Talk to YSSPs

Analytical Roots of a Decision Scientist

A Memoir

by

Howard Raiffa

Decision Roles

- Descriptive– Passive
- Understanding of how decisions are made
- Incoherencies
- Learning
- Prediction
- Gender, nationality, religious differences
- Predictability

Decision Roles

- Prescriptive– ‘Active
- For unitary actor:
  - As Decision Maker or Taker
    - How best to make decisions of a give kind
    - The PrOACT Way of Thought

  As Decision advisor, consultant, …to single DM

  Helping DM make wise choices -- using experts and advisors

  With straightening out incoherencies --- some psycho-analysis

Decision Roles

- **Prescriptive**– '**Active**
- As advisor to one party in game context
- As advisor to one party in negotiation context
- As **invitee** to help involved parties
- As conventional intervenor (facilittor, mediator, arbiotrator)
- As **invitor** to convene parties and help fashion a deal for them.

Contents

Outline of Talk

- Use chronologicl approach:
- Skip over my early and army years.
- Resume as I enter UoM
- Follow chronologically up to my IIASA years
- Three digressions:
  - My UoM Report
  - Classical vs.Bayesian Reporting
  - The Sapling : Intertwining notions ofg subjective probs and utility.

    Why EMV is wrong but EUV is right

UoM: Relevant Time Line

- BS degree : actuarial science
  - Choice and Chance
- MS degree: Statistics
  - The R.L. Moore Pedagogy
    - Decide to get a Ph.D in math
- Ph.D.
  - Joint Math. & Engineering Report
  - **SURPRISE !!!!!!!!!!!!!!!!!**

My Multi-Faceted Engineering Report

- Part I: the bi-matrix game without pre-play communication,
- Report submitted and published under auspices of ONR

- Apply Moore philosophy under tutelage of Professors Young and Copeland
- Think alone with no books.
- Start simple as possible

Looking for the simplist, non-trivial situation

- Starting simple and building up
- How many players?
- Statics or dynamics?
- How many choices for each player?
- Uncertainties ?
- Information?

Bi-Matrix Games

- Two Players:

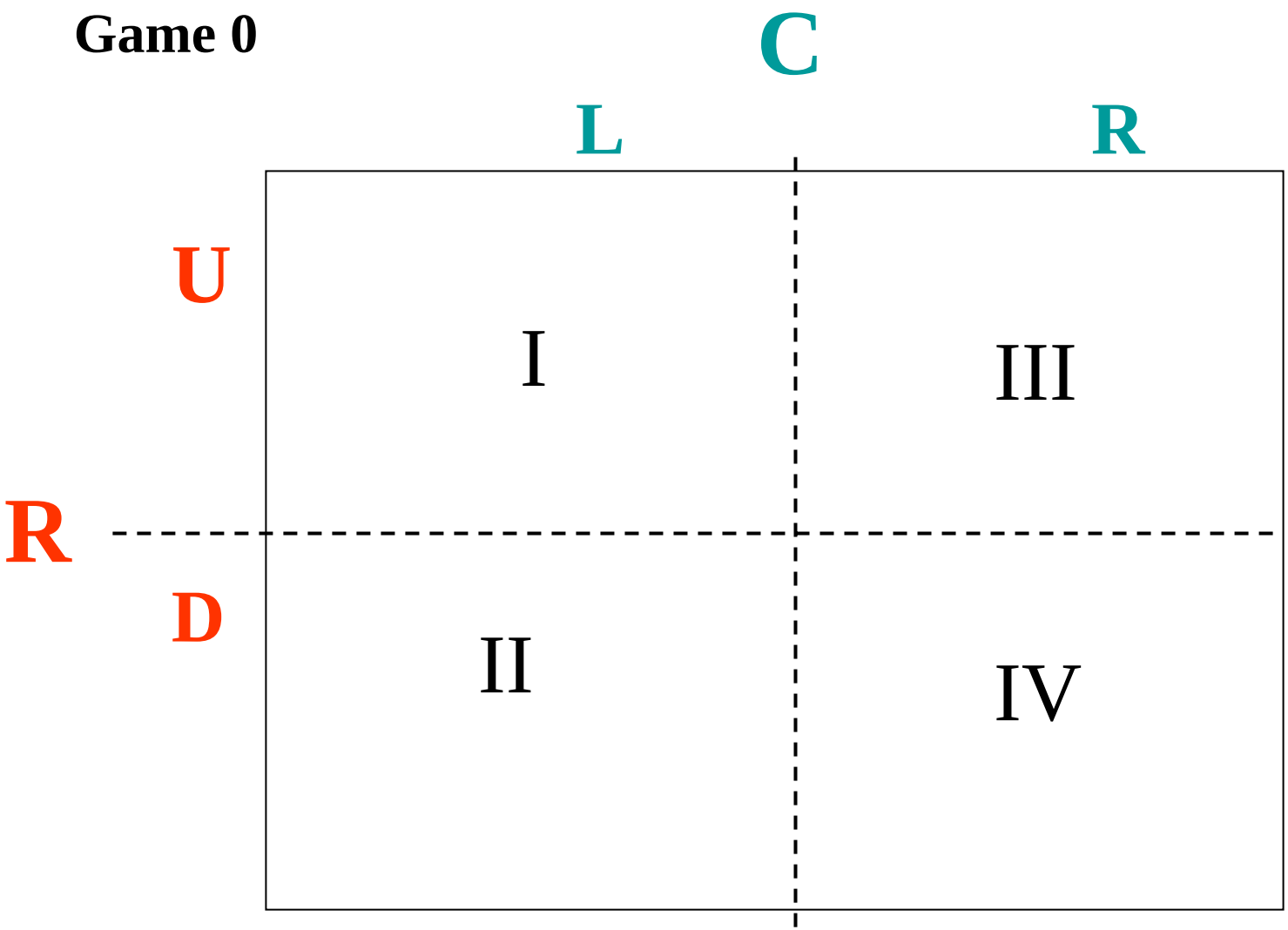
  R (for row) and **C (for column)**

- Choices for **R**: U (for up), D (for down)
- Choices for **C**: L(for left), R (for right)

