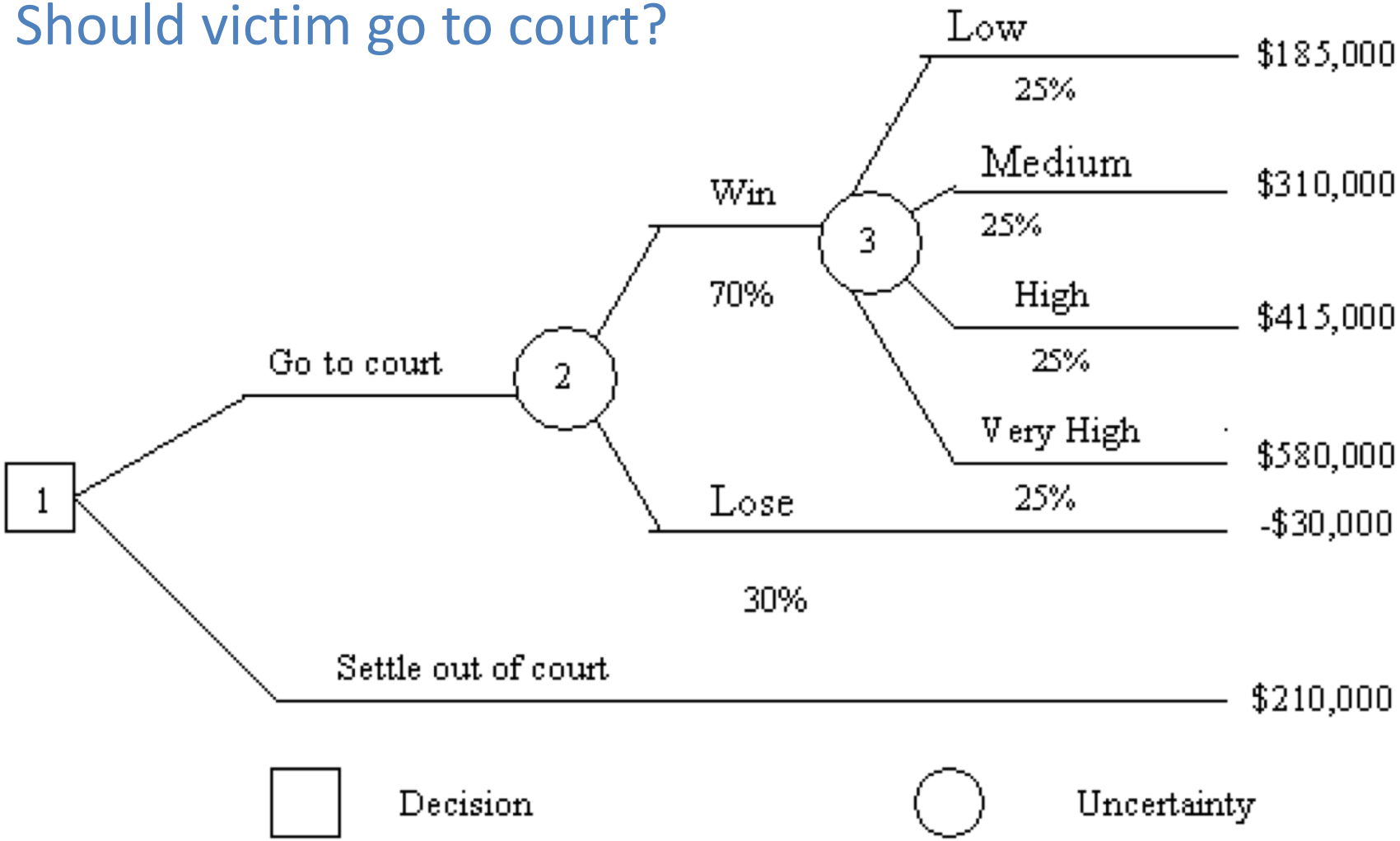
Learning Analytics

Dr. Bowen Hui
Computer Science
University of British Columbia Okanagan

DECISION TREE
POSSIBLE OUTCOMES OF DECISION TO SETTLE OR GO TO COURT

Should victim go to court?



