

Week 4 Review: Decision Trees

- ◆ This review session is completely optional.
 - If the decision-tree concepts introduced in Session 1 are clear to you
 - Then you can skip this review and move on to the practice problems.
 - After that, go ahead and tackle Week 4's homework.
- ◆ However if, before trying the practice problems...
 - You'd like an additional look at how to set up and analyze a decision tree
 - Then join me for a review
- ◆ Example from patent litigation
 - Collectis and Precision BioSciences

Background on Collectis and Precision BioSciences

- ◆ Both develop genomic editing technologies that they sell for use in genetic engineering.
- ◆ In 2008 Collectis sued Precision BioSciences for patent infringement, and the litigation ended in 2013.
- ◆ Imagine that it is 2008....Collectis's legal advisors note that the litigation process has three well-established stages.
 1. First, the court will decide whether or not Collectis's patent is valid.
 2. If the patent is considered valid, then the court will determine whether or not Precision BioSciences has infringed on Collectis's patent.
 3. If there is a determination of infringement, the court will then determine the magnitude of the damages payable to Collectis

If the court rules against Collectis in the 1st or 2nd phase, then litigation ends.

Collectis estimates the probabilities and cash flows

- ◆ Collectis and its attorneys estimate the probabilities of Collectis's litigation advancing from one stage to the next
 1. The chances of the patent being found valid in stage 1 are $\frac{2}{3}$.
 2. Given a valid patent, the chances that Precision BioSciences will be found to have infringed in phase 2 are only $\frac{1}{4}$.
- ◆ They estimate possible damage awards in Phase 3 by multiplying various royalty percentages by the value of the Precision BioSciences' contracts
 - Four equally likely outcomes: \$20 million, \$30 million, \$40 million, \$50 million.
- ◆ The legal team estimates its fees for each of the three trial stages
 - \$3 million for the first stage, patent validity
 - \$5 million for the second stage, determination of infringement
 - \$1 million for the third stage, damages

Collectis's decision problem

- ◆ When moving from one stage of litigation to the next...
 - If Collectis loses at that stage, it must stop and pay its attorneys' fees up through that stage.
 - Even if Collectis wins at that stage, it can decide to stop litigation and pay only its attorneys' fees up through that stage.

- ◆ More generally, Collectis must decide
 - Whether or not to litigate, to sue Precision BioSciences for patent infringement
 - If it litigates, then after each stage it wins, should it continue litigation or stop?

Q1: Construct a decision tree for Collectis

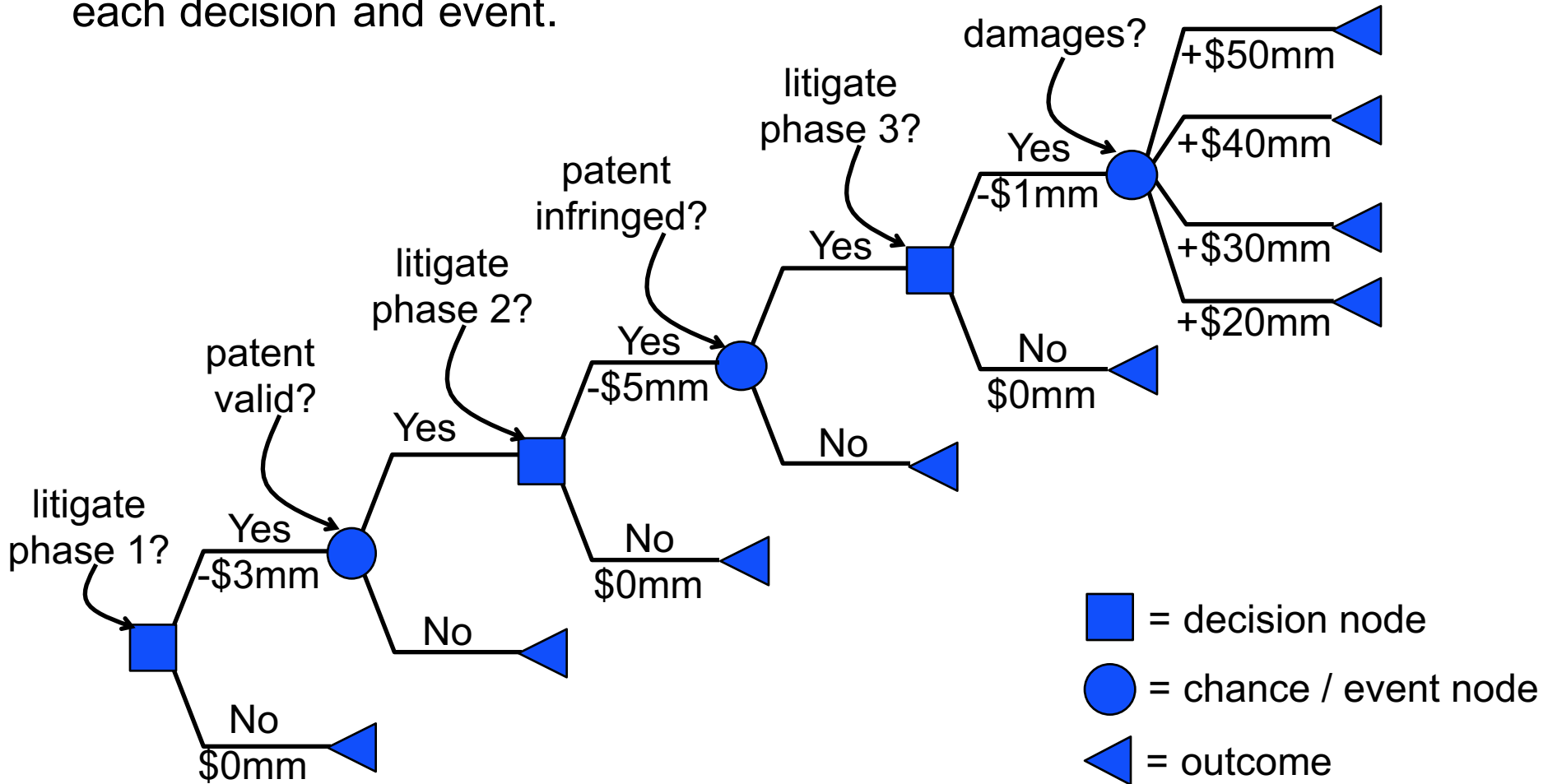
- ◆ Construct a tree with decision nodes (squares), event nodes (circles), and payouts (triangles). Write down the name and cash flows associated with each decision and event.
- ◆ For each event node, write down the probabilities that they occur. Make sure that the probabilities add up to one.
- ◆ For each payout, use the revenues and costs on the branches that lead up to it to calculate its value.