- Players choose simultaneously

Bi-Matrix Games: Consequences

Game 0



Assumptions

Fixed Strategies: No innovation

Common Knowledge: Choice sets; payoffs

Perfect Info: you know that they know full info

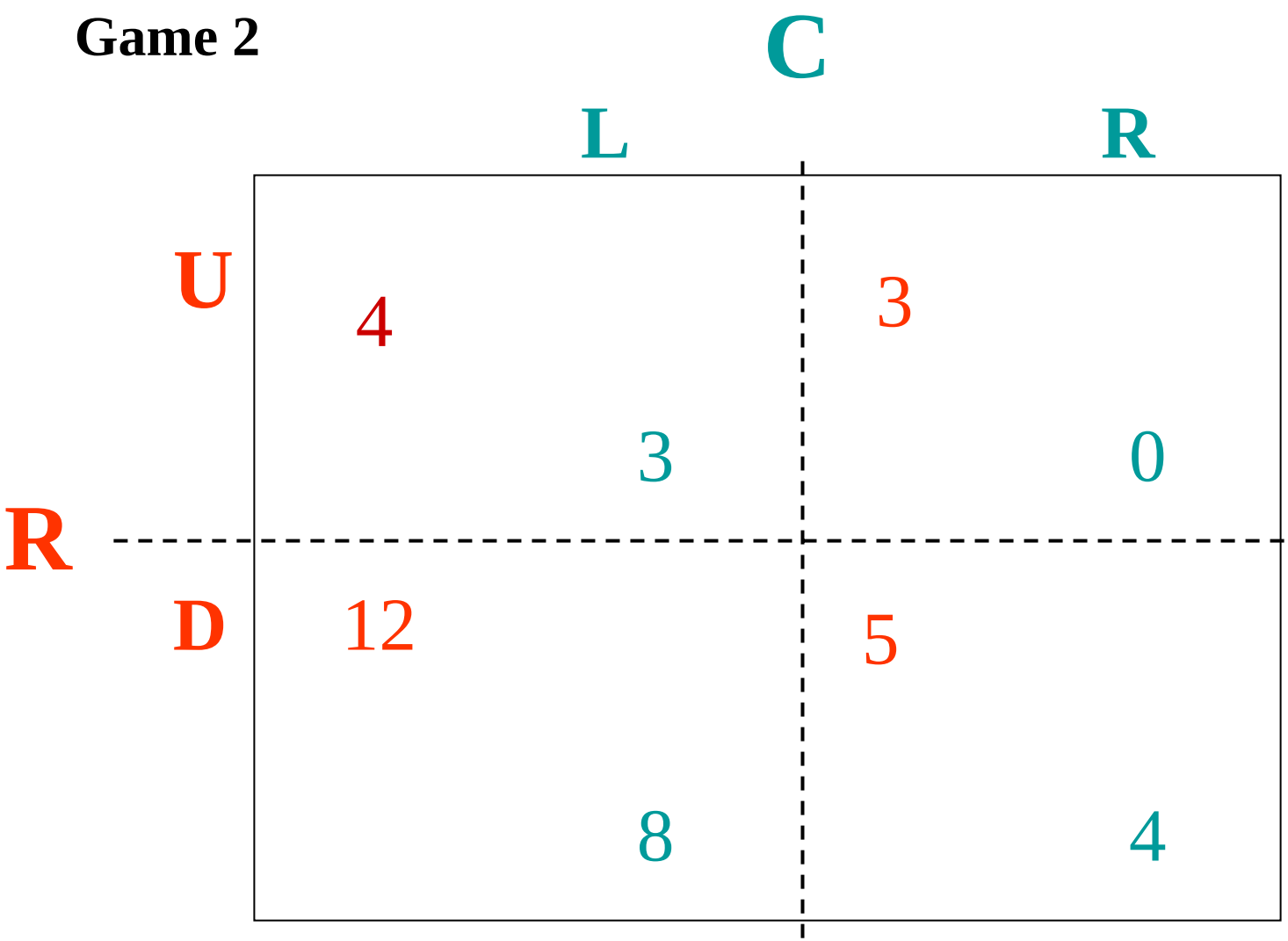
No Cheap Talk

Simultaneous Choices

Played Once

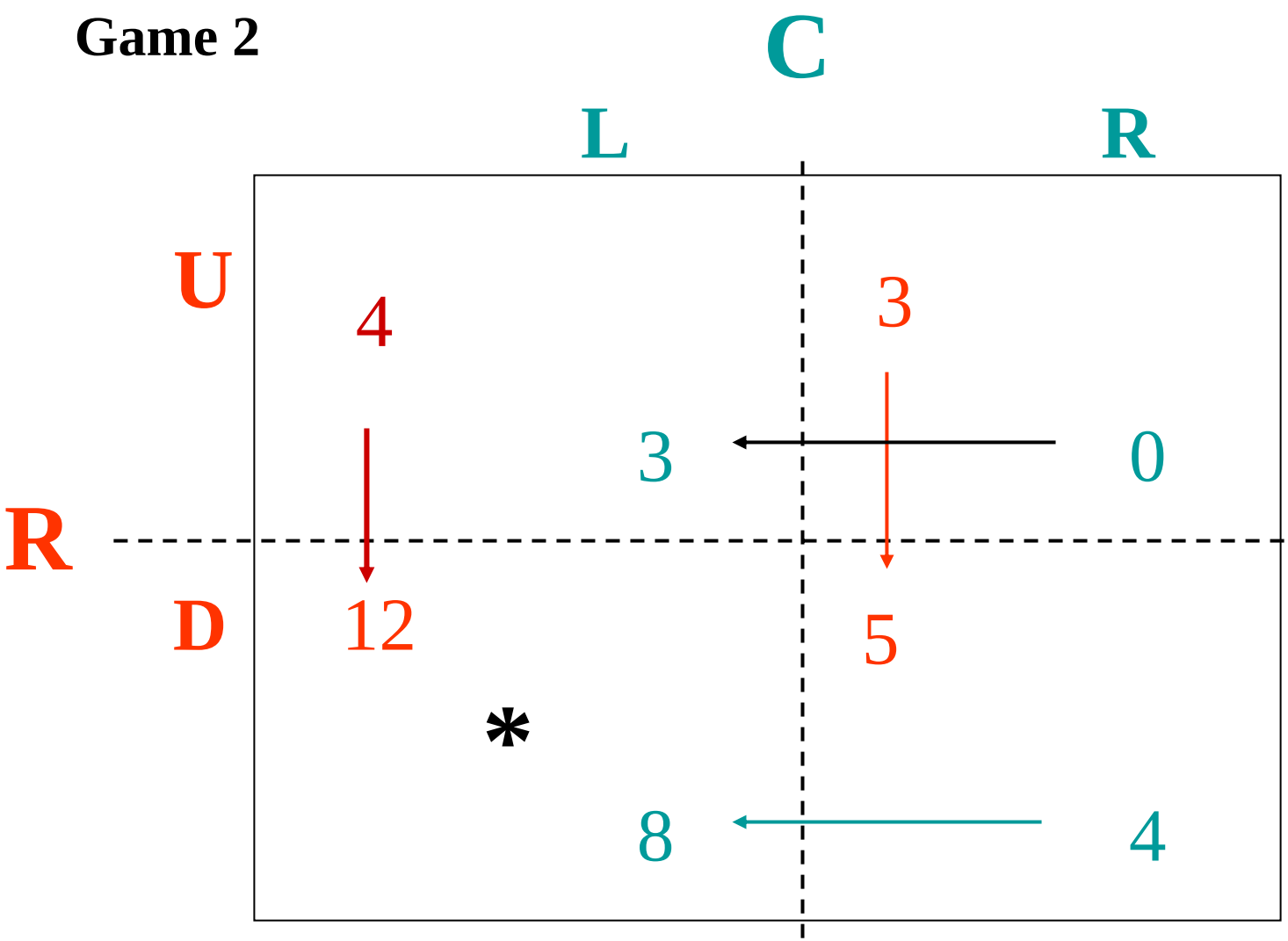
Bi-Matrix Games: Payoffs

Game 2



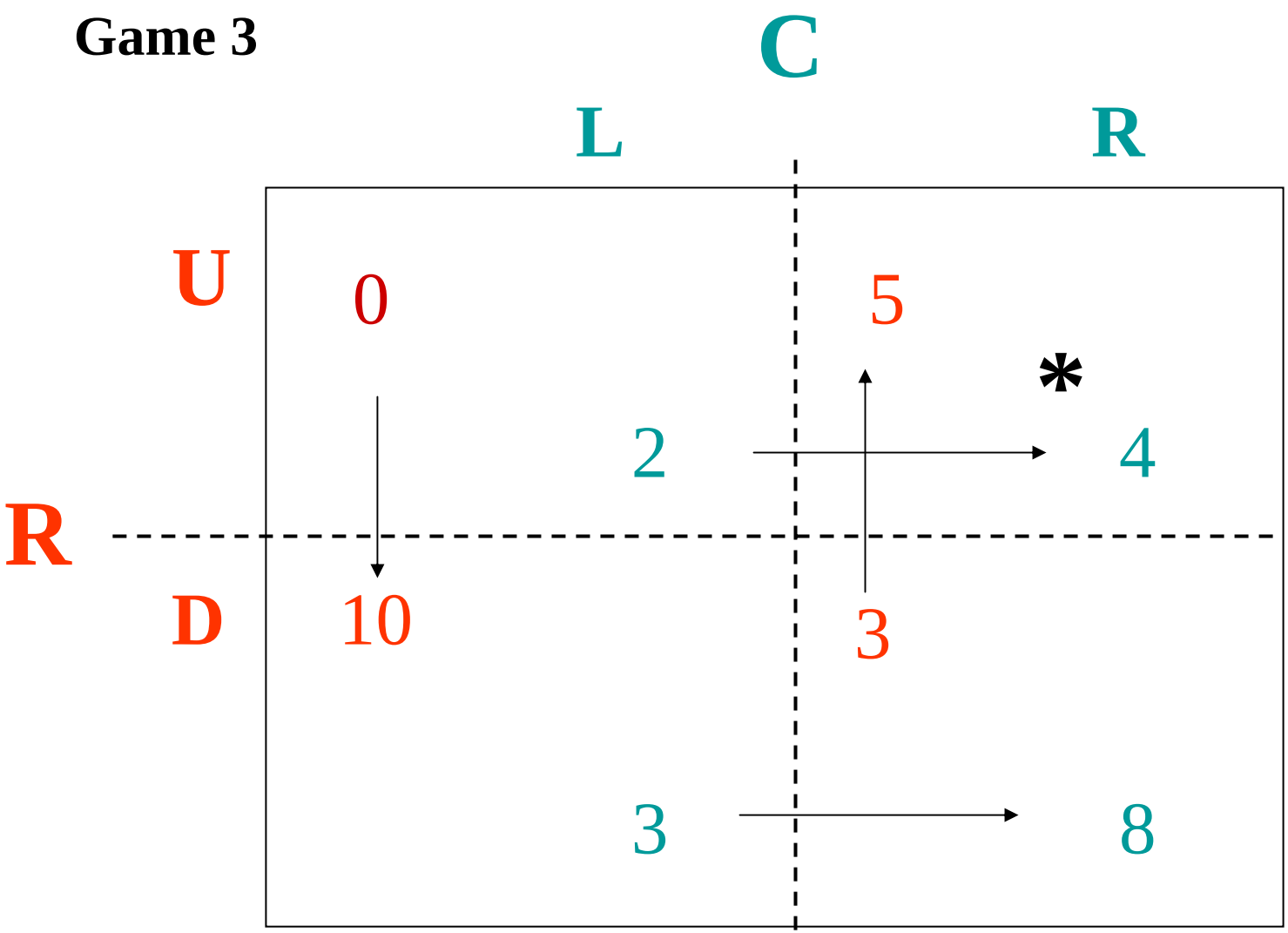
Bi-Matrix Games: Payoffs

Game 2



Bi-Matrix Games: Payoffs

Game 3



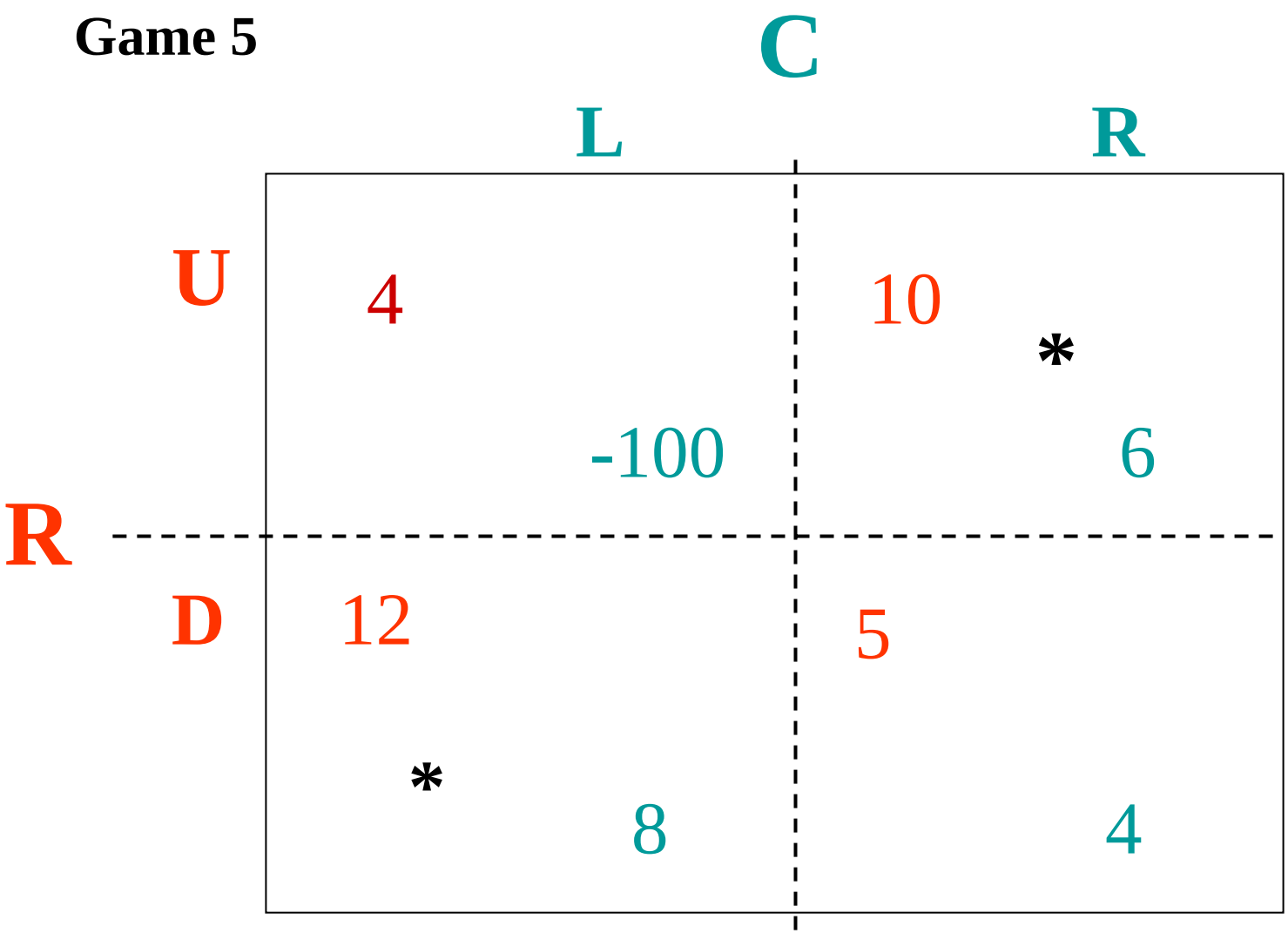
Bi-MatrixGames
Dominance

- **Dominance seems unassailable .. Ha ha just you wait !!!!**

- **Iterated dominance : Appealing but trouble brewa**

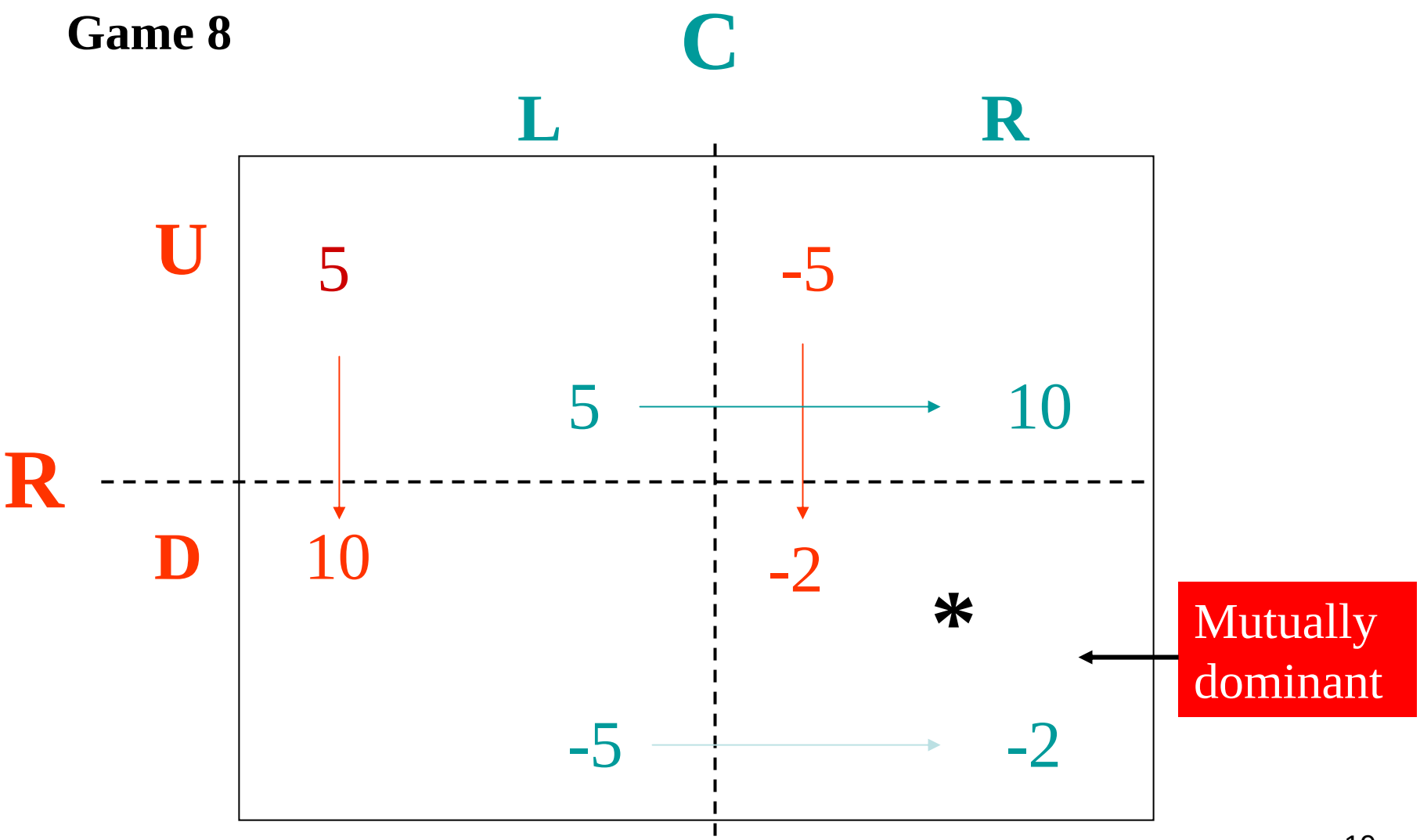
Bi-Matrix Games: Payoffs

Game 5



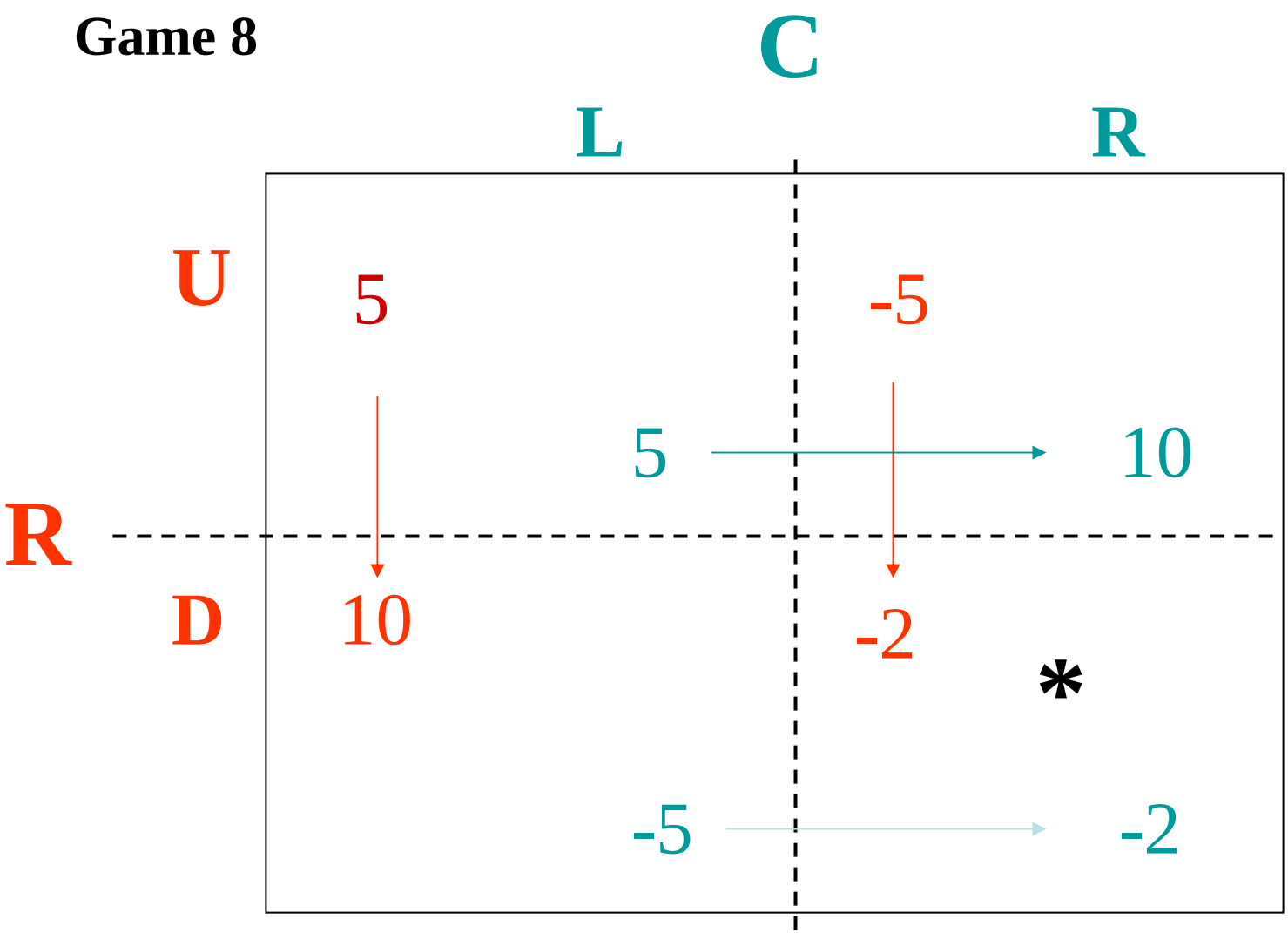
Social Dilemma Game
Social`Pathology

Game 8



D dominates U; R dominates L
Two dumb players do better than two wise players

Game 8



Part II: Report

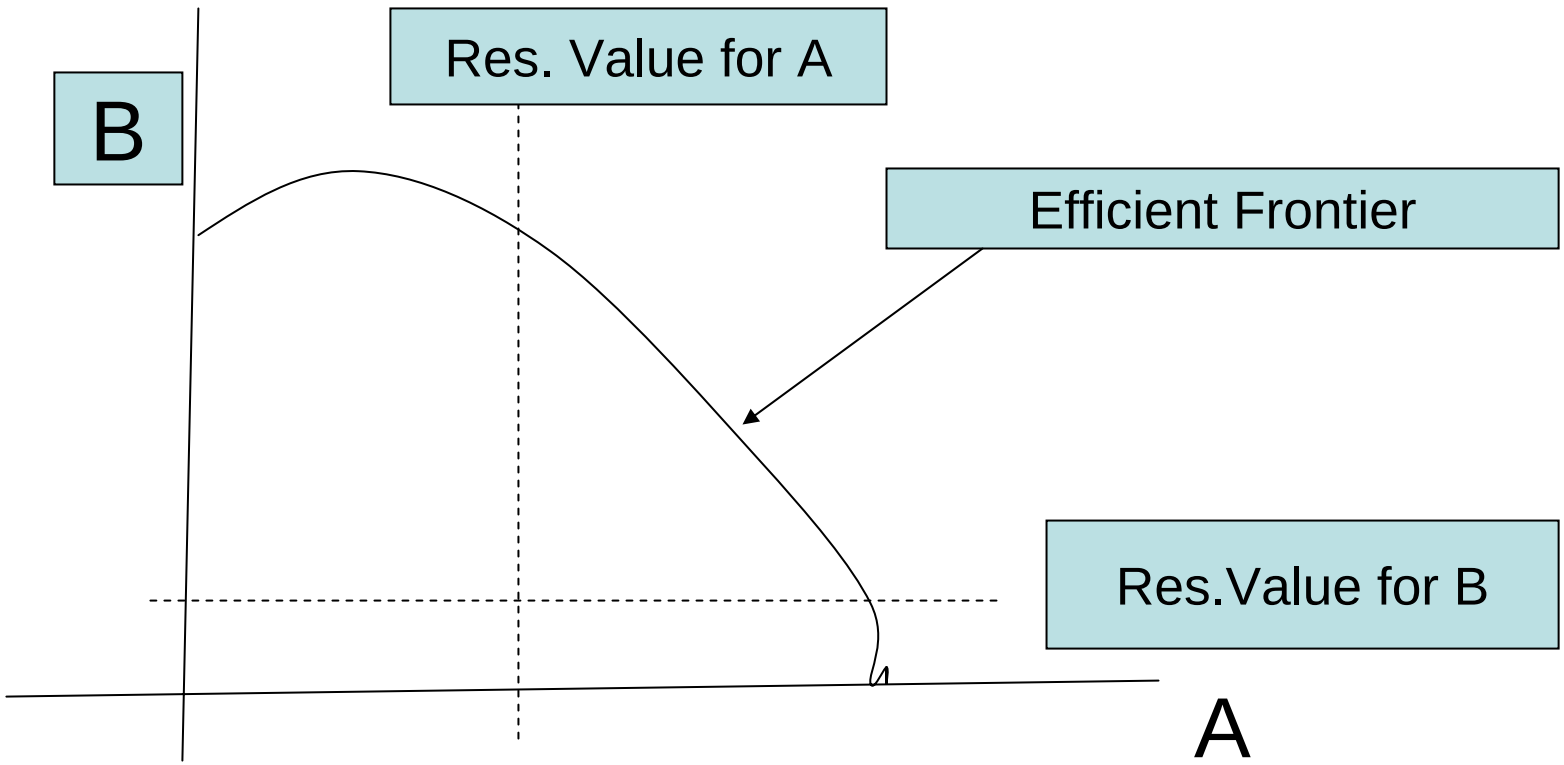
- Challenge: Players ask me to choose efficient and equitable solution of a non-solvable game. ‘

- What is fair?

Arbitration Schemes

(overlap with Nash – Nash uses IIA assumption.

Arbitration



4. My Columbia Years (1952- 57)

- The Columbia Opportunity: Wald's death
- Why me for replacement
  - Appeal to mathematical overseers
  - I gave seminar at UoM on Wald's book
- Initial Assignments:
  - Teach advanced course in Statistical Decision Theory
  - Teach beginning course in statistical methodology
  - Chair Behavioral Models Project
  - Administer ONR project

