

A Risk Management Framework

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Purpose of Risk Management

Balance the tradeoff between the level of livelihood (returns) and the stability of livelihood (risk).

It is not meant to encompass all aspects of decision making.

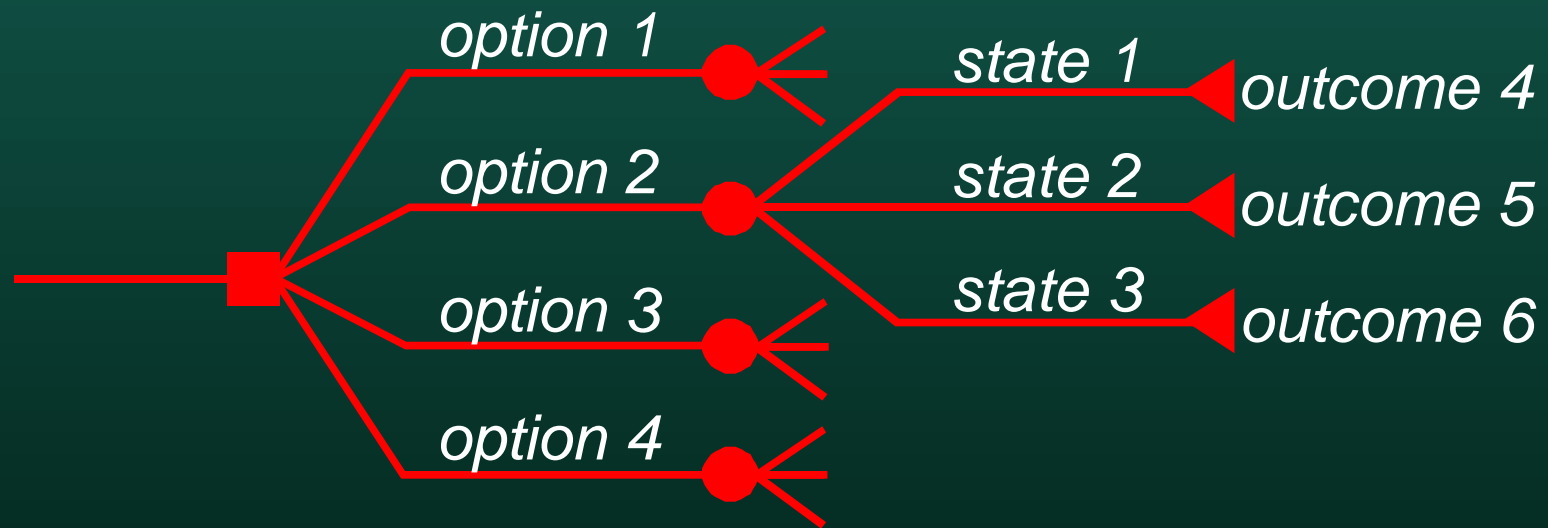
Decision Trees

Elements

decision
node

chance
node

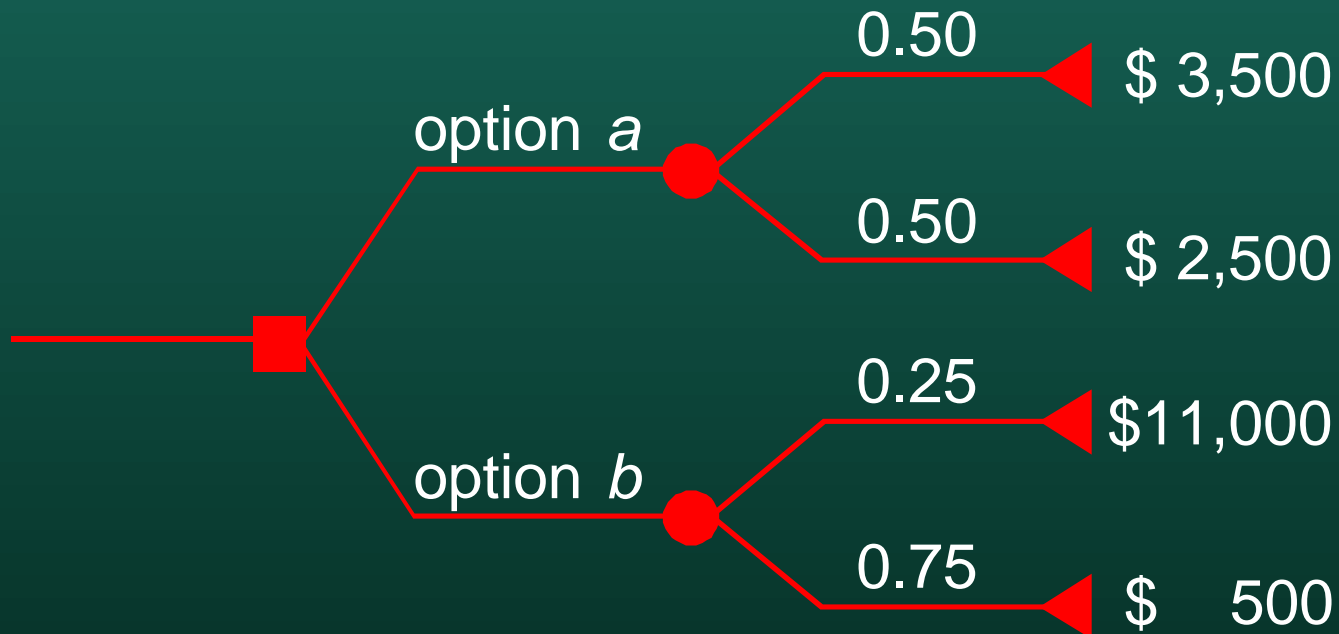
outcome
node



time →

Decision Trees

Expected Value

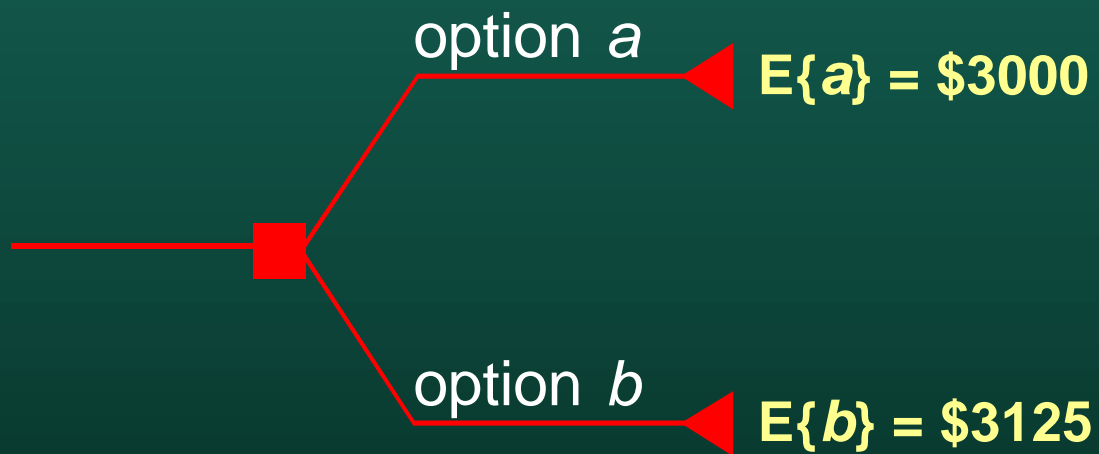


$$\begin{aligned}\text{expected value of } a &= 0.50 \times \$3,500 + 0.50 \times \$2,500 \\ &= \$3,000\end{aligned}$$

$$\begin{aligned}\text{expected value of } b &= 0.25 \times \$11,000 + 0.75 \times \$500 \\ &= \$3,125\end{aligned}$$

