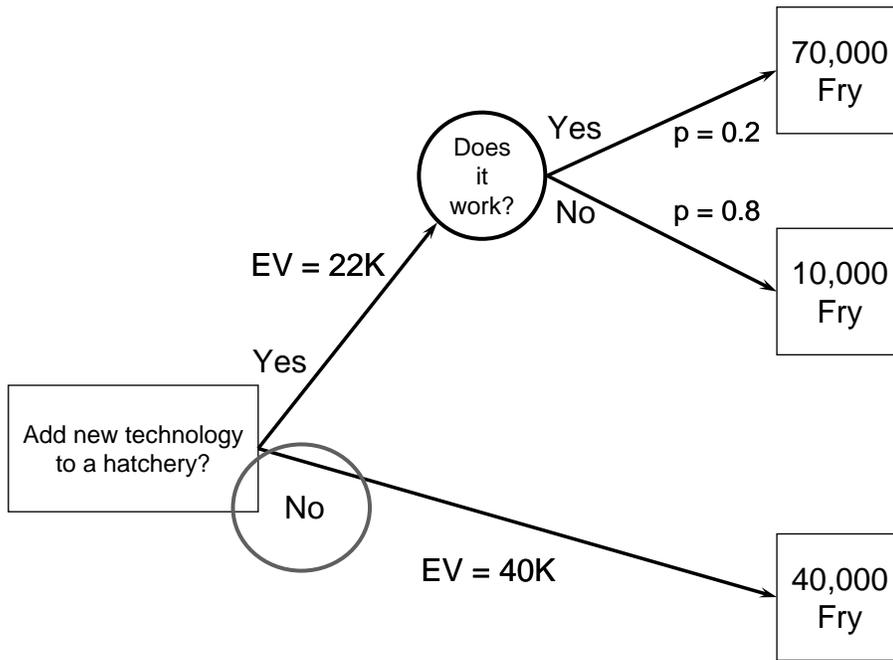
Risk-averse Utility

Trade a gamble with expected value of 58K for a sure thing with a value of 40K



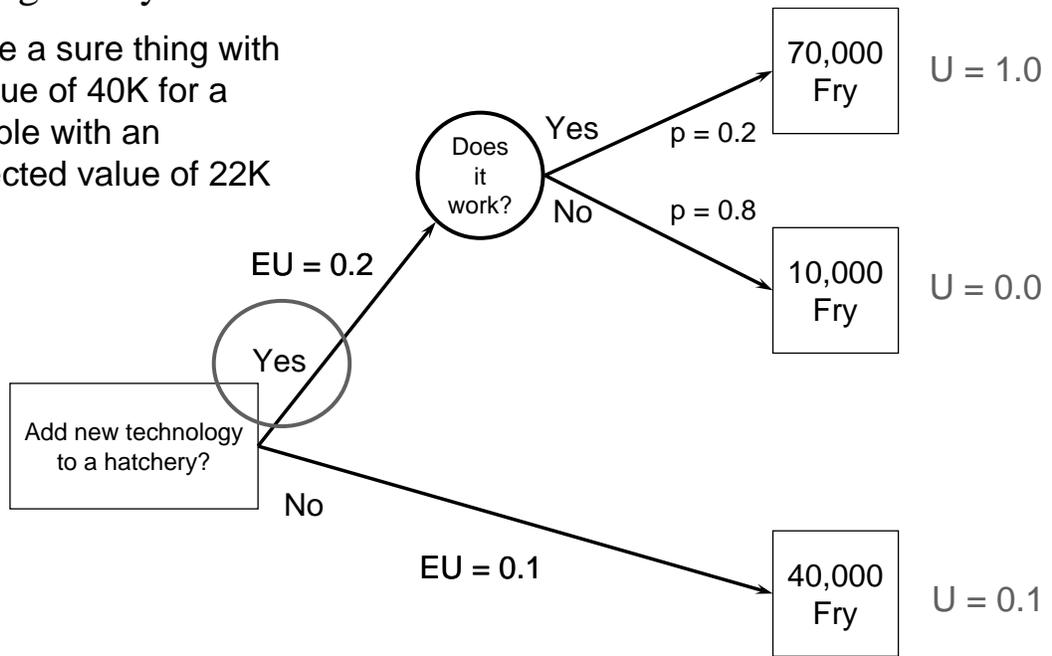
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Unproven Technology



Risk-seeking Utility

Trade a sure thing with a value of 40K for a gamble with an expected value of 22K



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Temporal Discounting

- One particular form of utility is used to deal with returns that occur at different times
 - How do we value a \$50 gain today vs. a \$55 gain in 10 years?
- Often, we discount future returns
 - In economic applications, we calculate the current value of future returns by applying the expected inflation rate
- Caution: as humans, when we make intuitive decisions, we have a very strong tendency to over discount the future

Discounting and Conservation

- Do we discount the future for conservation applications?
 - Compare: extinction of a species in 50 years vs. in 500 years; do you value these differently?
- A little bit of caution is needed, however, when applying discounting in some conservation settings
 - If you discount the future too heavily, e.g., in harvest situations, you will favor harvesting everything right now

Summary

- Decisions in the face of uncertainty
 - Need to consider decision maker's attitude toward risk
 - This amounts to valuing outcomes in way that is not linearly related to the gain or loss
 - The expected utility can capture the decision maker's risk attitude
- This assumes we have to live with the uncertainty
 - More on this assumption in the next module...

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Decisions in the face of Uncertainty: Climate Change

Speaking of uncertainty, we anticipate substantial changes to the environment over the coming decades, but we don't know all the ramifications of those changes to natural resource management. Presumably, however, there are some decisions we'd make differently if we knew which way things were going to play out. How might the concepts we've discussed in this course inform our approach to managing natural resources in the face of climate change?

- Structured decision making
- Multiple objectives
- Alternative actions
- Predicting consequences
- Uncertainty
- Risk
- Utility
- Other concepts...