4. My Columbia Years (1952- 57)

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- Pressure, Pressure , and Just-in-Time Learning
- Doubts Creeping In – Cracks in the Classical Edifice
- Classical Statistics
- Worrying about What Could Have Happened but Didn’t
- Inference or Decision
- My Religious Conversion to a Closet Bayesian

Comparing:

Classical (objectivist)Statistics, and

Bayesian(subjectivist)Statistics

The classicist will never assign probabilities to population parameters (like the unknown proportion of subjects that have a given property).

Comparison of Classical (objectivist) and Bayesian (subjectivist) Viewpoints

Decision Trees

Tests of Hypotheses

Confidence Intervals

Estimation

Optional Stopping

Questionnaire:
On Classical Reporting

On Tests of Hypothes:

An investigator wishes to show that the probability of a success with a new treatment is more than .22. Accordingly she sets up the null hypothesis (H: $p \leq .22$) and hopes that her data will allow her to reject the null hypothesis at the .05 level of significance.

She collects data and obtains significance at the .05 level.

Should she be more pleased if this conclusion was obtained with a small sample or with a large sample ?? Or doesn't it make a difference?

Questionnaire: On Confidence Intervals

An investigator reports:

"On the basis of the sample evidence, the true population proportion lies in the interval from .195 to .325 with confidence .95 ."

Does this mean that p lies in the interval from .195 to .325 with probability .95?

What does it mean?