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General Decision Making Problem

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- Possible actions (intended to be helpful)?

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  - A3: Provide hints for completing the statement
  - A4: Ask if user needs help in a pop-up dialogue
    …
  - A5: Keep observing the user (do nothing)

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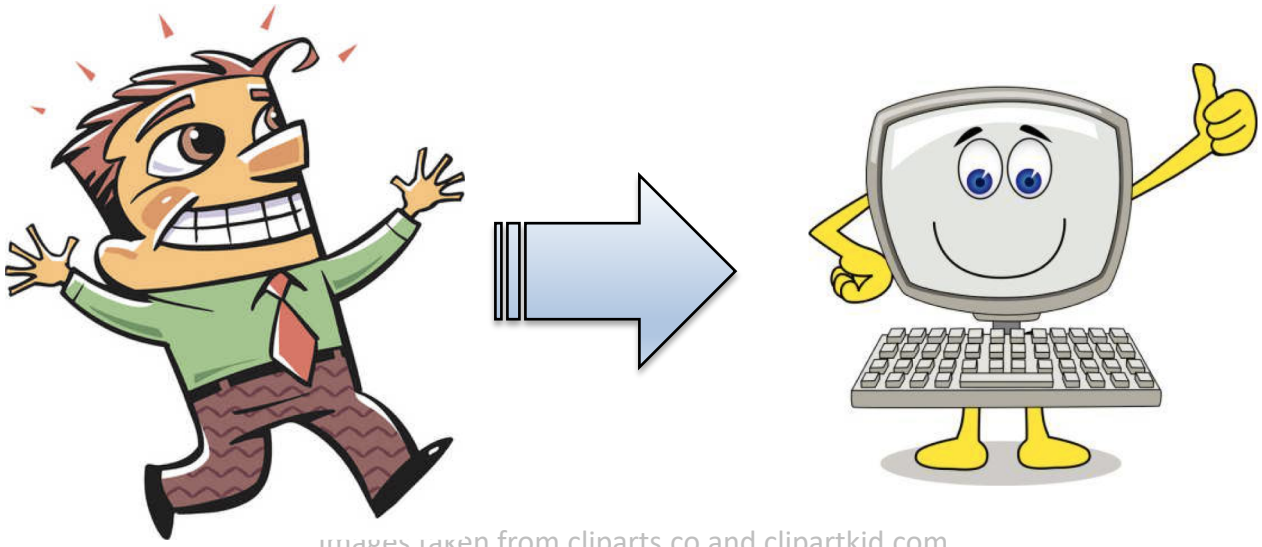
- What system does should depend on helpful it can be for the user

“Your Happiness is My Happiness”



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- System acts to help user
- If user is happy, system is doing the right thing

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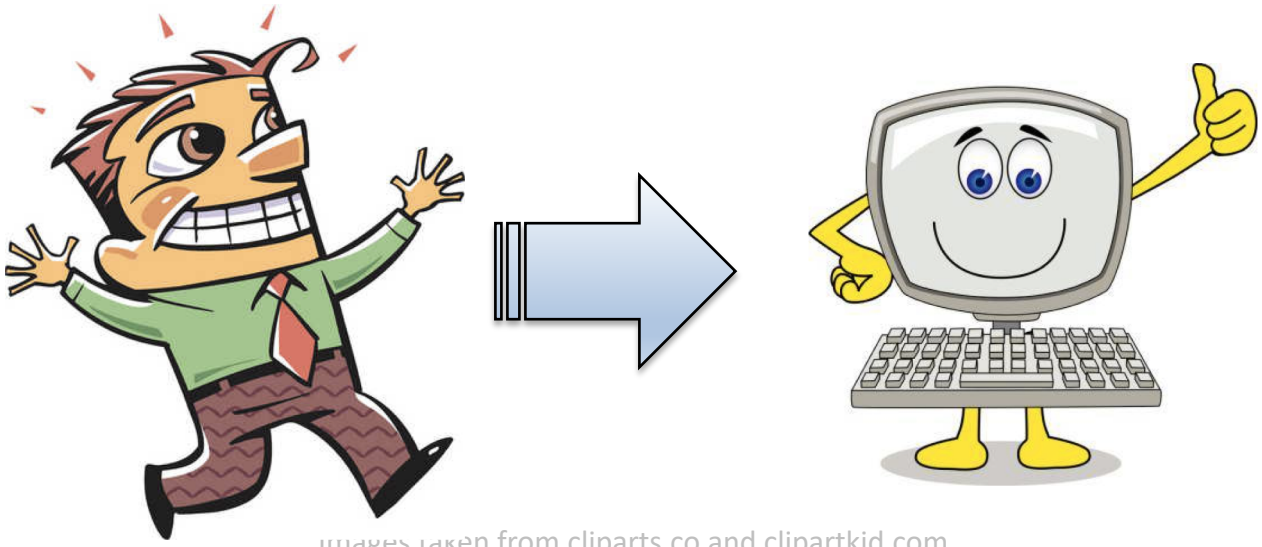