Q2: Analyze Collectis's decision tree

- ◆ What is Collectis's maxi-min set of decisions?
- ◆ What is Collectis's maxi-max set of decisions?
- ◆ What set of decisions maximizes Collectis's expected value?

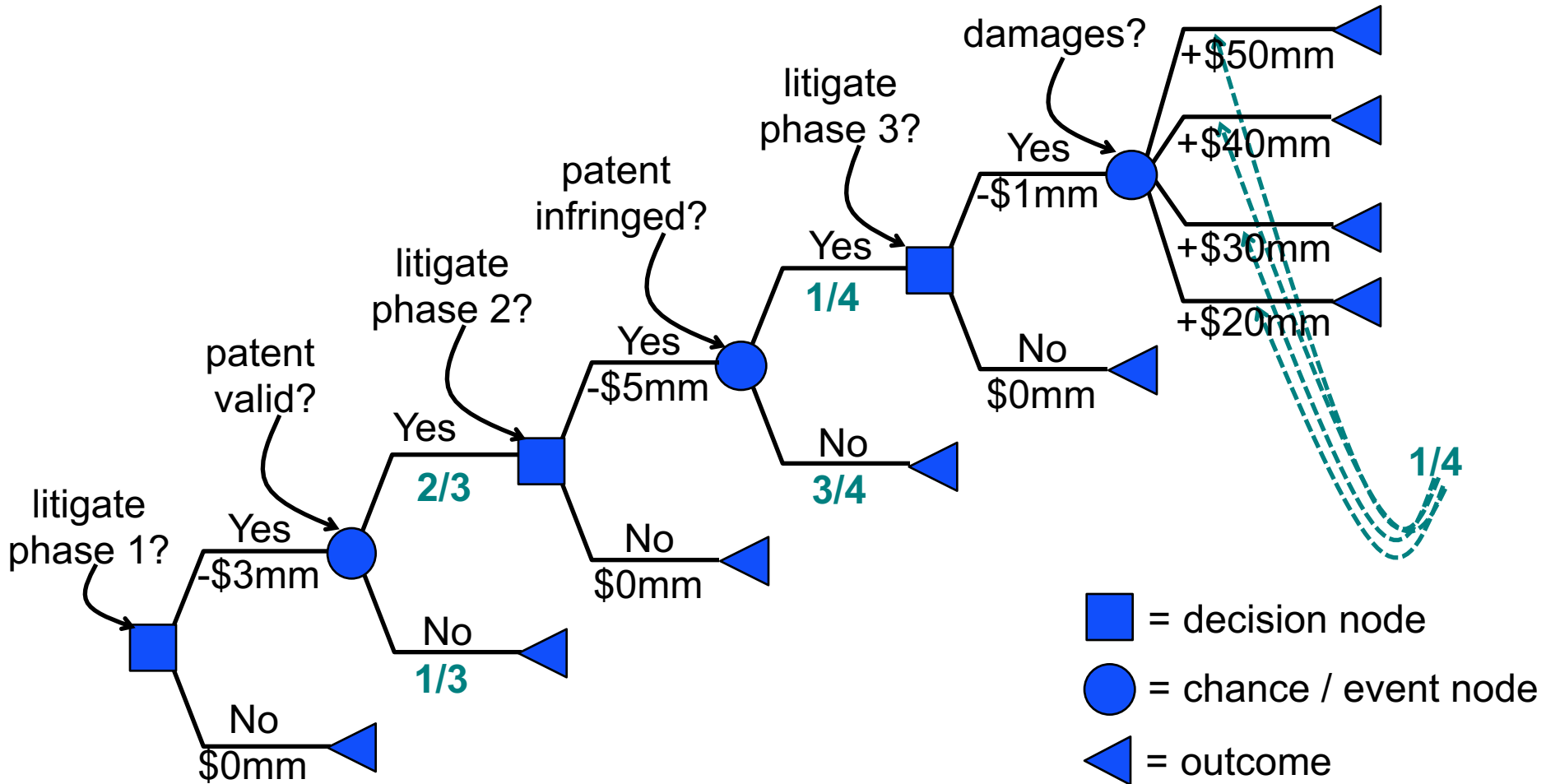
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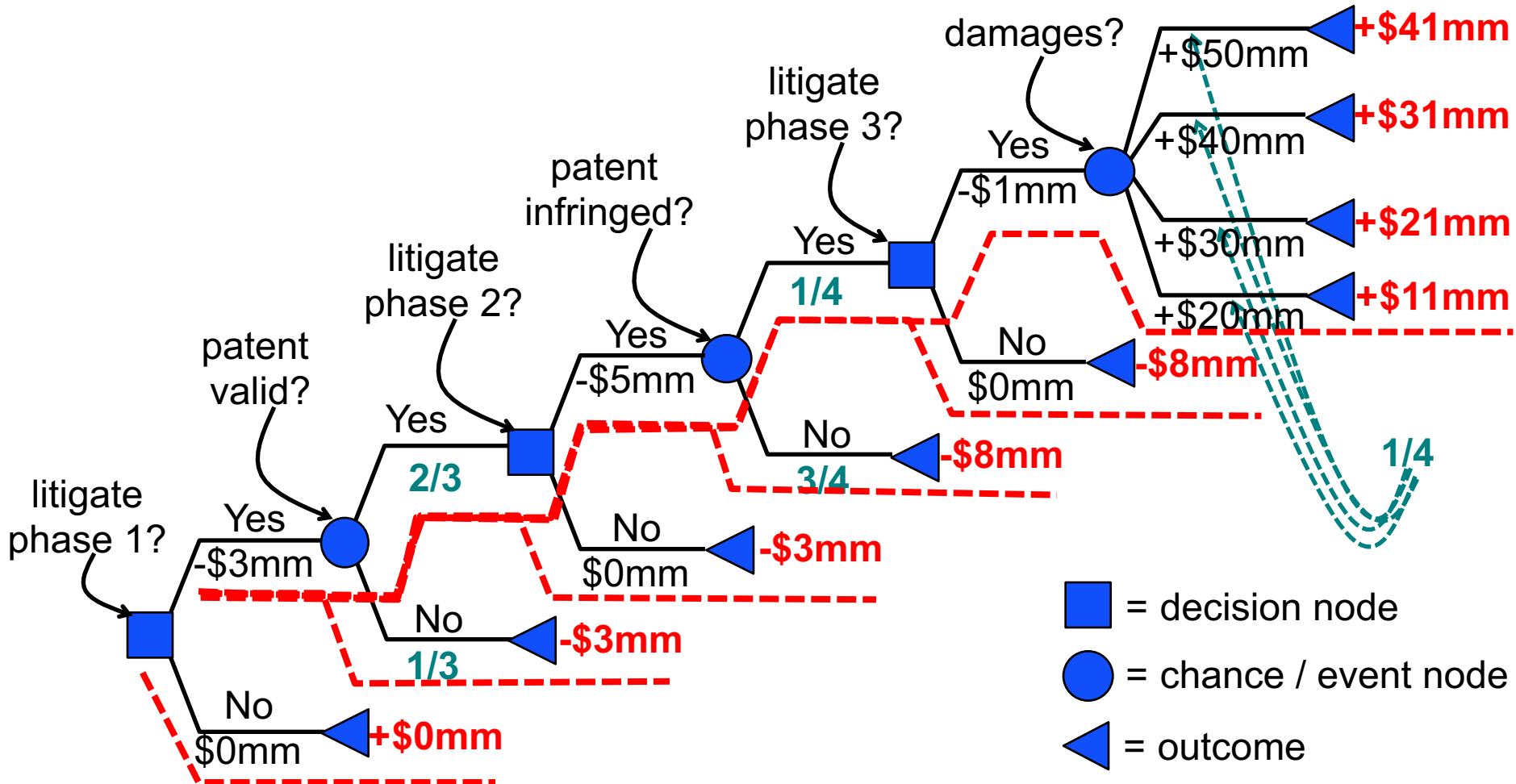
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Q1: construct a decision tree for Collectis