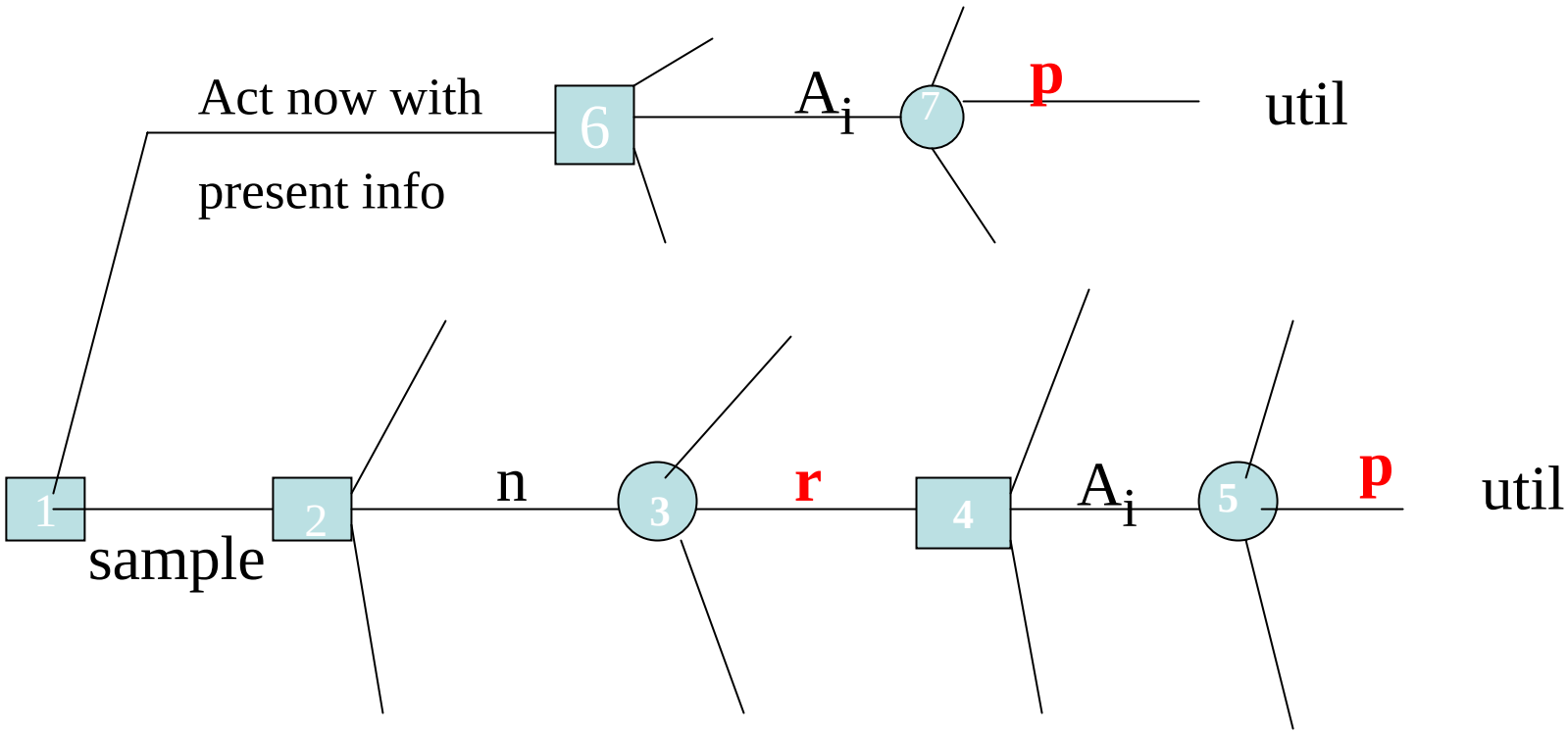
A user asks: I'm particularly interested in the interval .25 to .30. What confidence can I give to this interval?

Questionnaire: On Optional Stopping

A disappointed investigator cannot report significance at the .05 level on the basis of a sample of size n= 20. She continues taking evidence and notices that with 17 more observations the total sample of size n= 37 yields a statistically significant result. So she reports all the 37 observations and reports her results are statistically significant.

Is she violating acceptable statistical protocol? She is stopping her investigations at a propitious time, but she is reporting all of her data. It's a question of optional stopping; not optional selection of the evidence.

Decision Trees



The classicist chooses not to assign probs at nodes 3 , 5, and 7.

Statistical Posterior Reporting (1)
The Bayesian (subjectivist) Approach

Hypothetical Case: The existing treatment for XYZ has a success rate of .22 based on thousands of observations. David Masters has reason to believe that a new treatment may yield a higher success rate p.

Before collecting data he submitted a report to an independent group asserting, among other things:

• His current belief of the new p is beta(2,5) for reasons submitted -- but omitted here. .

Statistical Reporting (1)
The Classical (Objectivist) Approach

Hypothetical Case: The existing treatment for XYZ has a success rate of .22 based on thousands of observations. David Masters has reason to believe that a new treatment may yield a higher success rate p.

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Confidence Intervals

"On the basis of the observed sample, we conclude that the unknown population parameter, p, lies in the interval from .192 to .345 with confidence .95."

This statistical report does **not** mean:

"The odds are 95 to 5 that p lies in the interval from .192 to .345."

The word "confidence" is not synonymous with "probability". The lay public falsely equates these two words. There would be no need to introduce the convoluted idea of "confidence" if the classicist were willing to talk about probabilities of population parameters like p.

Optional Stopping

Observer #1 reports that she did not initially decide to take 10 observations but to sample until she got two Ss in a row. Should this affect how #1 analyzes the problem after the sample is recorded?

This does not affect col 3 and therefore does not affect the posterior in col 5.

Objectivists and subjectivists differ on the importance of the stopping procedure.

Optional Stopping

Observer #1 further confesses that she originally planned to take 7 observations but she was expecting more Ss and decided to sample further until her finances ran out. Since the next three results favored S, she decided to quit sampling. She has submitted all her data.

This does not affect col 3 and therefore does not affect the posterior in col 5.

Objectivists and subjectivists differ on the importance of the stopping procedure.

In order to decide what to do or report after observing a given sample outcome, the classicist must think about what he or she would do at every possible sample outcome .

4. My Columbia Years (1952- 57)

- The Columbia Opportunity
- Pressure, Pressure , and Just-in-Time Learning
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- Classical Statistics
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From Columbia to Harvard

- Hard choice: Multiple of conflicting alternatives. No simple dominance

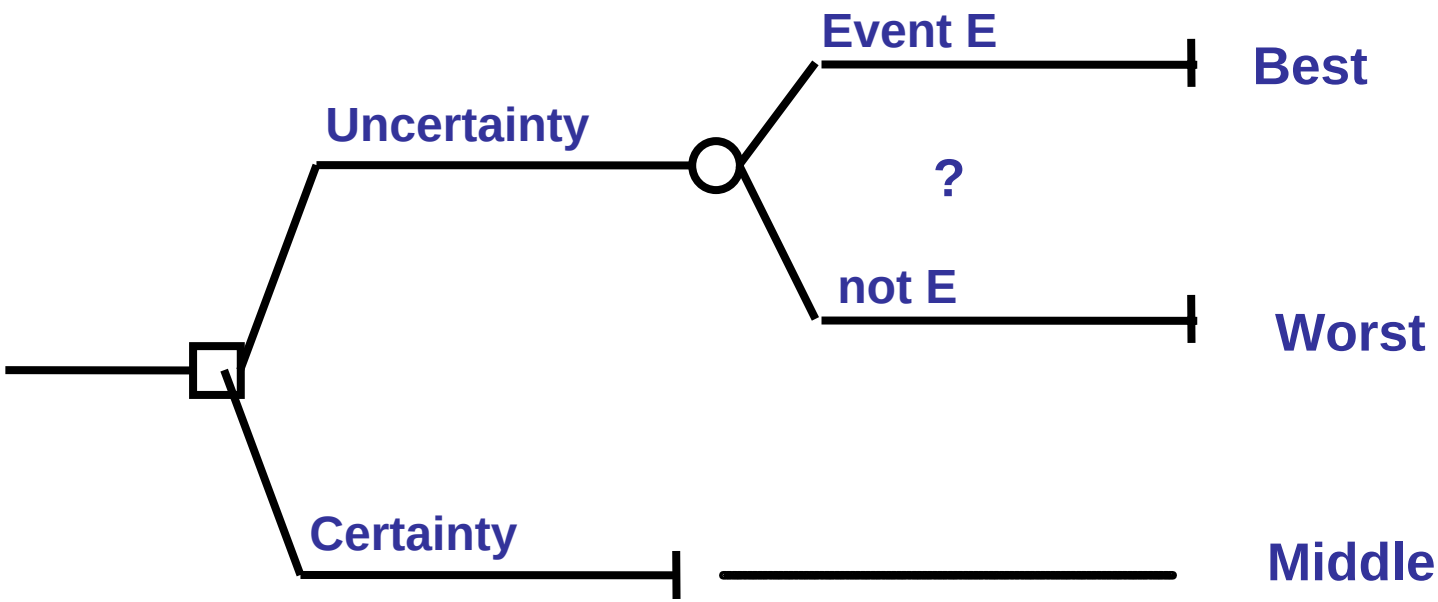
- Conversation with Ernest Nagel:
  - Ernest: Why, Howard are you having so much trouble deciding? You're supposed to be an expert in making decisions."
  - Howard: But Ernest, this is for real"
- Never happened!

Decision under Uncertainty

Introducing the Sapling, the Simplest, Non-Trivial Decision Tree

The Sapling

Best > Middle > Worst

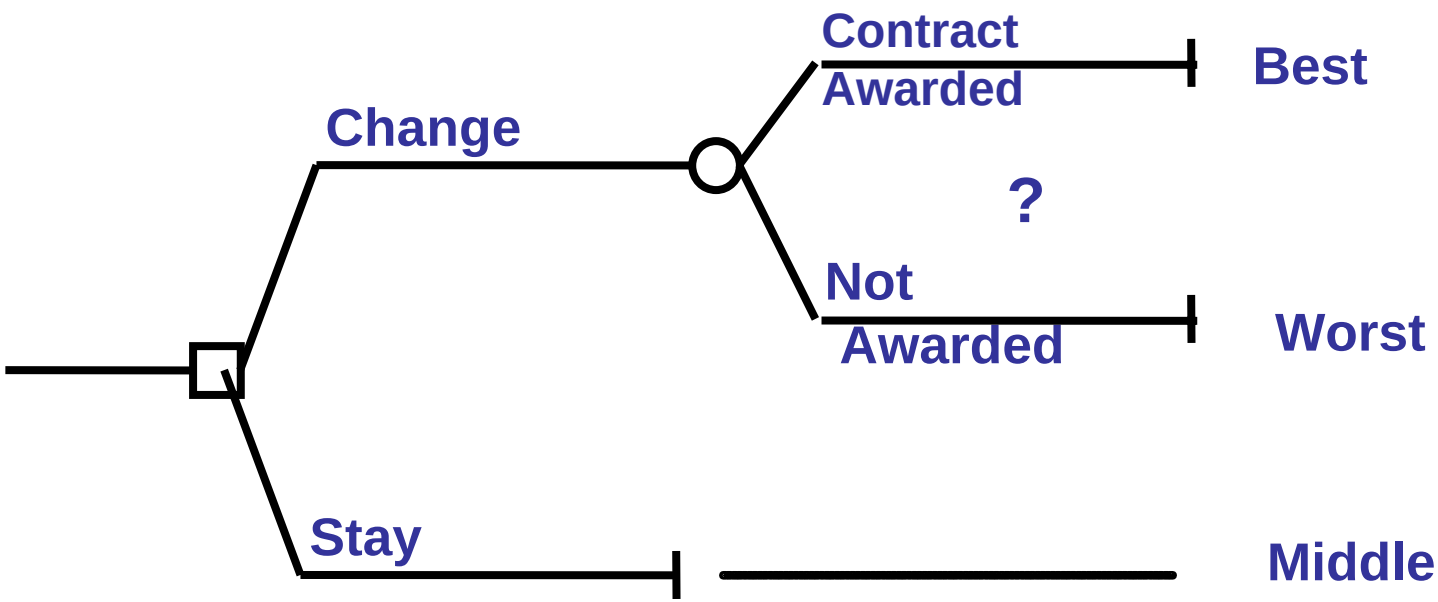


What does the Choice Depend Upon?