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- System acts to help user
- If user is happy, system is doing the right thing
- Therefore:
  - System makes actions to keep user happy
  - Utility function should reflect user’s preferences

Utility Function with User Variables

- System's decision problem:
  - Which is the best action to make user most happy?
  - With consideration to how much help the user needs right now

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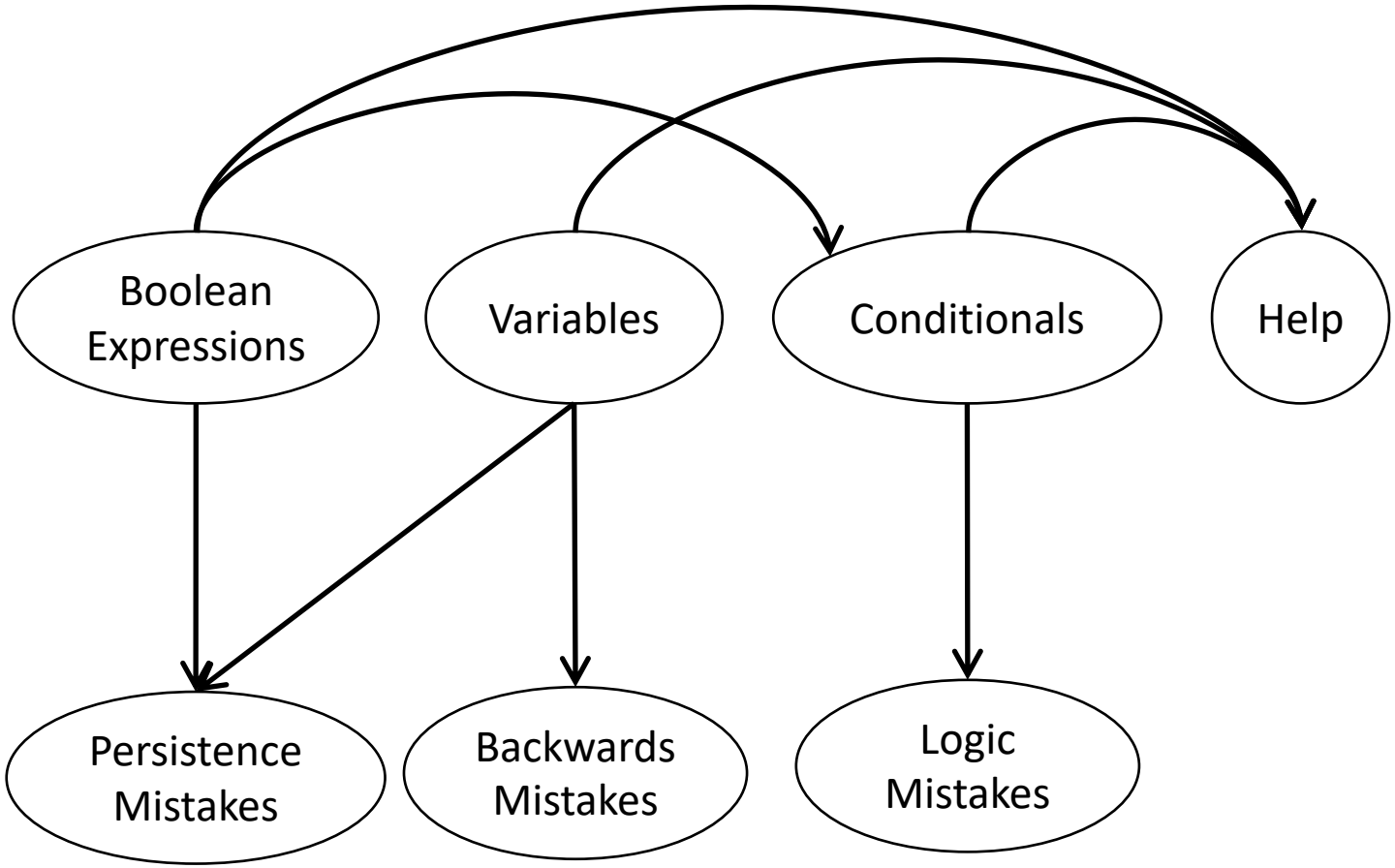
- $EU(Action) = Pr(Help) \times U(Help,Action)$