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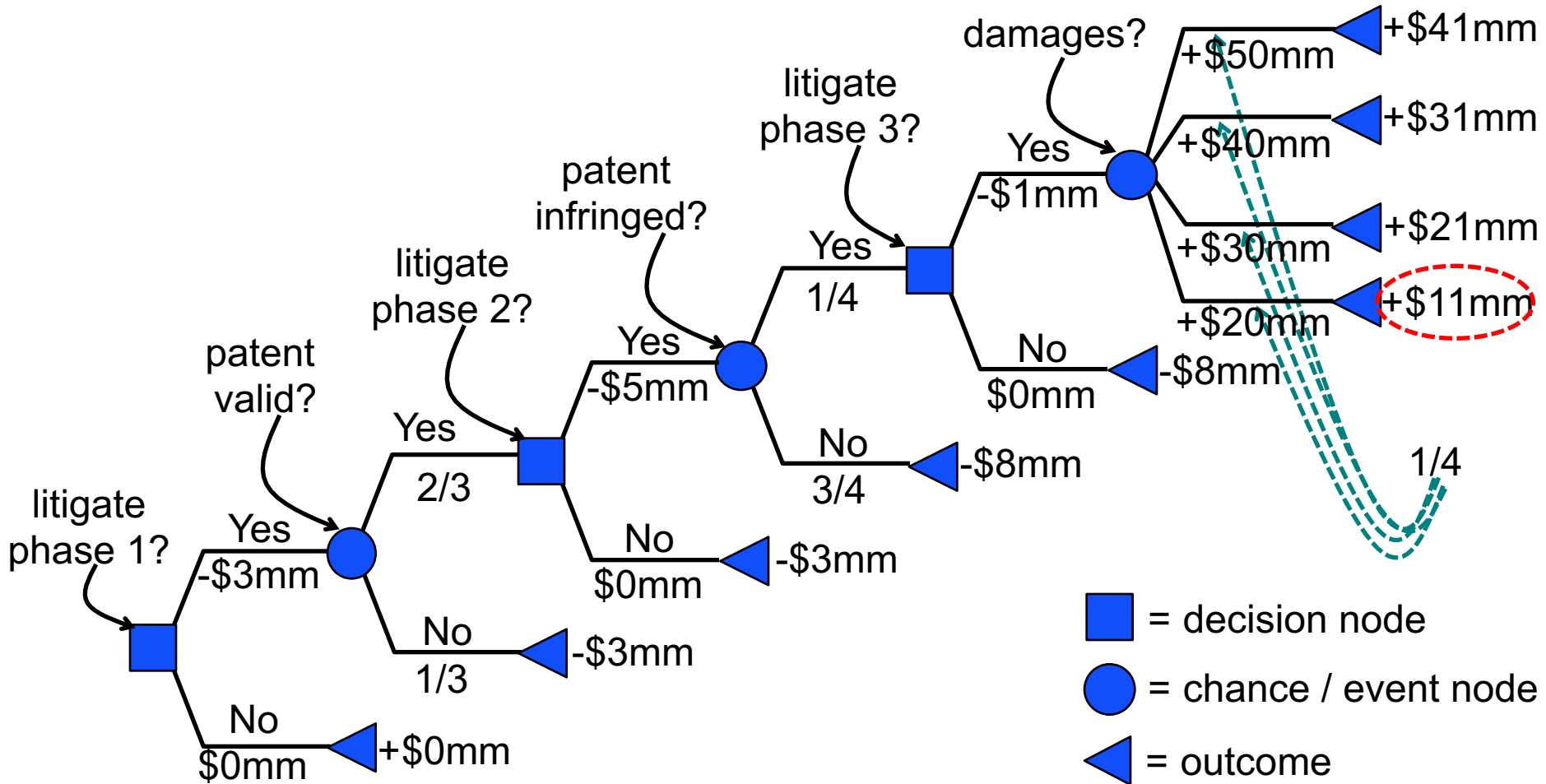
Q2: analyze Collectis's decision tree