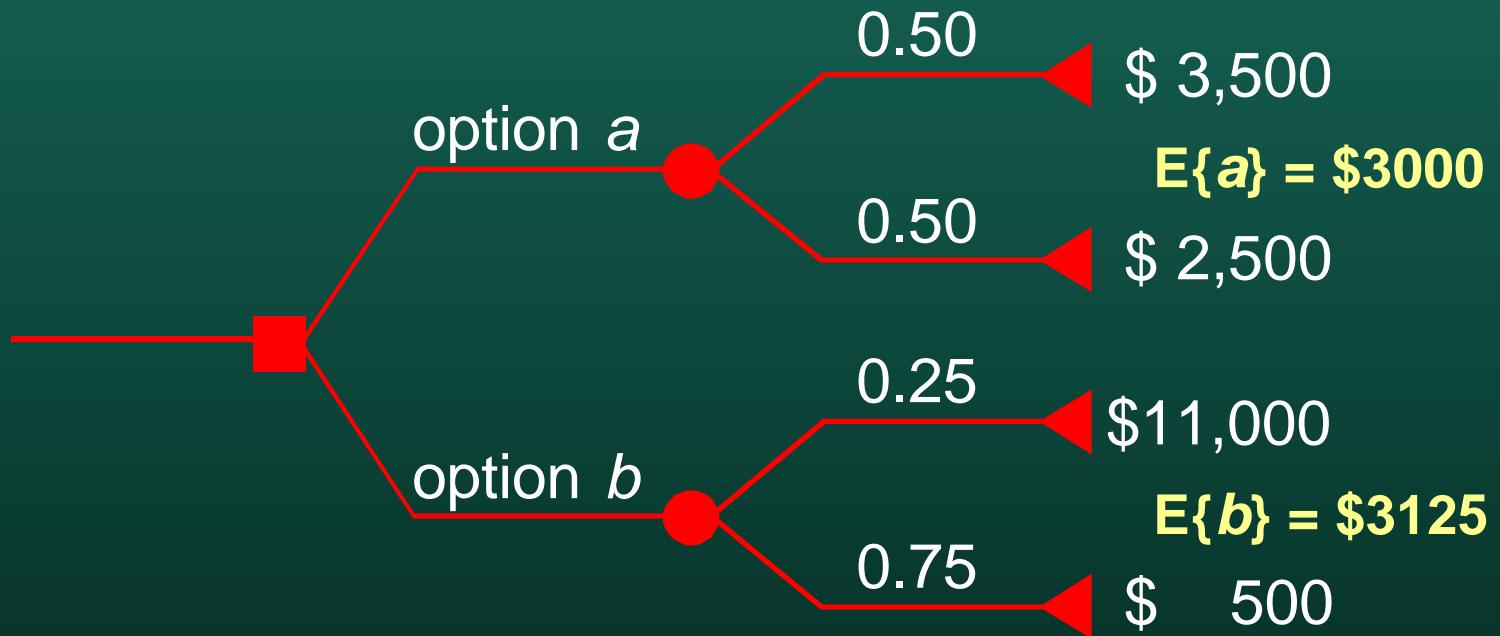
Decision Trees

Expected Value



Decision Trees

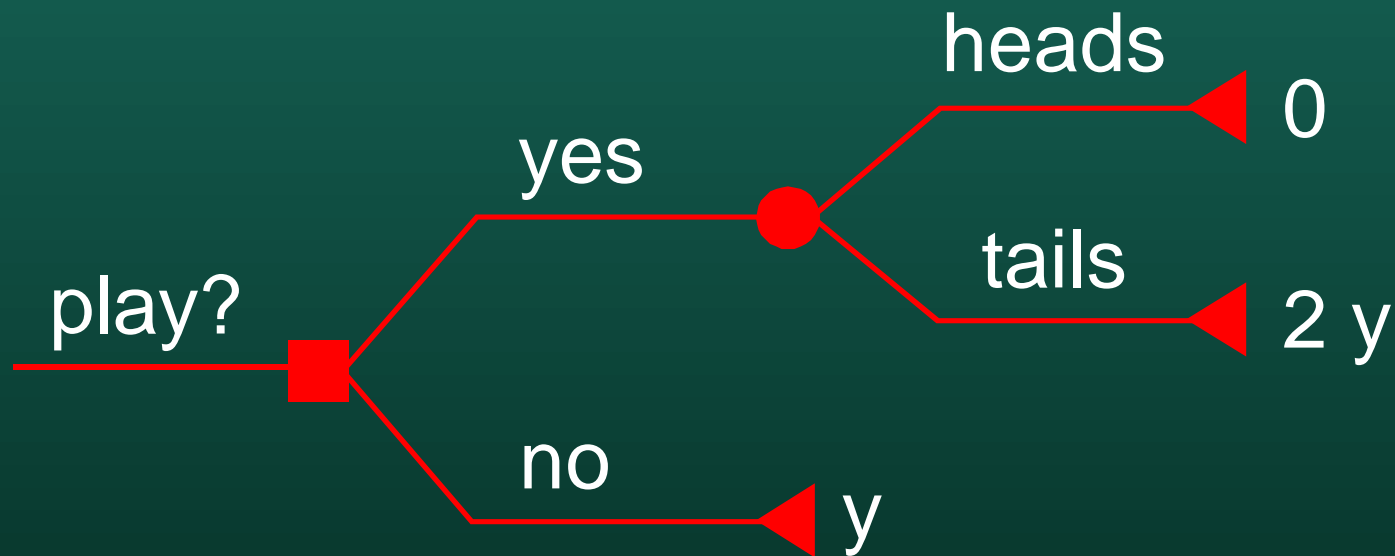
Expected Value



Is option *b* the best?

Decision Trees

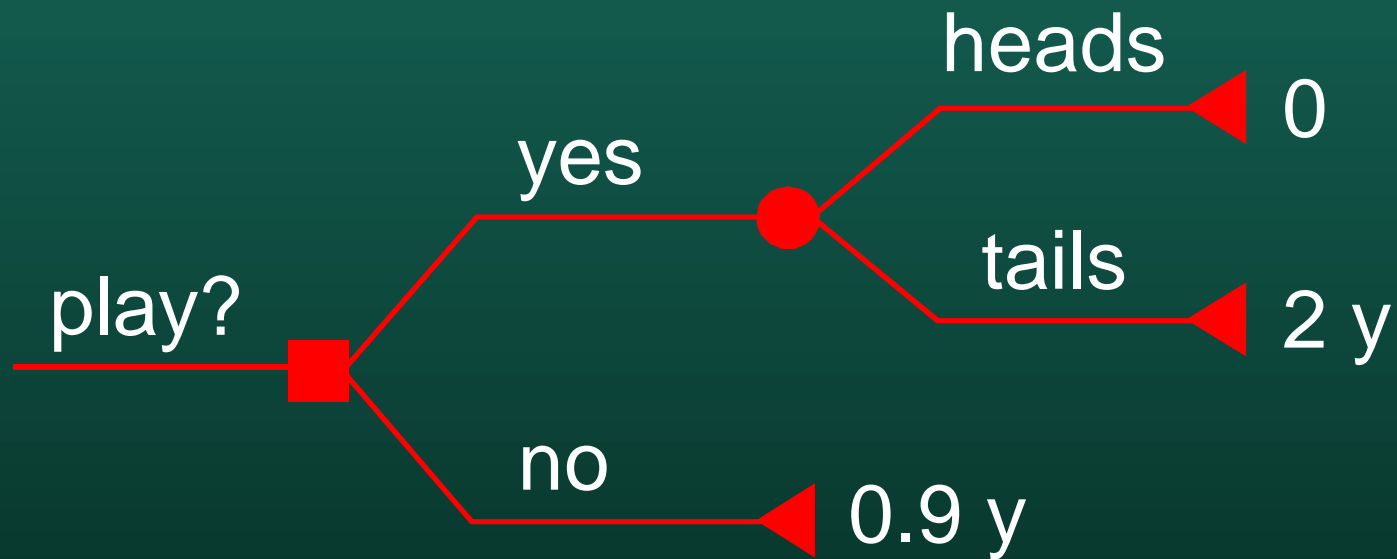
The “Coin Toss” Problem



What would you rather do?