Comes from marginal distribution computed from Bayes net

Comes from utility defined/elicited and stored in separate file

Possible Way to Compute Pr(Help)



We will come back to this…

Defining U(Help,Action)

- For each scenario, assign real number to each action: auto-complete, suggest options, hint, ask, do nothing

- If Help is high,
  - Auto-complete, Suggest options, Hint are more appropriate
  - Note: Should also model quality of suggestion
- If Help is medium,
  - Ask and Hint is more appropriate
- If Help is low,
  - Do nothing is more appropriate

Example: U(Help,Action)

- Define U in [-10, +10]
  - Best outcome gets +10
  - Worst outcome gets -10
- Case: When Help is low, Do nothing is best
  - U(1, 5) = 10
  - U(1, 4) = -10 % pop-up dialogue, super annoying
  - U(1, 3) = -5 % hint, somewhat disruptive
  - U(1, 2) = -7 % suggest, somewhat disruptive
  - U(1, 1) = -2 % auto-complete, not too intrusive if easy to ignore
- Case: When Help is high, Auto-complete, Suggest options, Hint are best
  - U(3, 1) = 10 % auto-complete
  - U(3, 2) = 8 % suggest, still helpful when stuck
  - etc.
- Case: When Help is medium, Ask and Hint are most appropriate
  - U(2, 1) = -5 % auto-complete, not as great

Finally, we can do something

- Computing Pr(…) is like doing only categorization
- Now we can start making decisions

What to do with our Beliefs?

- Given our belief of the world, Pr(**X**|**E**), we want to see what action is best
  - Uses probability theory

- Need to quantify how good an action is with respect to each possible state defined by **X**
  - Uses utility theory