- ◆ What is Collectis's maxi-min set of decisions?
 - Remember that maxi-min decisions maximize the minimum outcome
 - To identify them, we start at the tree's outcomes and work backward to its root
 - At each event node, we choose the minimum outcome
 - At each decision node, we choose the outcome-maximizing decision

Q2: analyze Collectis's decision tree

- What is Collectis's maxi-min set of decisions?

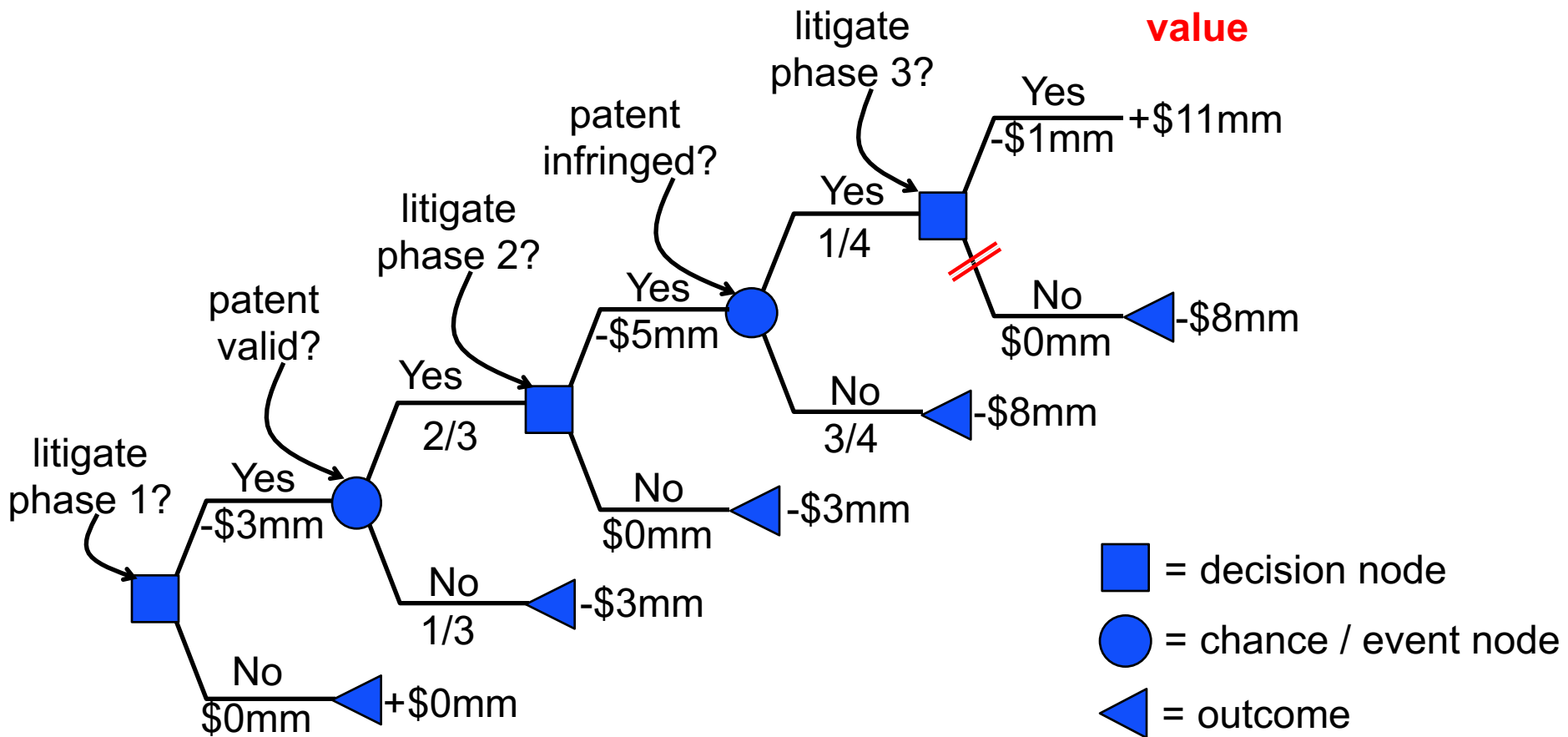
select the minimum event outcome



Q2: analyze Collectis's decision tree

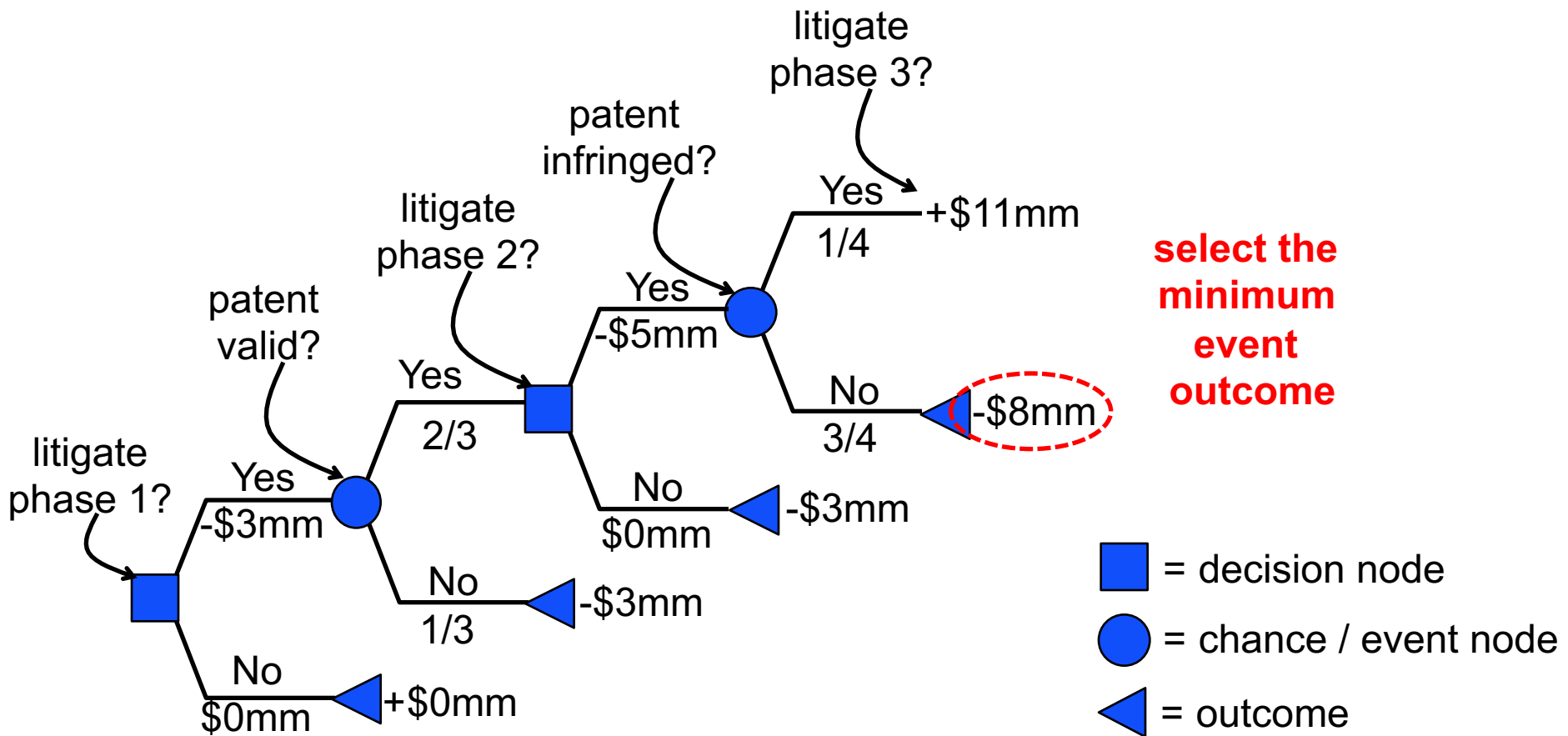
- ◆ What is Collectis's maxi-min set of decisions?