Decision Trees

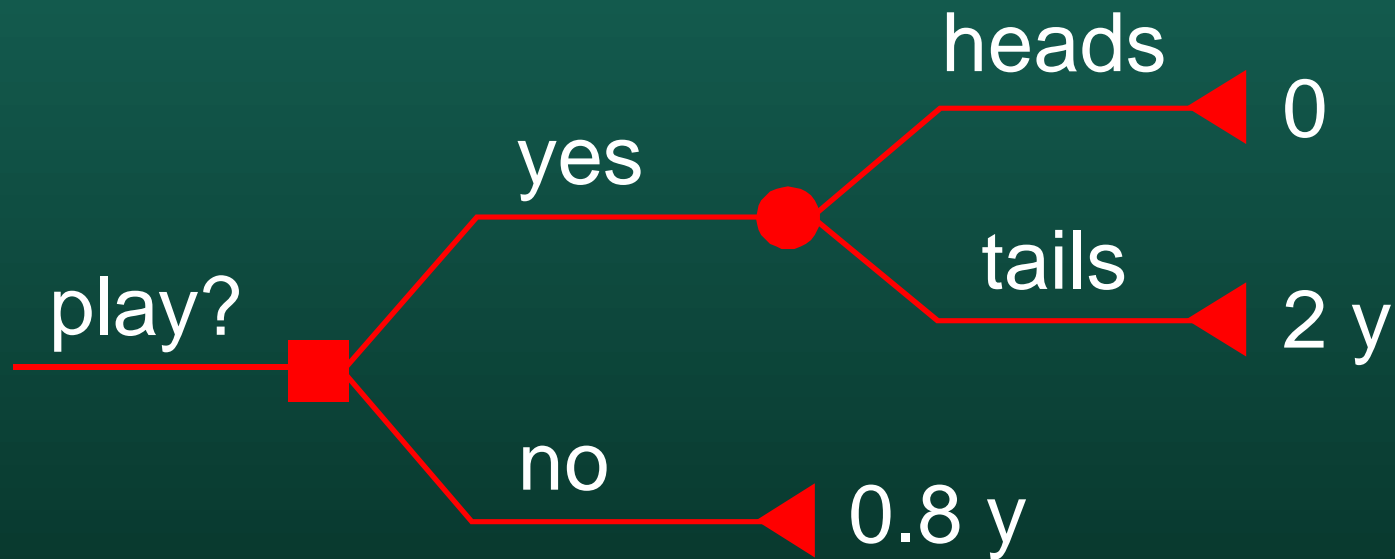
The “Coin Toss” Problem



What would you rather do?

Decision Trees

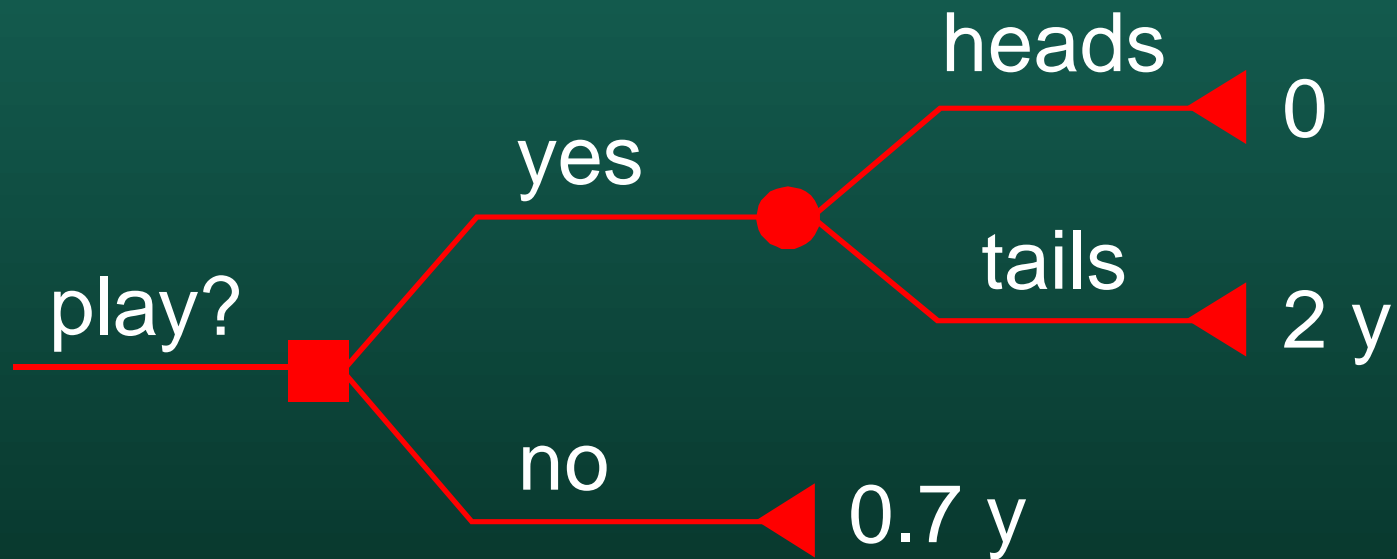
The “Coin Toss” Problem



What would you rather do?