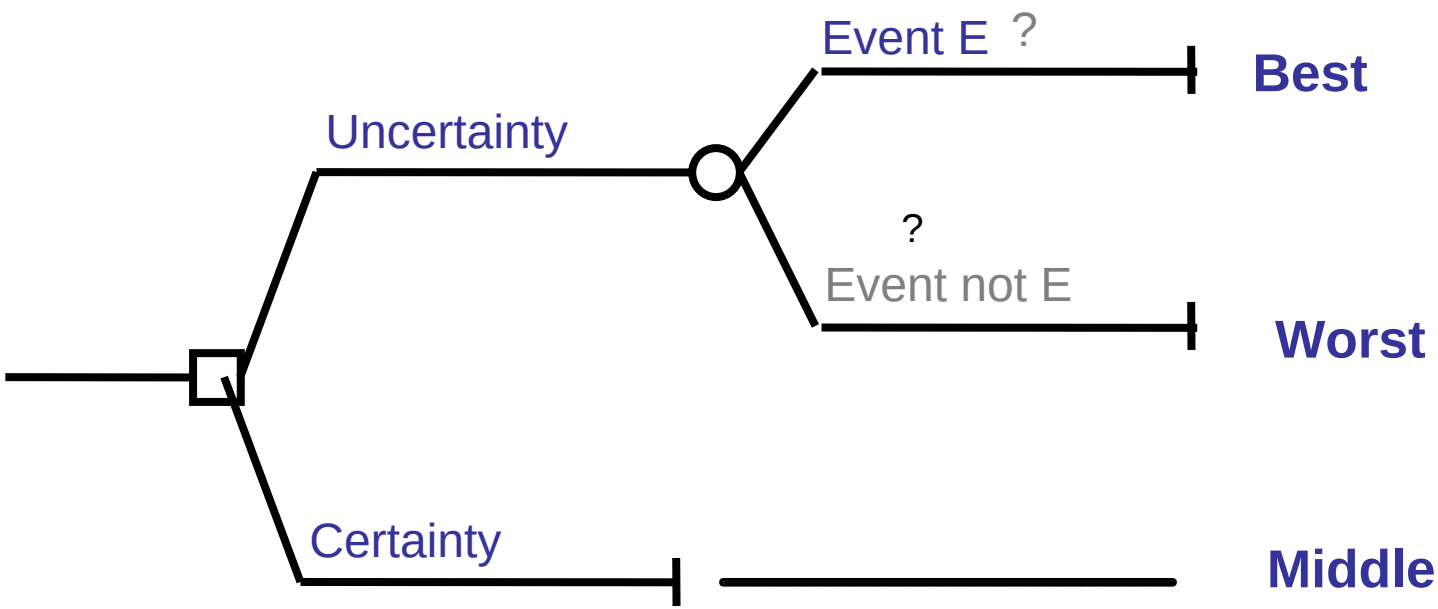
Real-World Interpretations

- **Challenge**:
- Think of some cases that might apply to you , personally.
- … that might apply to a friend, or might apply to an important character in the news, or to some fictional character.

An Example of a Sapling



The Sapling



What does the Choice Depend Upon?

Punchlines: What the Analysis of the Sapling Will Illustrate

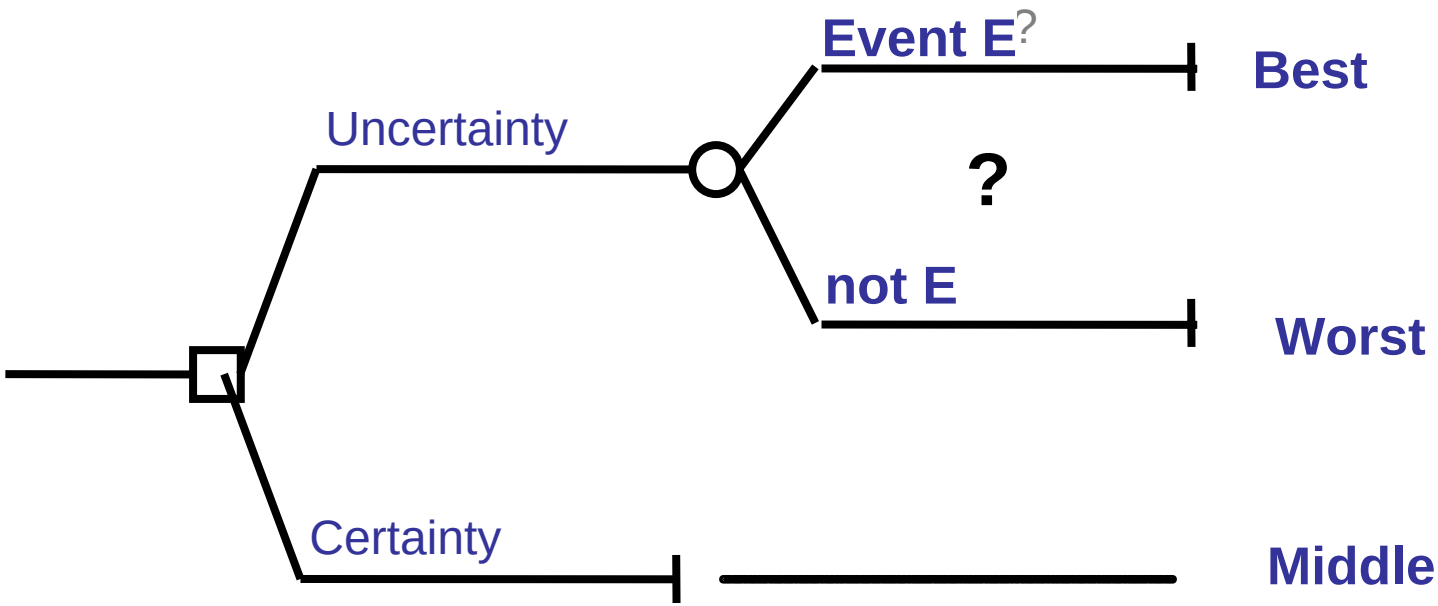
Separation of analysis of uncertainty and of value

Interpretation of a judgmental probability as a breakeven canonical probability

Interpretation of utility as a breakeven canonical probability.

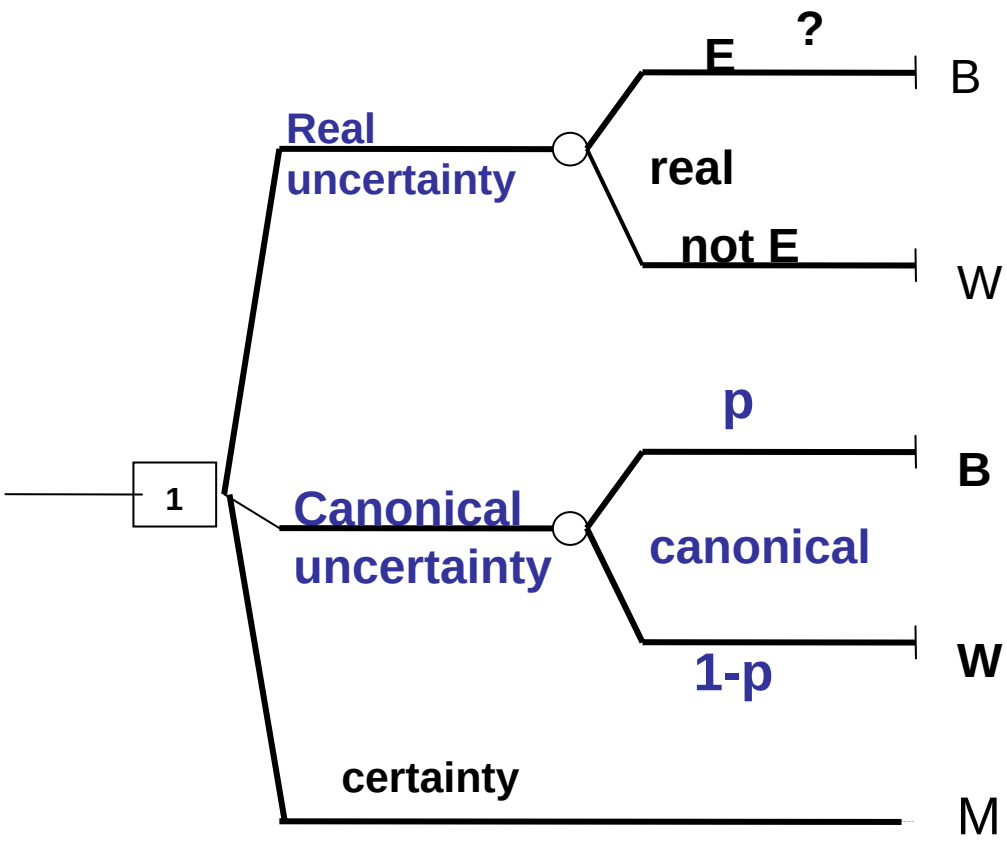
Subjective Expected Utility (SEU) Analysis

The Sapling



The choice depends on the likelihood of E and the strength of preferences for the consequences.

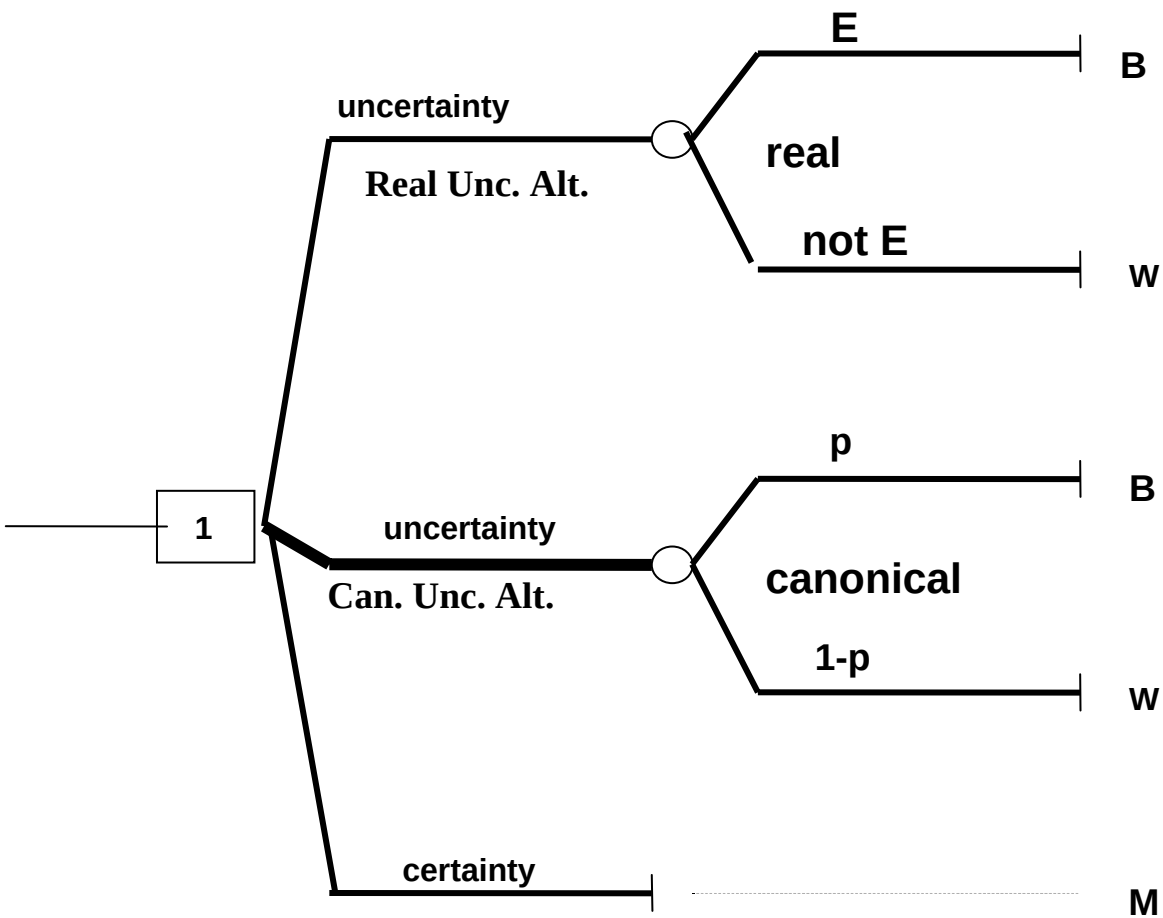
For Calibration Purposes:Introduce the Canonical Uncertain Alternative