**choose the
maximum
value**



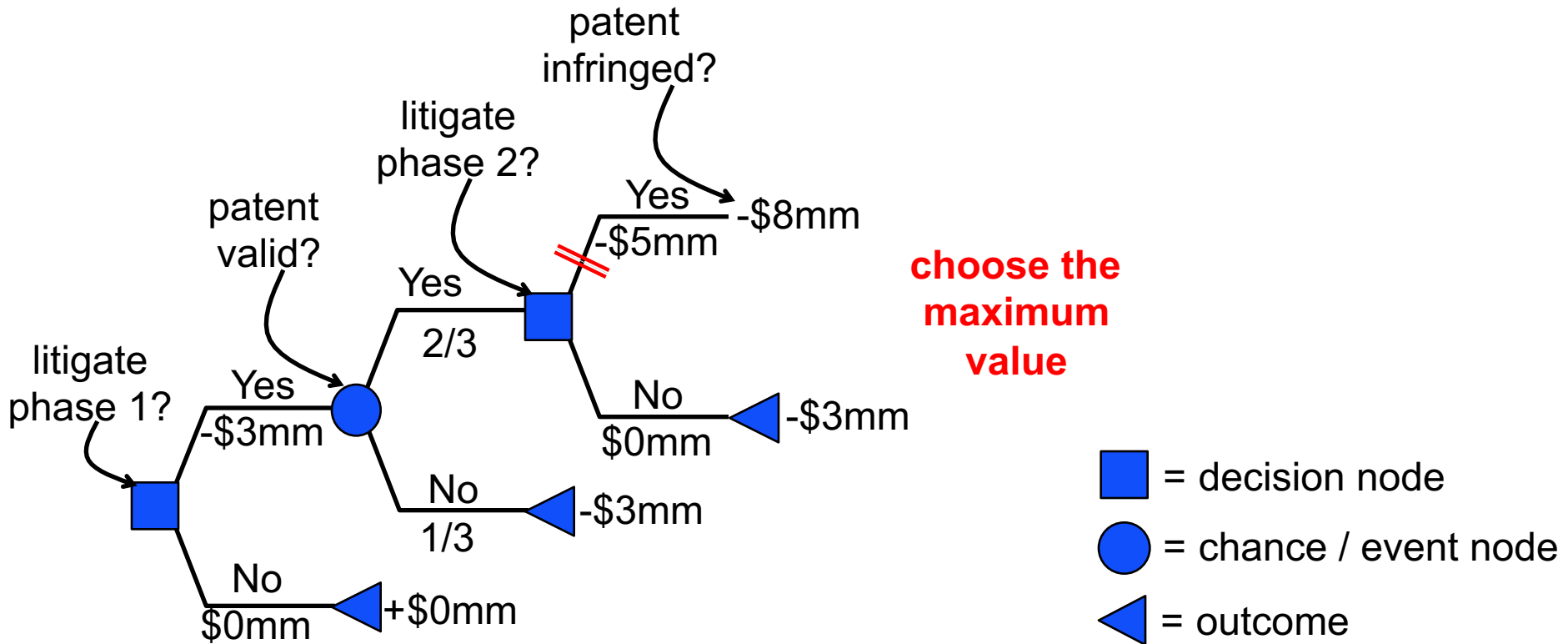
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- ◆ What is Collectis's maxi-min set of decisions?



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Q2: analyze Collectis's decision tree

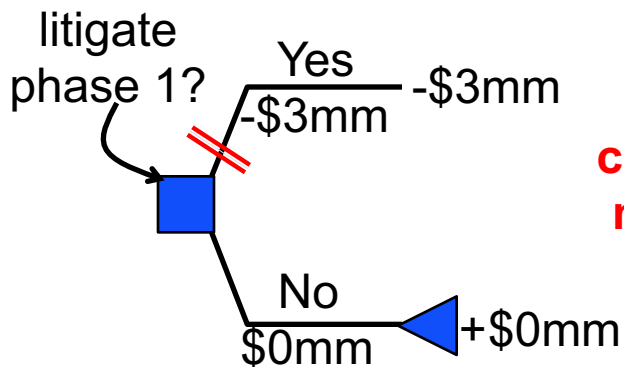
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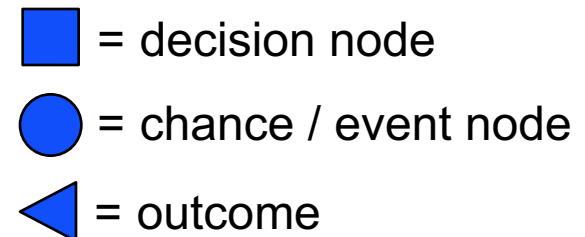
Q2: analyze Collectis's decision tree

- ◆ What is Collectis's maxi-min set of decisions?

To maximize its minimum payout,
Collectis should not enter into litigation at all.