Decision Trees

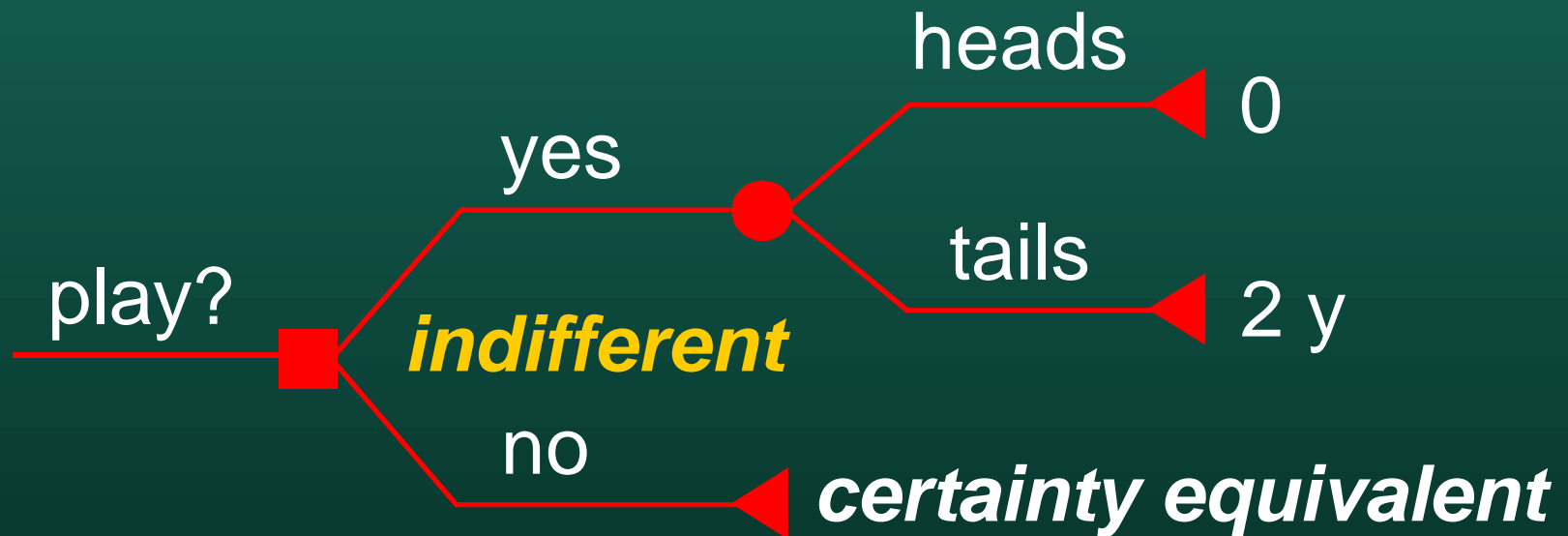
The “Coin Toss” Problem



What would you rather do?

Decision Trees

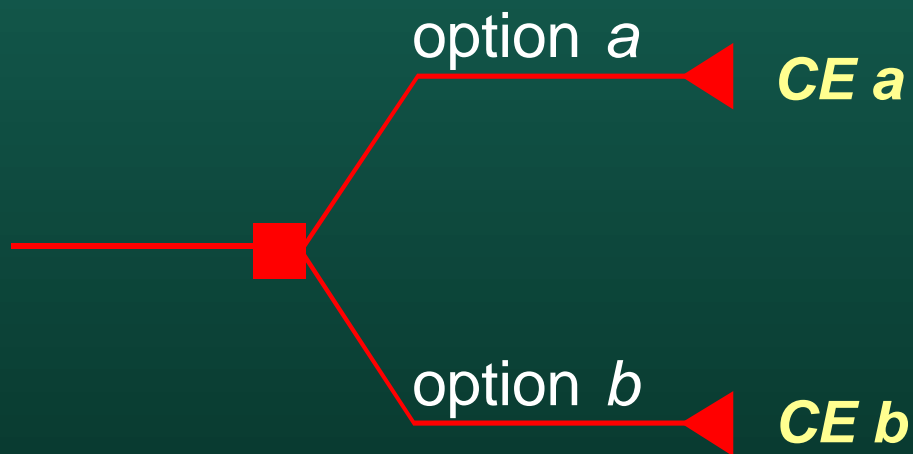
Certainty Equivalent



...the subjective value, under certainty, of the risky scenario

Decision Trees

Replace expected value with CE



Decision Trees

Decision trees are a useful way to think about risky decisions, but force decision options and states of nature to be discrete.

Agricultural decisions are often continuous.

Climate impacts are generally continuous.

Expected Utility

Notion of Utility

P The subjective value that an individual places on an outcome

P A function of how much resource one has (i.e., wealth)

P Unitless:

- < Can compare preferences among outcomes
- < Cannot compare preferences among individuals