Decision Making Example

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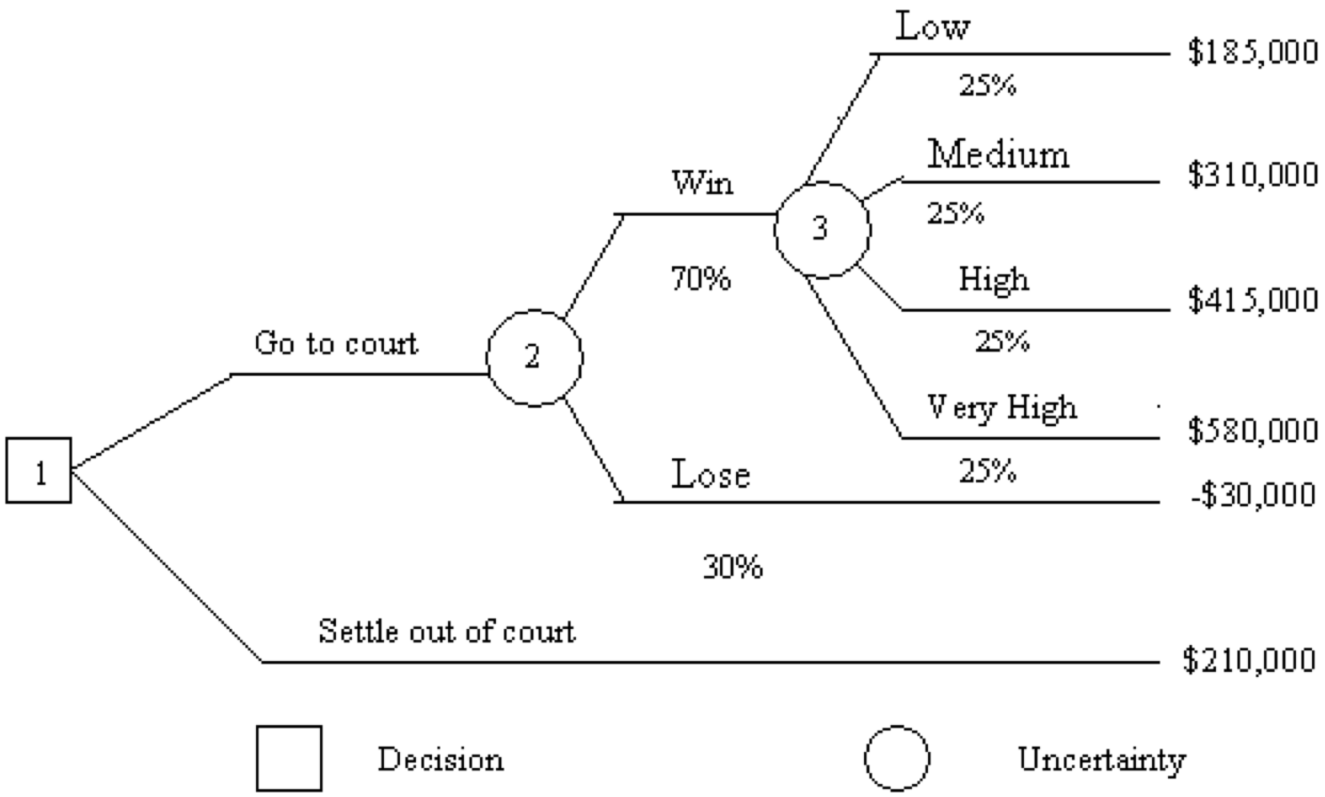