Interpretation of a canonical probability

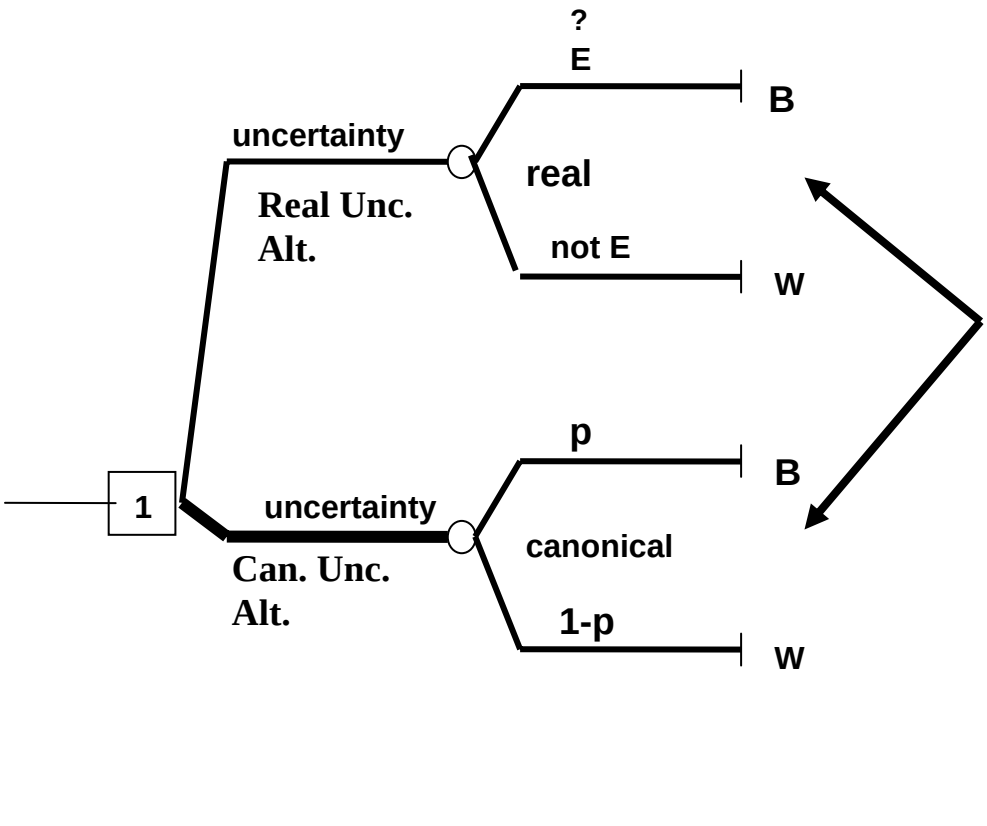
Comparisons:1. Real-Unc. Alt. Vs. Canonical-Unc. Alt.

2. Canonical- Unc. Alt. Vs. Certainty



The IIA Assumption: Independence of Irrelevant Alternatives

Comparisons:1. Real Unc. Alt. Vs. Canonical Unc. Alt.

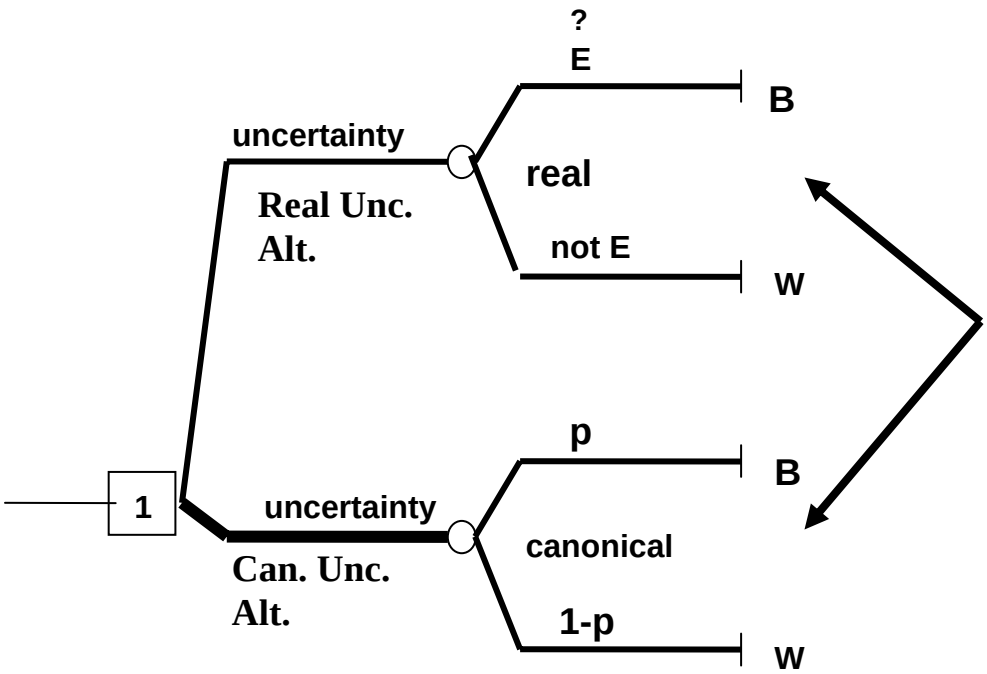


Which is preferred if the canonical p is very high?

… is very low?

What happens as p moves from high values to low values ?

Comparisons:1. Real Unc. Alt. Vs. Canonical Unc. Alt.

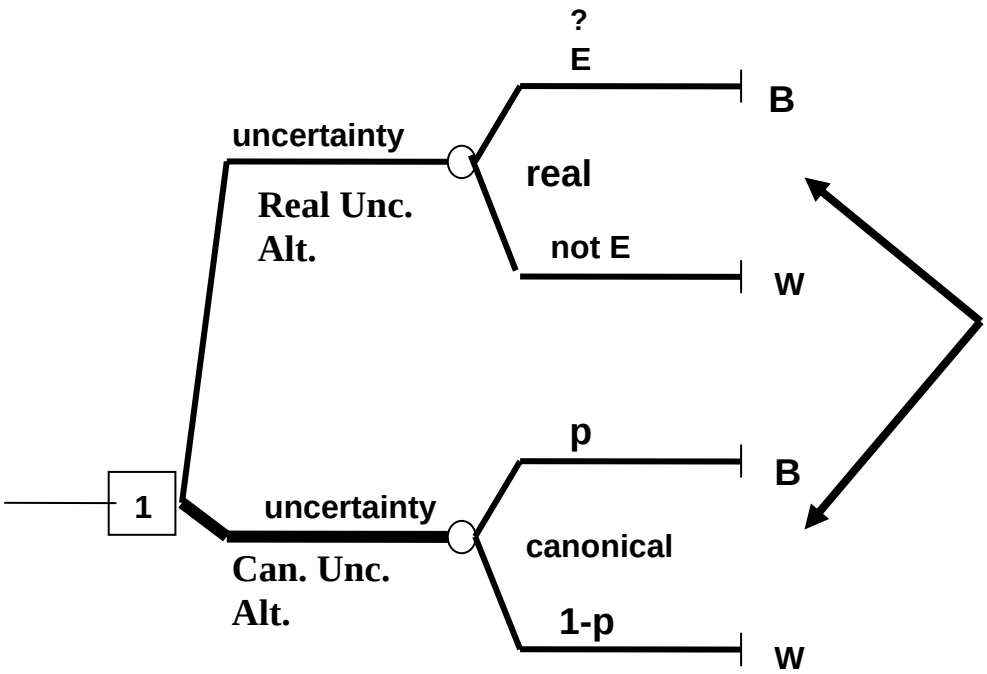


Continuity Assumption:

There exists a breakeven p_b value such that the real Unc. Alt. and the Canonical Unc. Alt are indifferent.

The value p_b does not depend on M or on B and W as long as B > W .

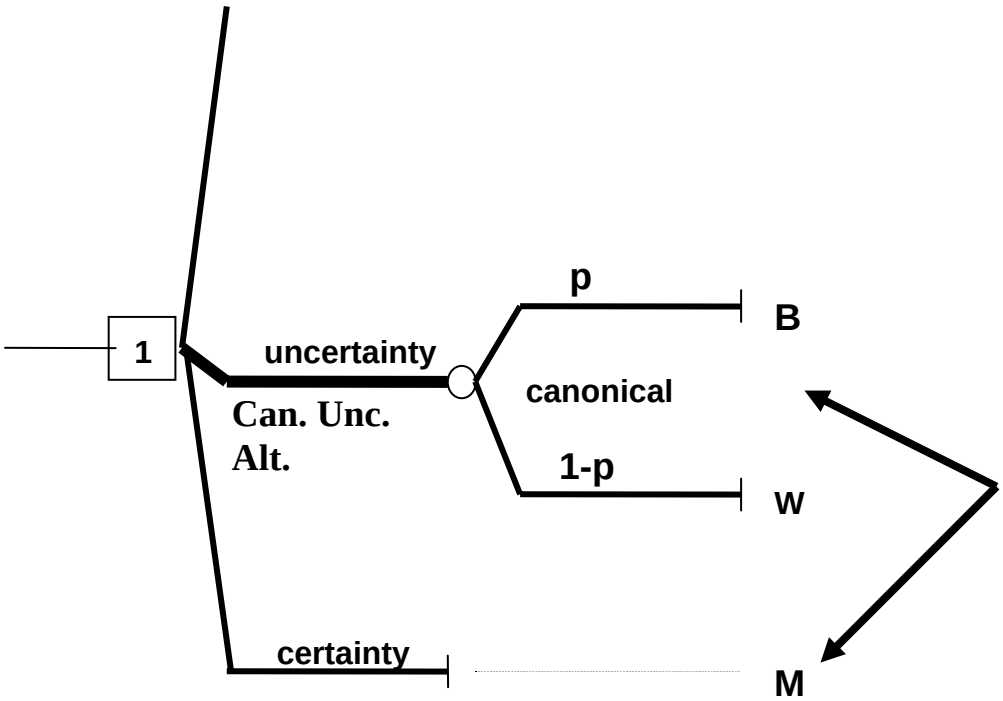
Comparisons:1. Real Unc. Alt. Vs. Canonical Unc. Alt.



Let indifference occur at p_b = .65. We then say: the judgmental probability of E is .65.