choose the
maximum
value



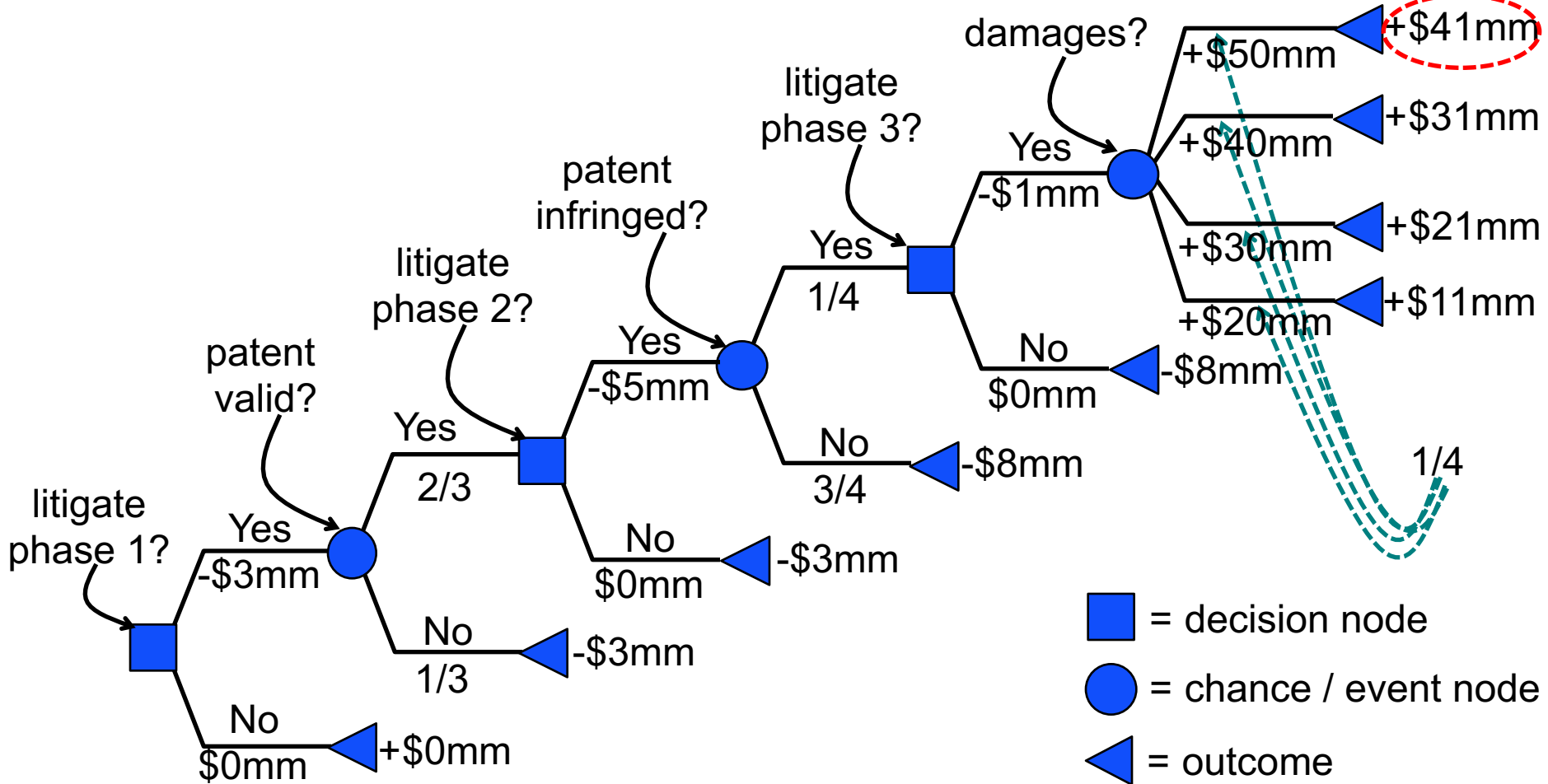
Q2: analyze Collectis's decision tree

- ◆ What is Collectis's maxi-max set of decisions?
 - Remember that maxi-max decisions maximize the maximum outcome
 - To identify them, we start at the tree's outcomes and work backward to its root
 - At each event node, we choose the maximum outcome
 - At each decision node, we choose the outcome-maximizing decision

Q2: analyze Collectis's decision tree

- What is Collectis's maxi-max set of decisions?