Expected Utility

The Subjective Expected Utility Hypothesis

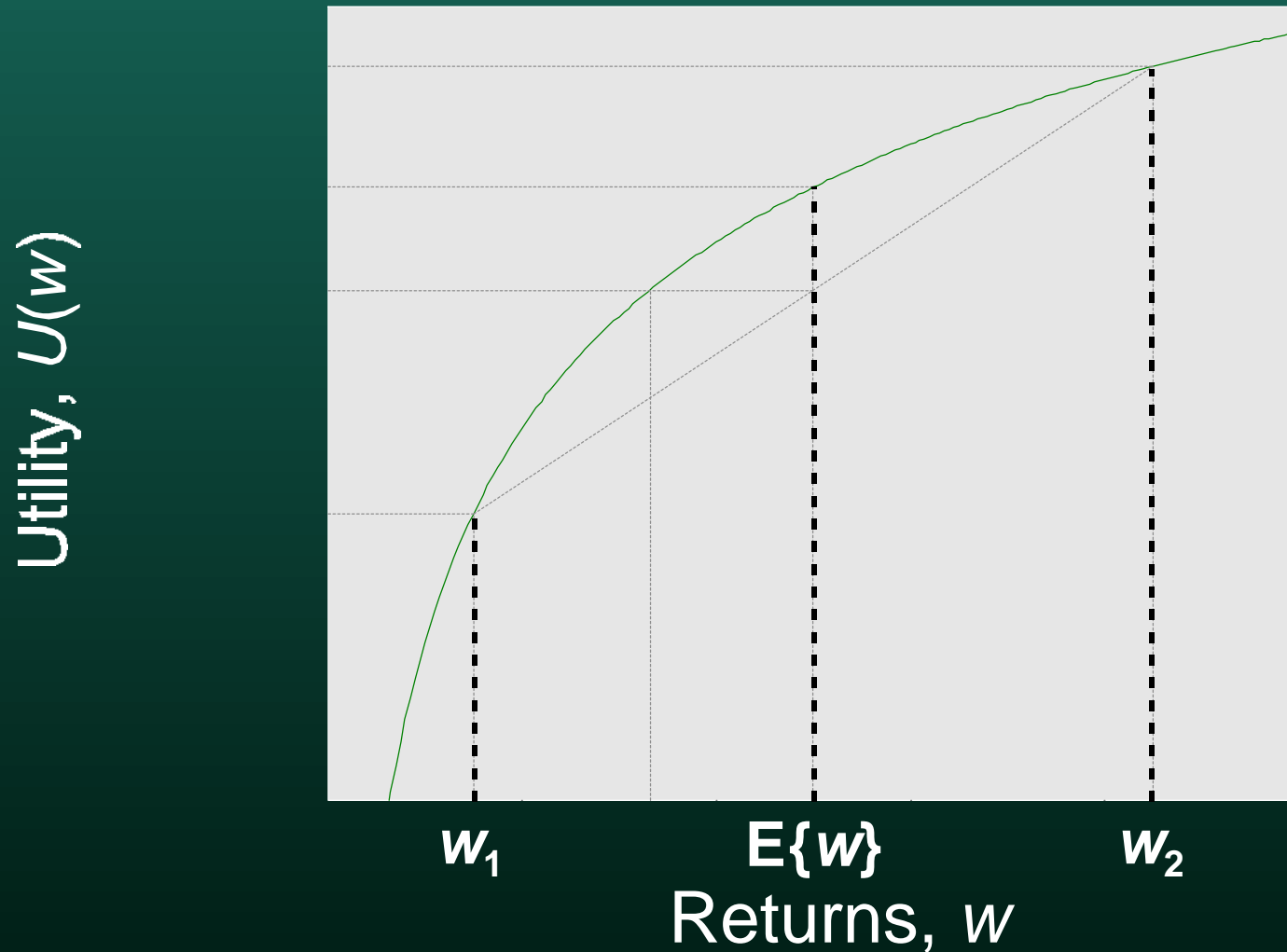
PA decision maker facing a risky prospect will seek to maximize expected utility for her subjective distribution of outcomes, subject to constraints

PIntegrates:

- < Subjective beliefs (probability)
- < Subjective preferences (utility)
- < Reality (constraints)