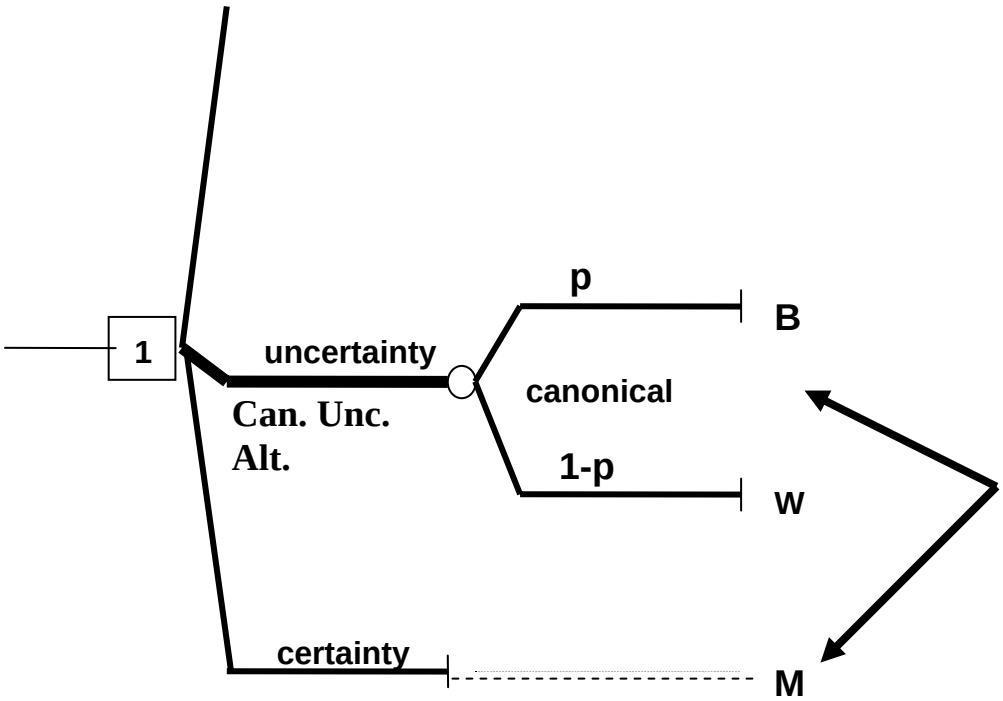
Comparisons: 1.

2. Canonical-Unc. Alt. Vs. Certainty



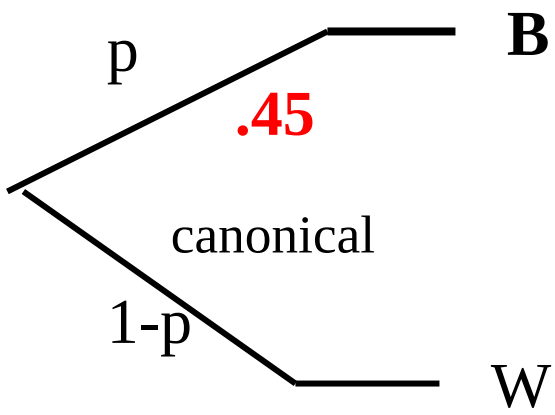
What happens as p moves from high values to low values ?

Comparisons: 2. Canonical Unc. Alt. Vs. Certainty



Suppose that indifference occurs at p = .45. This scales M judgmentally between B and W.

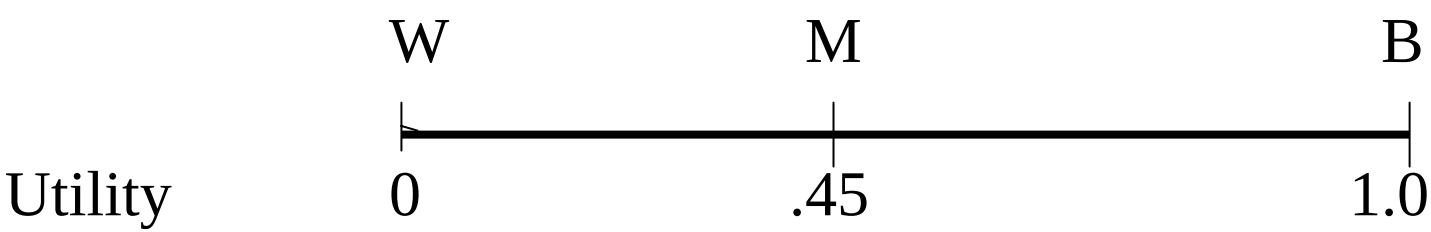
Utility Scaling



Vs. M

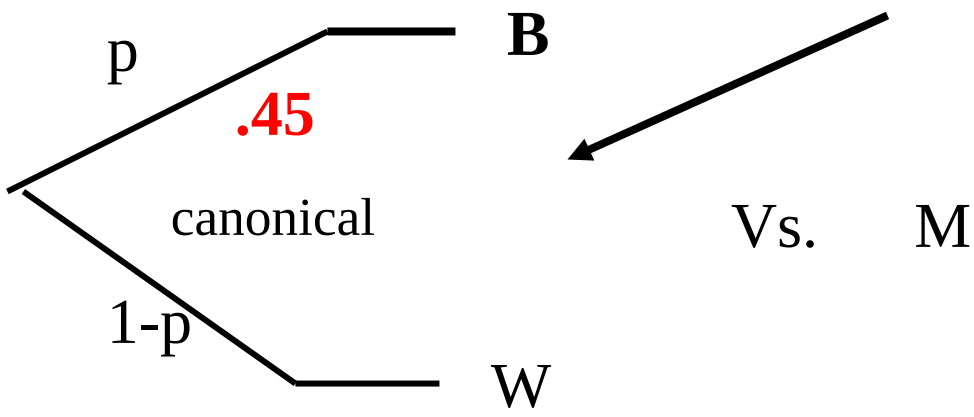
Where does M fall in your opinion?

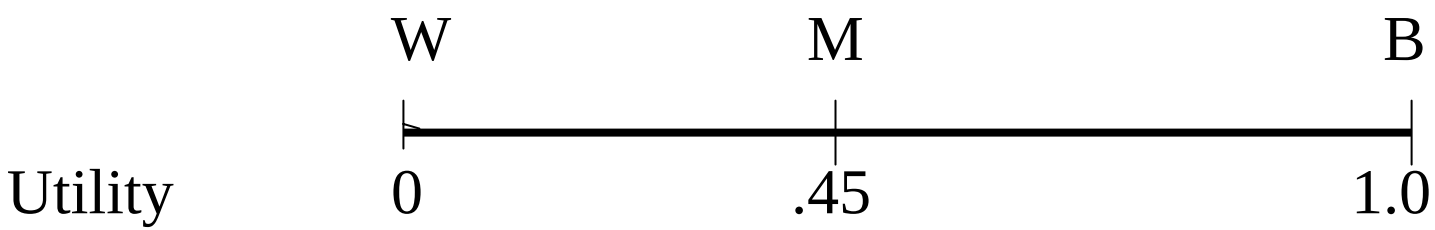
Say at p = .45



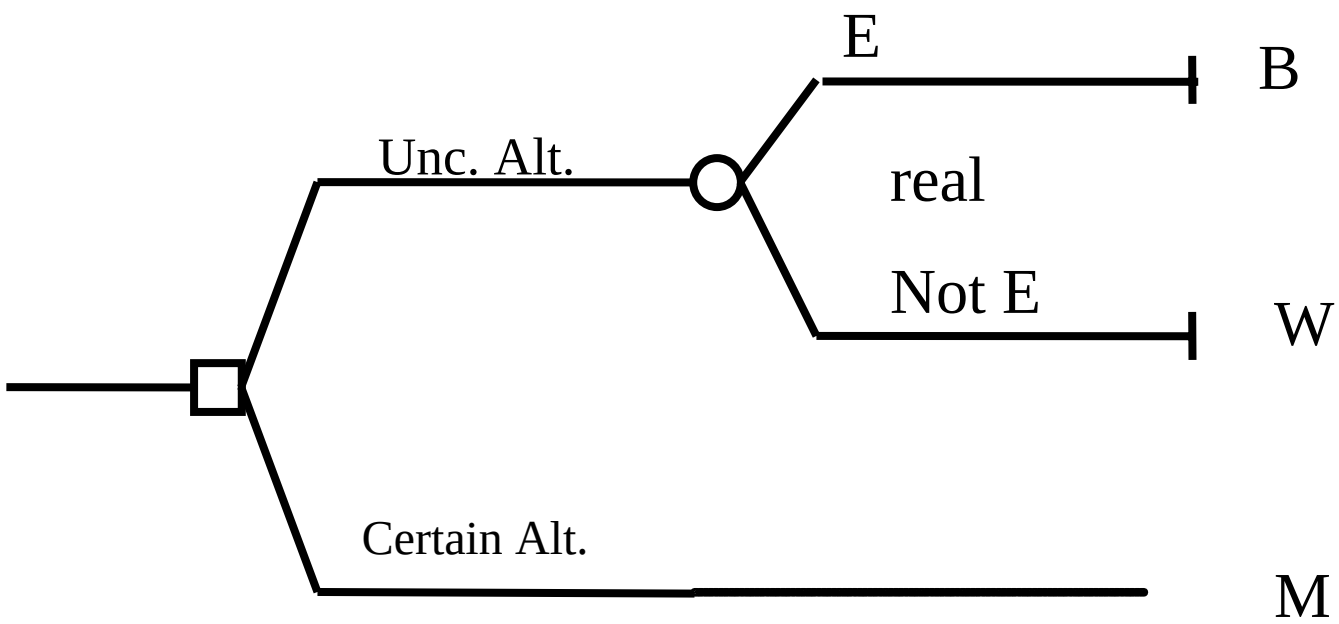
Utility Scaling

.45 **Basic Reference Lottery Ticket (BRLT)**with reference prizes B and W





Revisiting the Sapling



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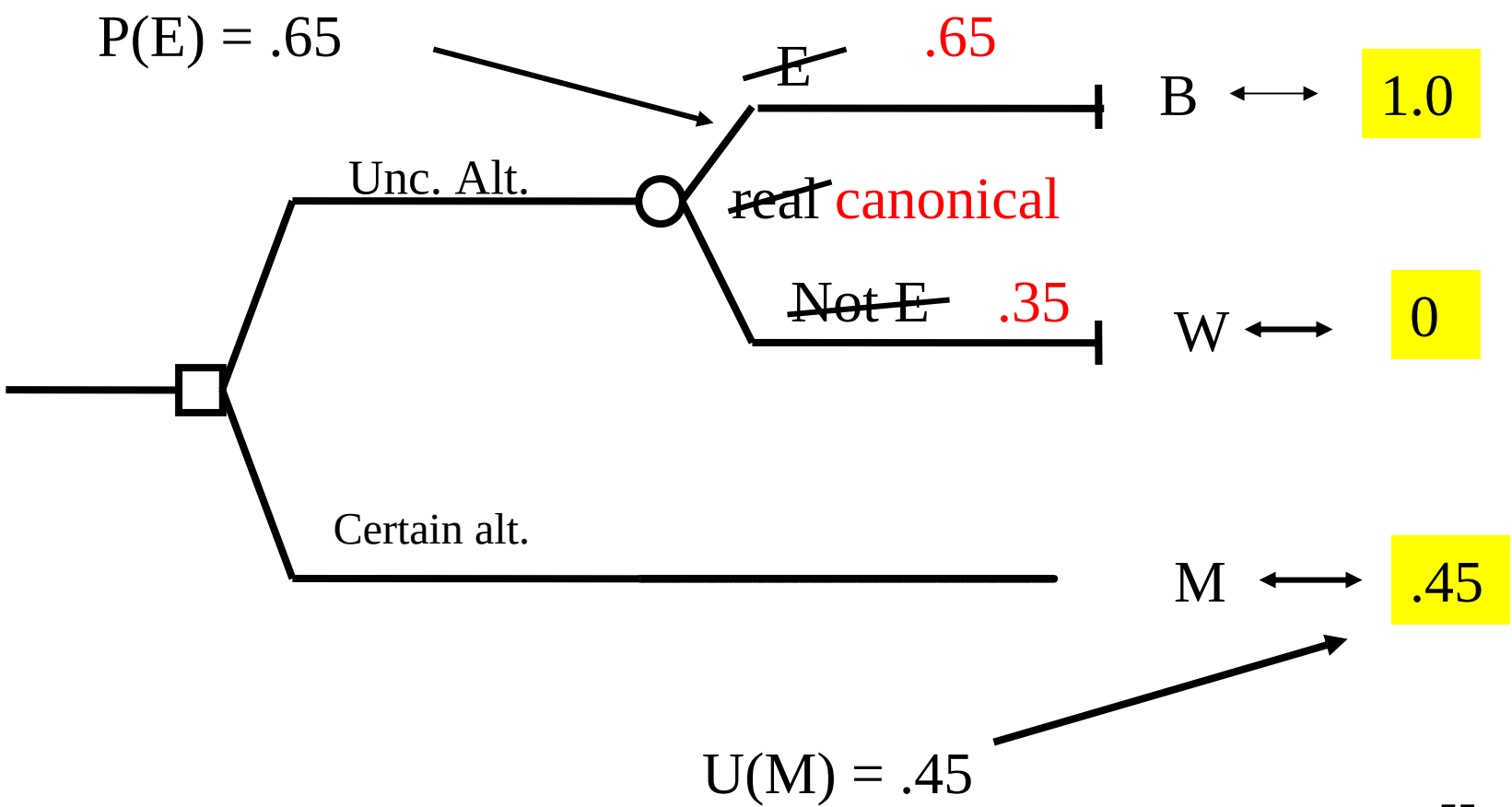