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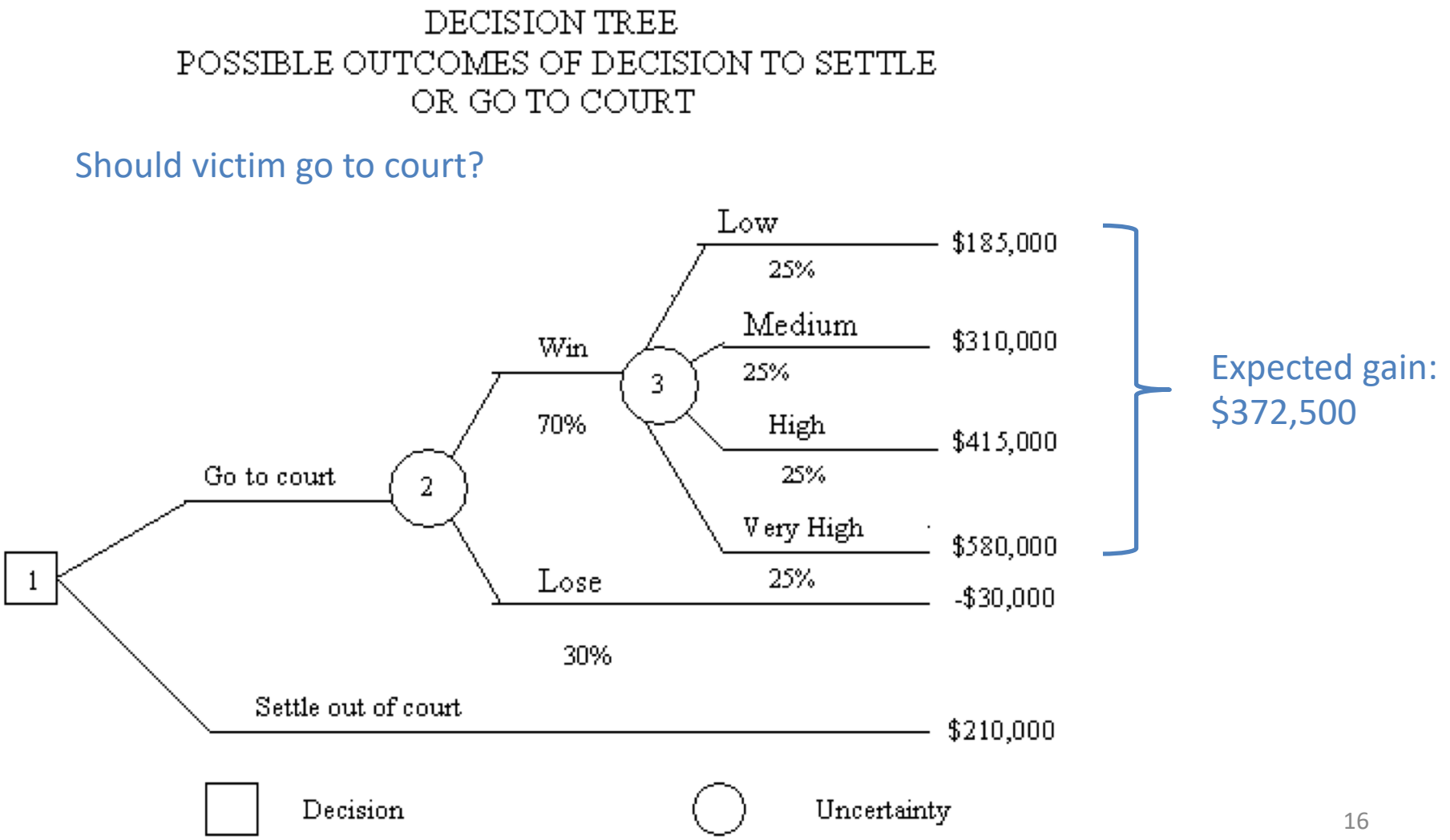