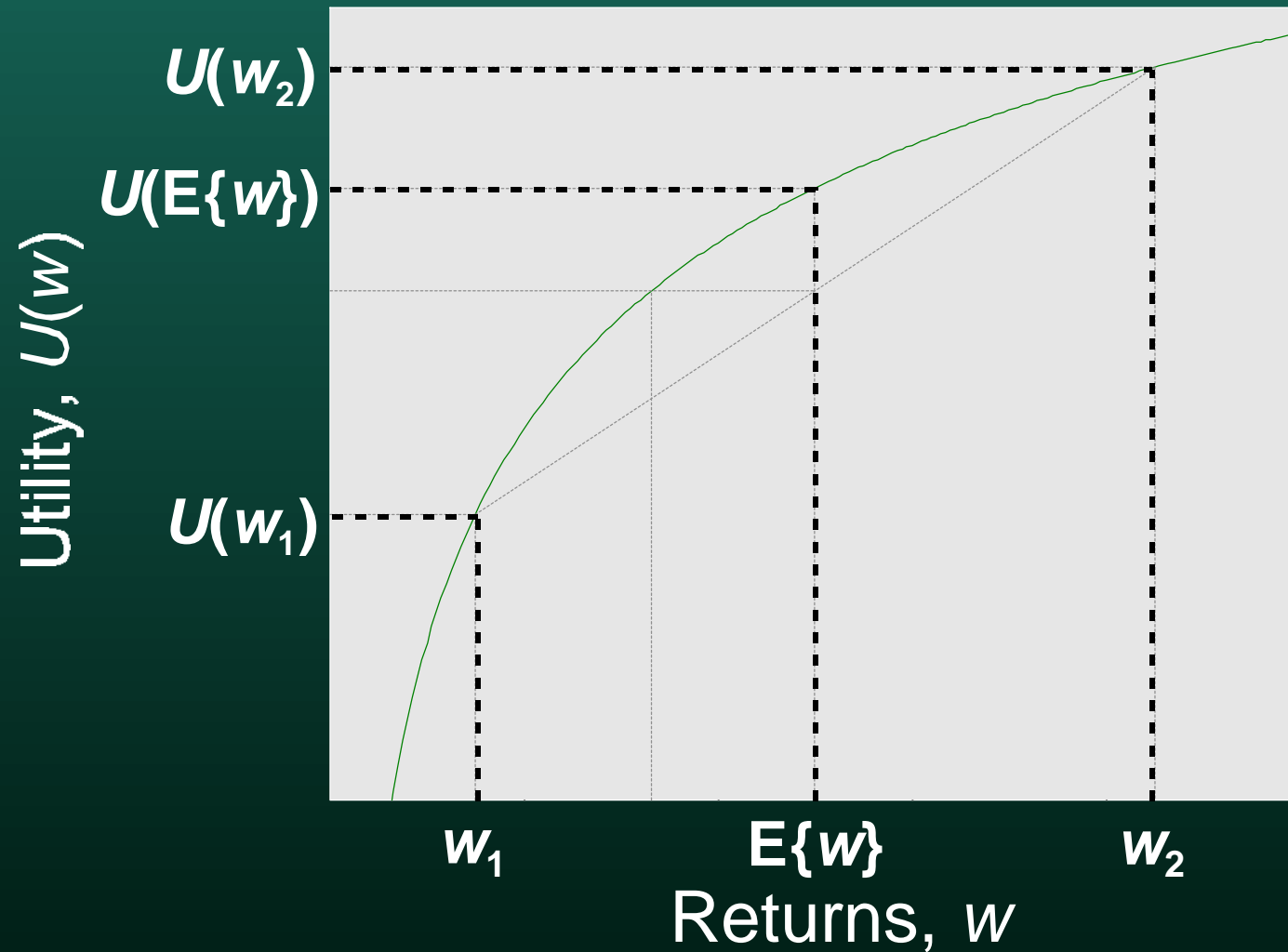
Expected Utility

“Coin Toss Problem” Revisited



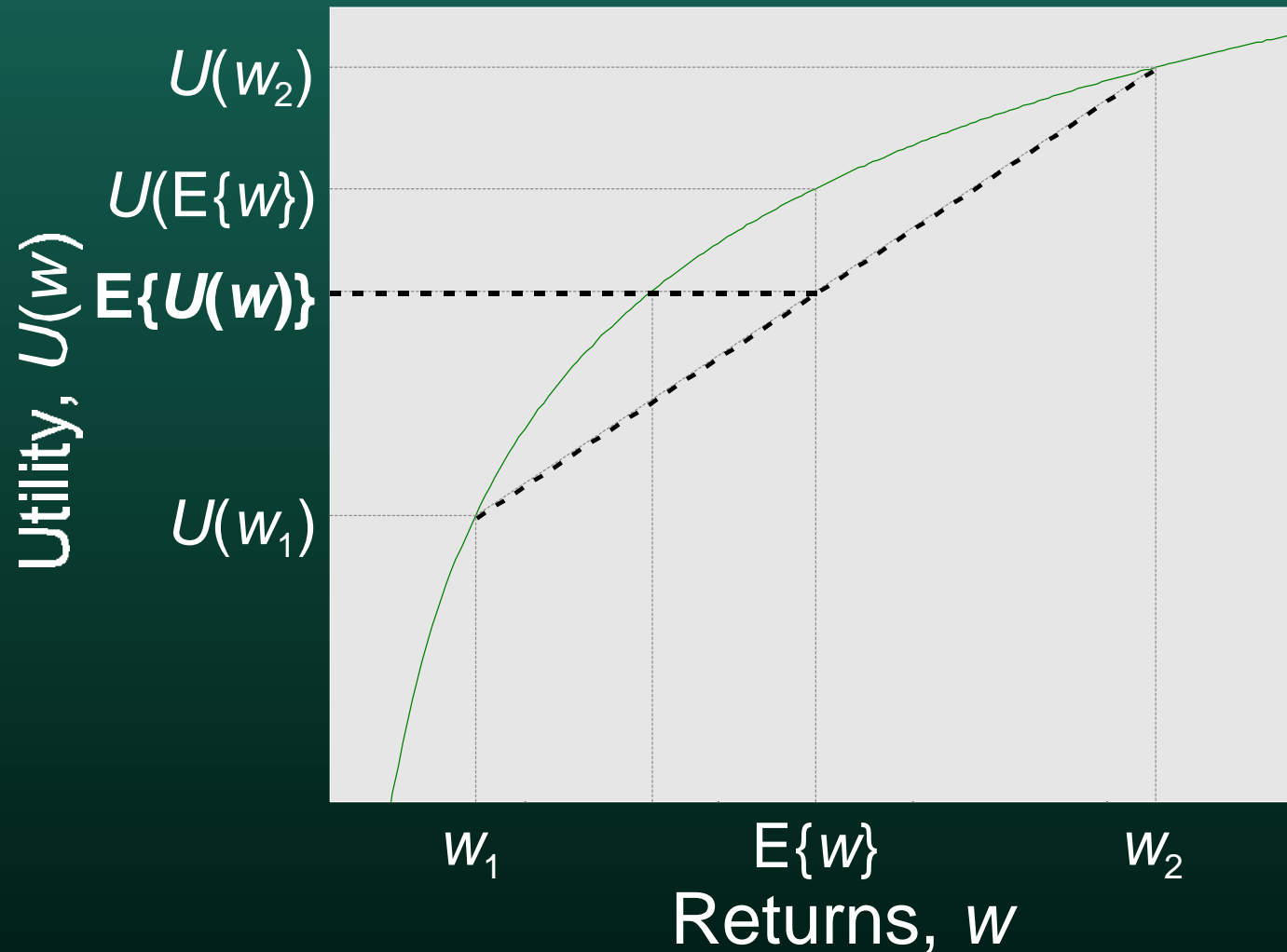
Expected Utility

“Coin Toss Problem” Revisited



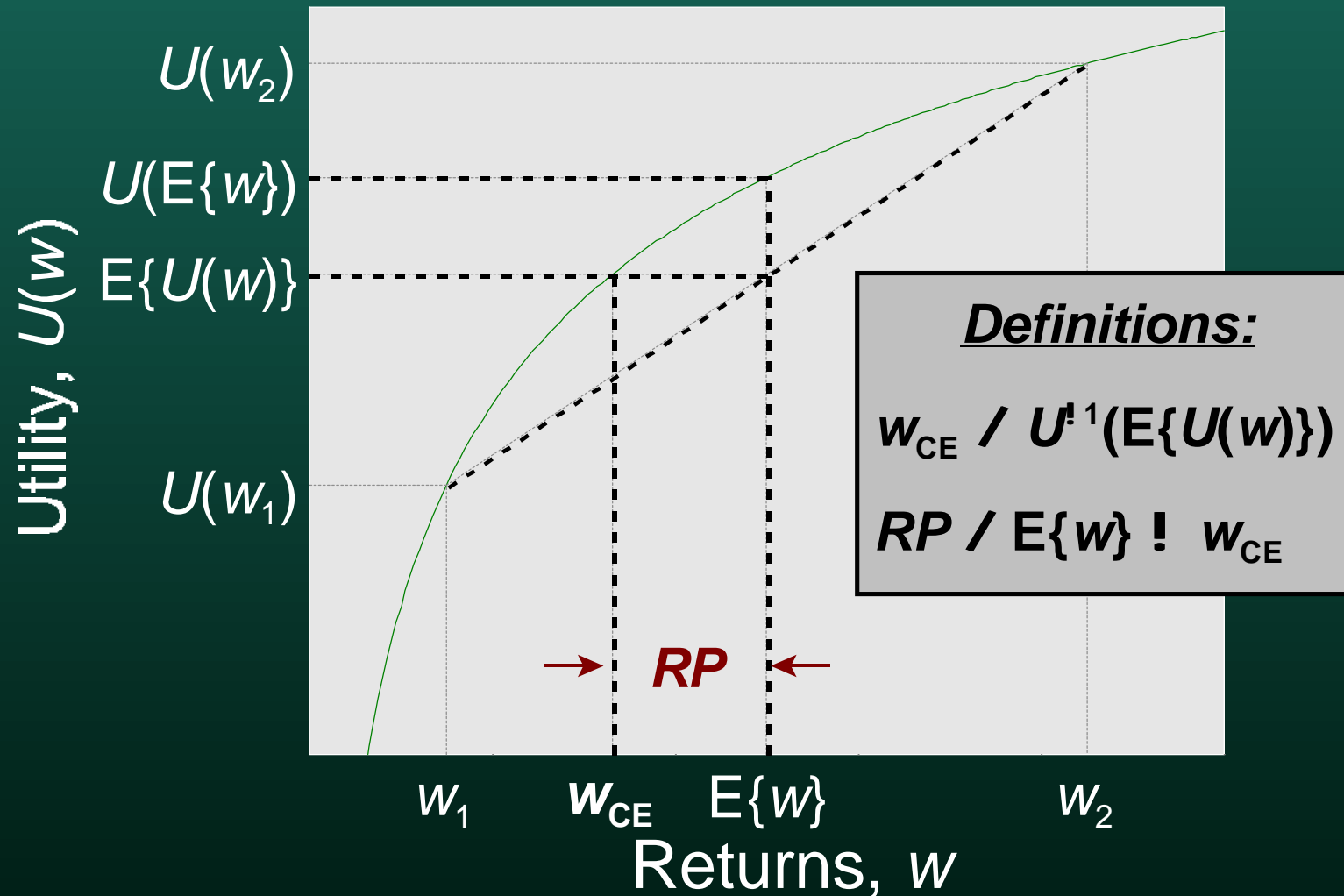
Expected Utility

“Coin Toss Problem” Revisited



Expected Utility

“Coin Toss Problem” Revisited



Risk Aversion

P The shape of utility function embodies one's attitudes toward risk:

- < Concave = risk averse (most people)
- < Linear = risk neutral (profit maximizers)
- < Convex = risk seekers (gamblers)

P Quantified by ratio of second and first derivatives of U

P Expressed as function of wealth W

Risk Aversion

Absolute Risk Aversion