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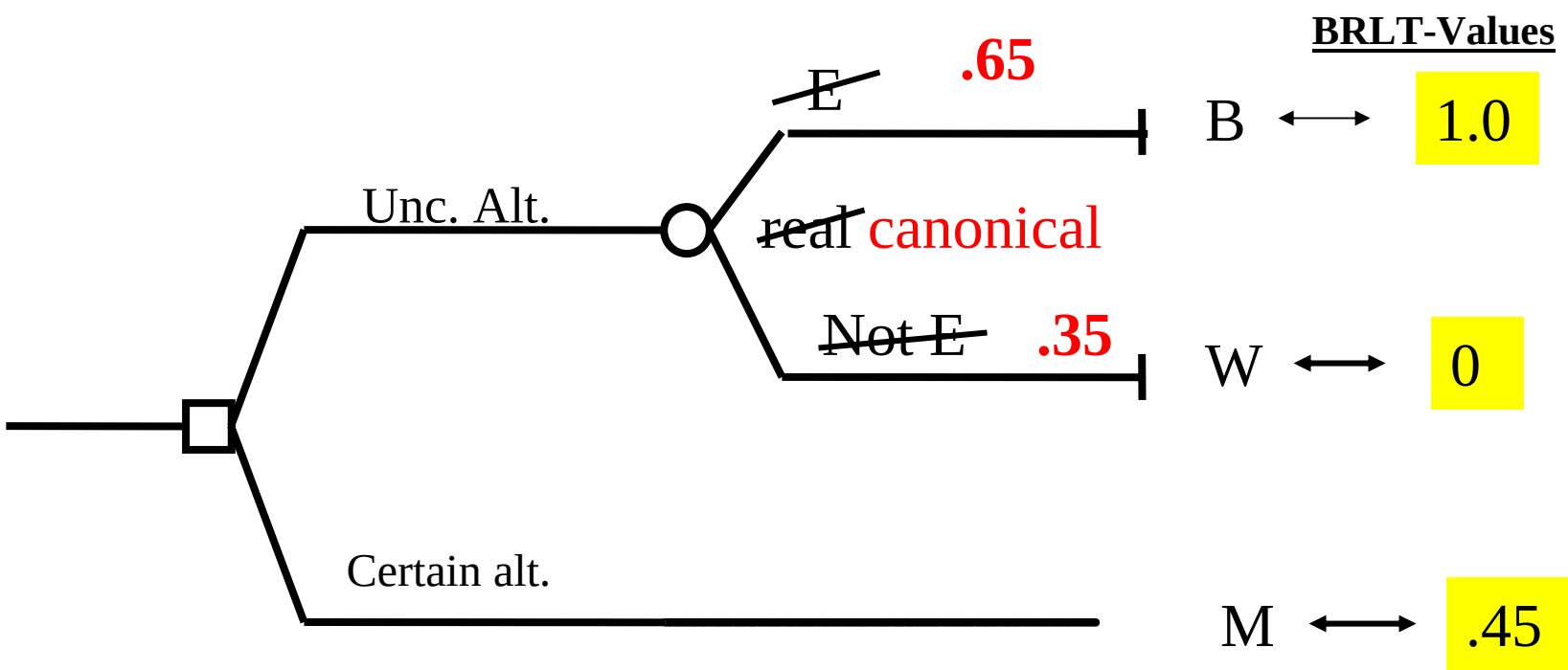
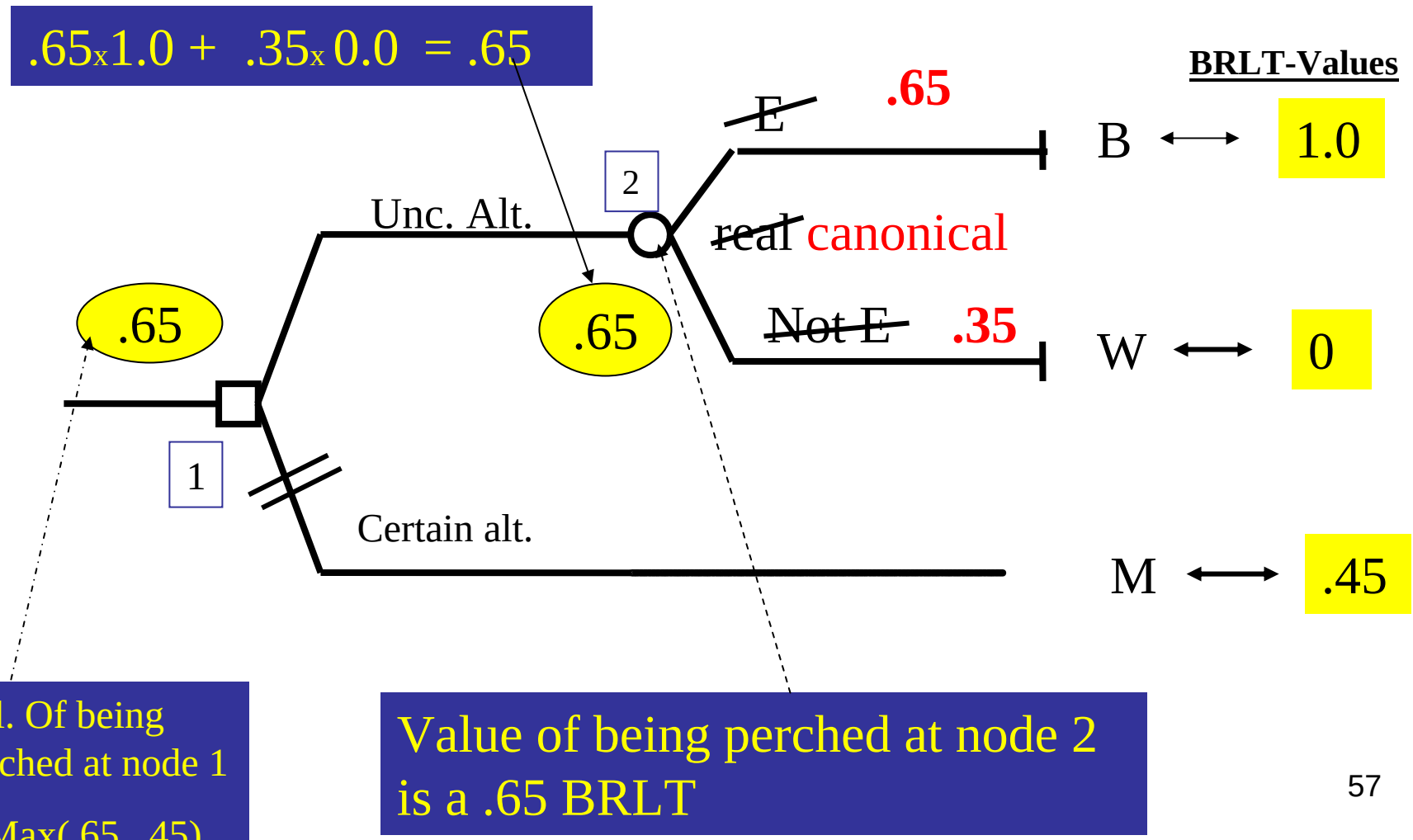
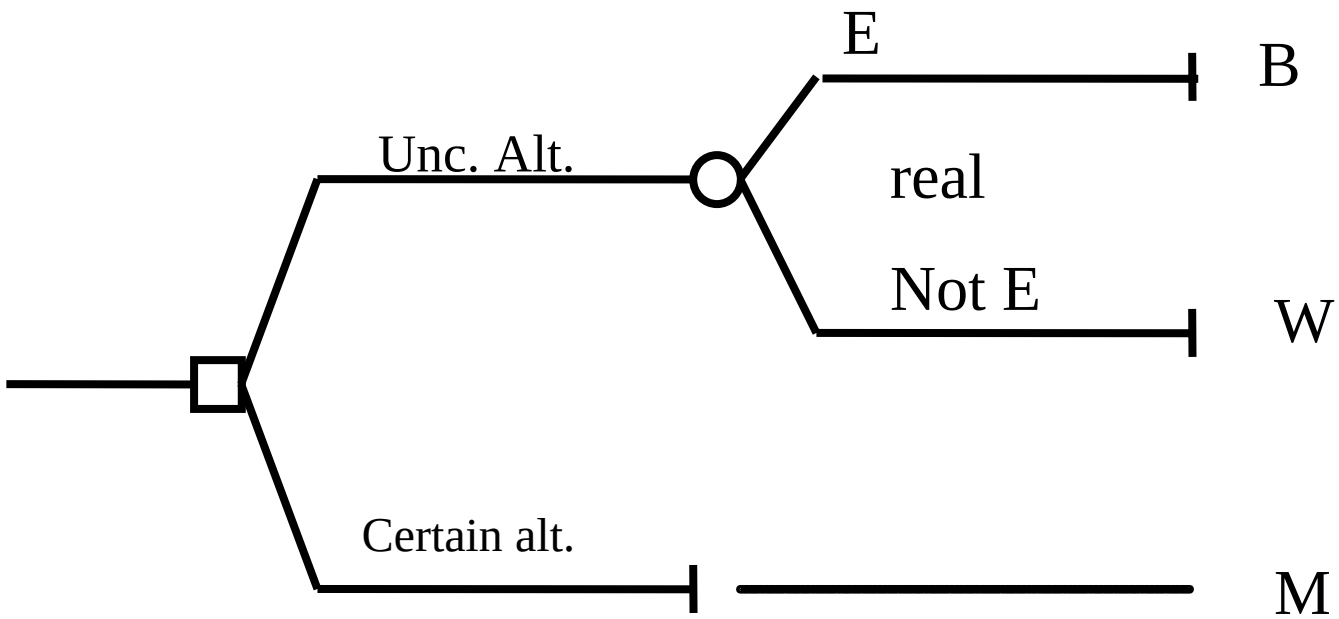


Revisiting the Sapling: Working Backwards



Separation of Tasks: a. Uncertainty analysis
b. Value or Utility Analysis



Decision hinges on the comparison of P(E) & U(M)

Transitions

- From amorphous aspirations to
- BS in Actuarial Math [Choice and Chance]
- MS in Statistics [RL Moore]
- Ph.D. in pure Math [Non Thesis]
- Social Science Connections [Rapporteur of seminar and Lecturer in program for SS]Chair of Behavioral Models Project at Columbia
- *Games and Decisions*

More Transitions

- Statistical Decision Theorist [Case method at B School and risk sharing dissertations]

- Managerial Economist
  Dissertations in Econ
- Policy analyst
- Decision Analyst Medicine ,
- Decision Scientist

-