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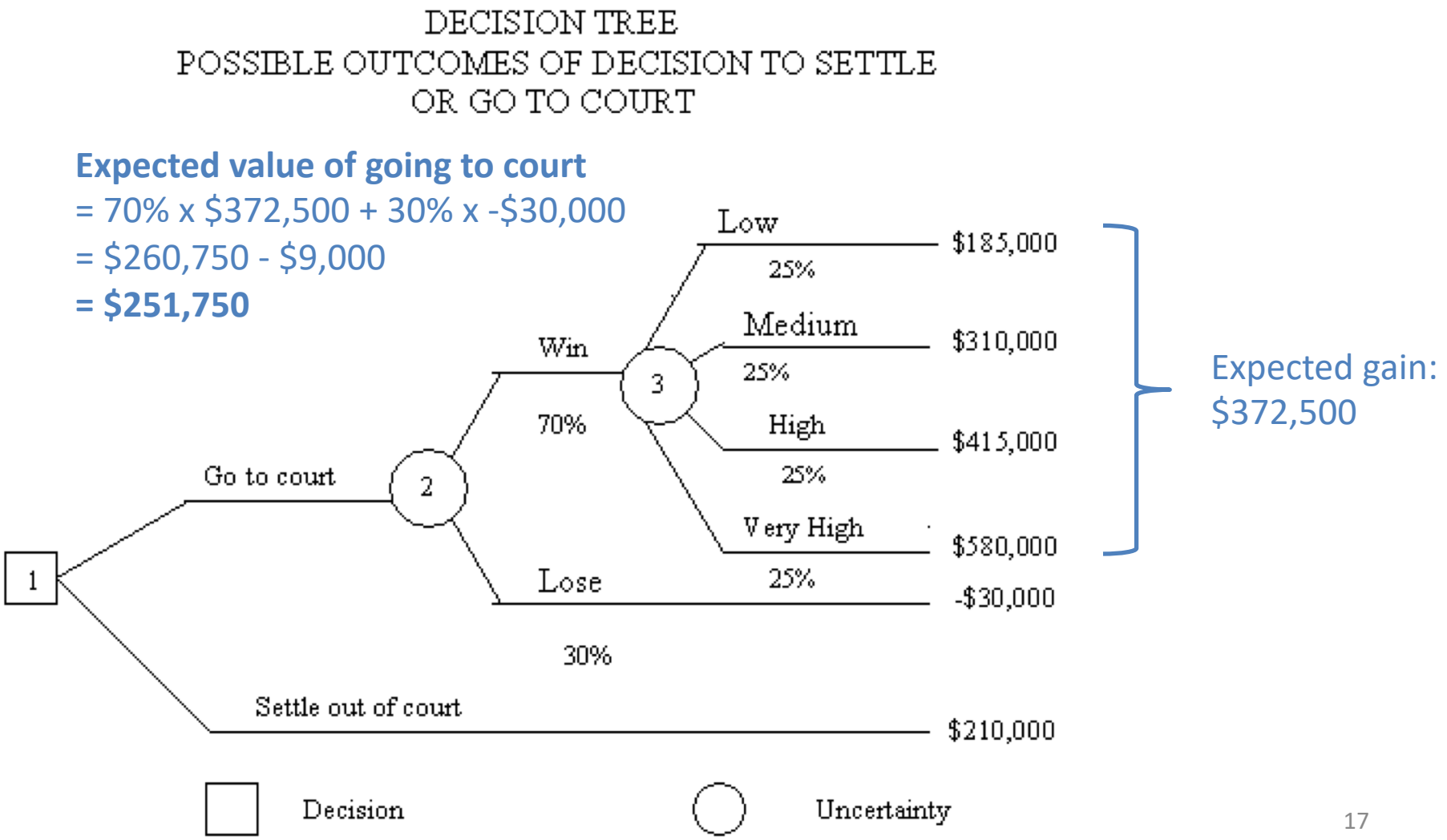

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Example

- You want to take a morning walk but not sure if you should bring an umbrella
- You don’t really want to carry an umbrella
- But it looks like it may rain and you don’t want to get wet

- Possible actions: bring umbrella, leave it at home

- How do you decide what to do?

Decision Making

- How much do you like being wet vs. dry?
- How much do you like having to carry an umbrella around?

- You have a set of preferences over the alternatives
  - E.g.: not having to carry umbrella and staying dry, is better than carrying umbrella and staying dry, is better than …

Example: Decision Scenarios

		States	
		It rains	It doesn't rain
Actions	Take umbrella	Encumbered, Dry	Encumbered, Dry
	Leave umbrella	Wet	Free, Dry

- 2 states x 2 actions = 4 possible outcomes

Example: Decision Scenarios

		States	
		It rains	It doesn't rain
Actions	Take umbrella	Encumbered, Dry +7	Encumbered, Dry +5
	Leave umbrella	Wet -8	Free, Dry +10

- 2 states x 2 actions = 4 possible outcomes
- Utility = a real number value of each outcome

Example: Decision Scenarios

		States	
		It rains 0.4	It doesn't rain 0.6
Actions	Take umbrella	Encumbered, Dry +7	Encumbered, Dry +5
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- EU(takeUmb) = Pr(rain)U(encDry) + Pr(noRain)U(encDry)
  = (0.4)(7) + (0.6)(5) = 5.8

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- EU(leaveUmb) = Pr(rain)U(wet) + Pr(noRain)U(freeDry)
  = (0.4)(-8) + (0.6)(10) = 2.8

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- EU(takeUmb) = 5.8
- EU(leaveUmb) = 2.8
- Which action will you choose?

Key Ideas

- Main concepts
  - Probability theory enables us to estimate beliefs of the world
  - Utility theory enables us to express the strength of our preferences over outcomes
  - Decision making problems require both
- Representation:
  - Decision making under uncertainty:
    - Probability distribution of outcomes
    - Utility function to express preference of outcomes