P Coefficient of absolute risk aversion,

$$R_a(W) = -U''(W) / U'(W)$$

P Sensitive to the units of W (units are W^{-1})

P Negative exponential utility function,

$$U(W) = 1 - \exp(-R_a W), \quad R_a > 0,$$

yields constant R_a (CARA)

Risk Aversion

Relative Risk Aversion

P Coefficient of relative risk aversion,

$$R_r(W) = W R_a(W) = -W U''(W) / U'(W)$$

P Can compare across currencies, etc.

P Power function,

$$U(W) = (1 / (1 - R_r)) W^{(1 - R_r)}, \quad R_r \dots 1,$$

$$U(W) = \ln(W), \quad R_r = 1,$$

yields constant R_r (CRRA)

Risk Aversion

CARA vs. CRRA

- P** Intuition suggests R_a should decrease and R_r should increase with W
- P** CRRA generally preferred assumption
- P** CARA sensitive to units of W but insensitive to size of W
 - < Risk analysis on unit area basis assumes CARA
- P** CRRA insensitive to units of W but sensitive to size of W
 - < Analysis should consider entire livelihood portfolio

Risk Aversion

P Risk aversion difficult to measure

P Recommended ranges of R_r (CRRA)[†]:

< $R_r = 0.5$: hardly risk averse

< $R_r = 1.0$: somewhat risk averse (normal)

< $R_r = 2.0$: moderately risk averse

< $R_r = 3.0$: very risk averse

< $R_r = 4.0$: almost paranoid

[†] Anderson, J.R. and Dillon, J.L., 1992. Risk Analysis in Dryland Farming Systems. Farming Systems Management Series No. 2, FAO, Rome.