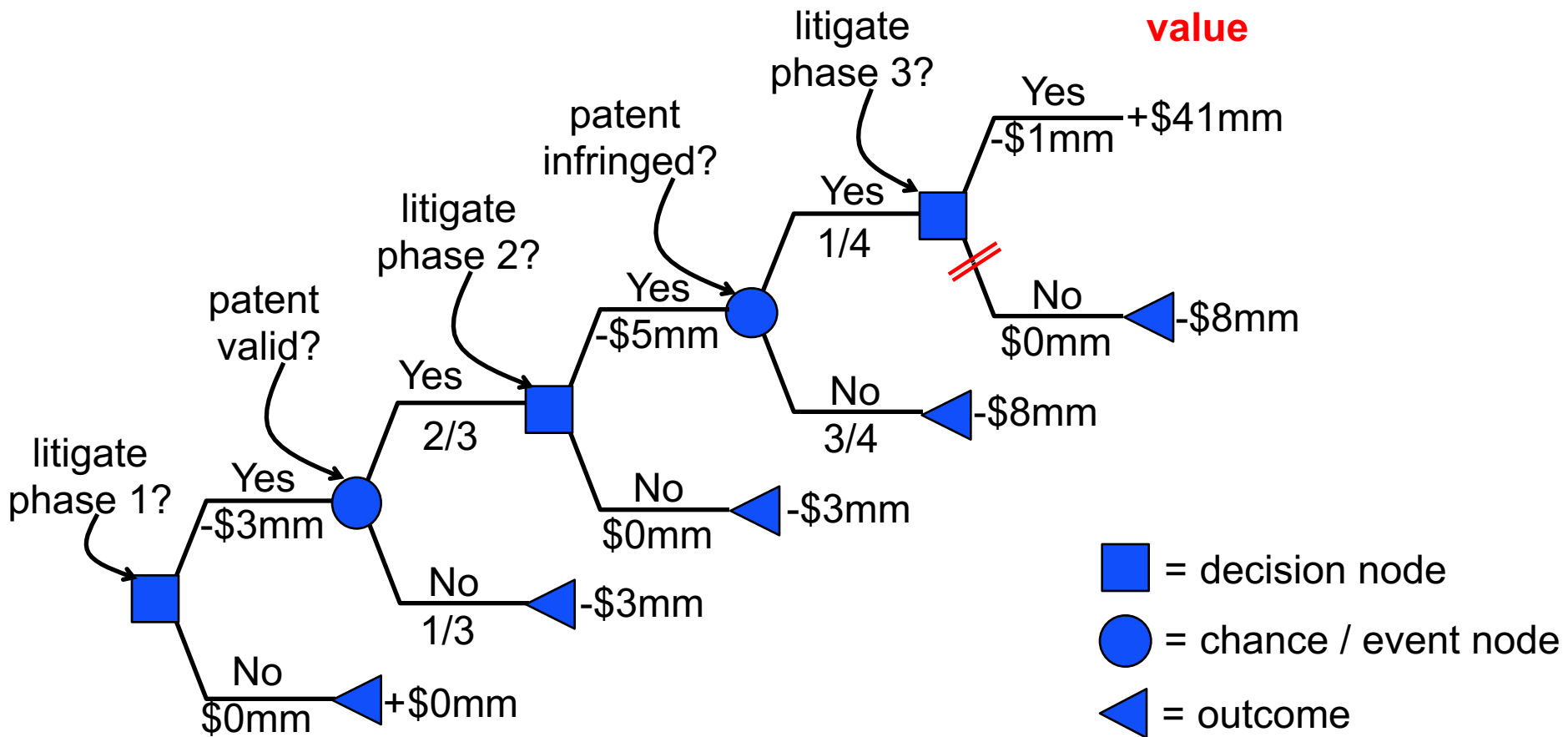
select the minimum event outcome



Q2: analyze Collectis's decision tree

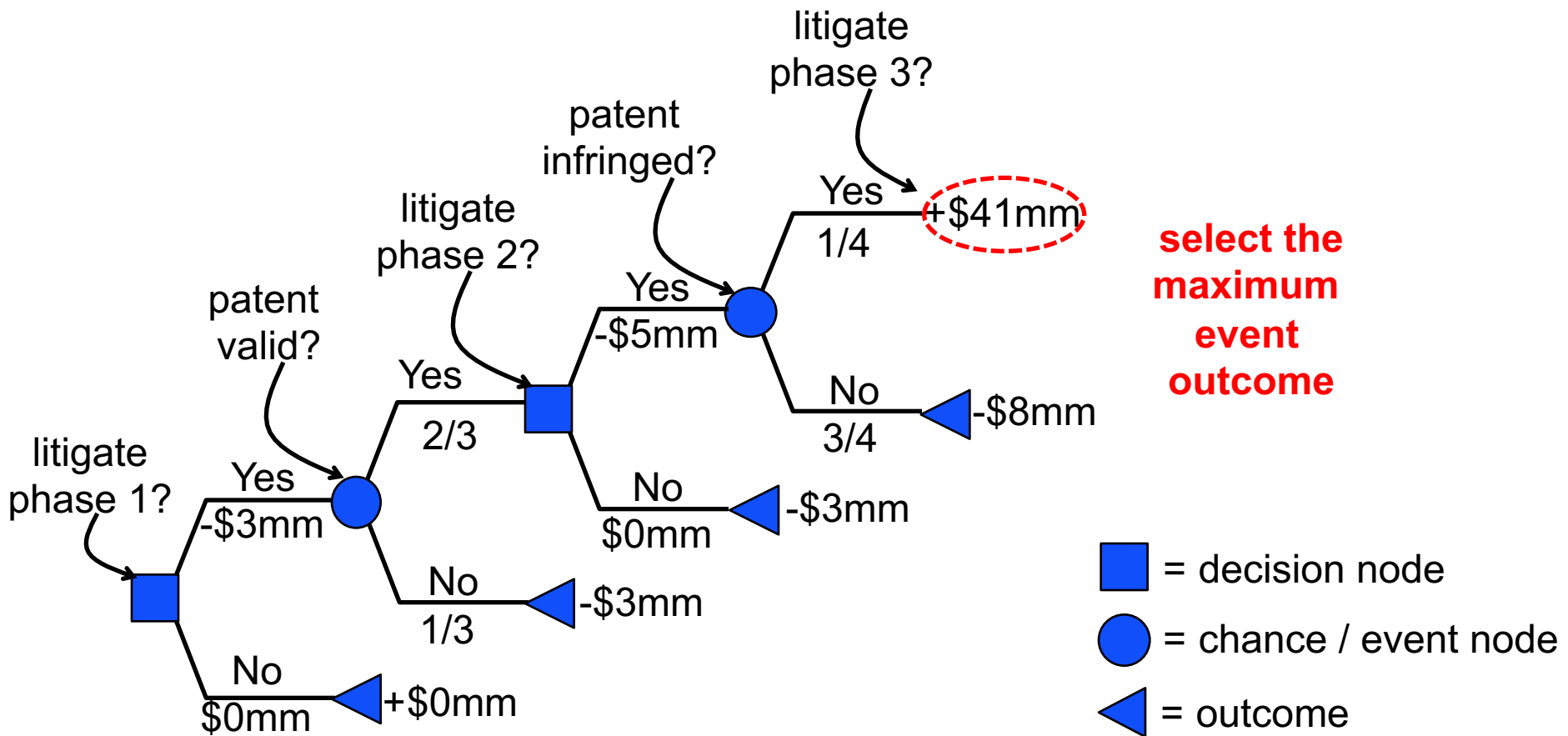
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**choose the
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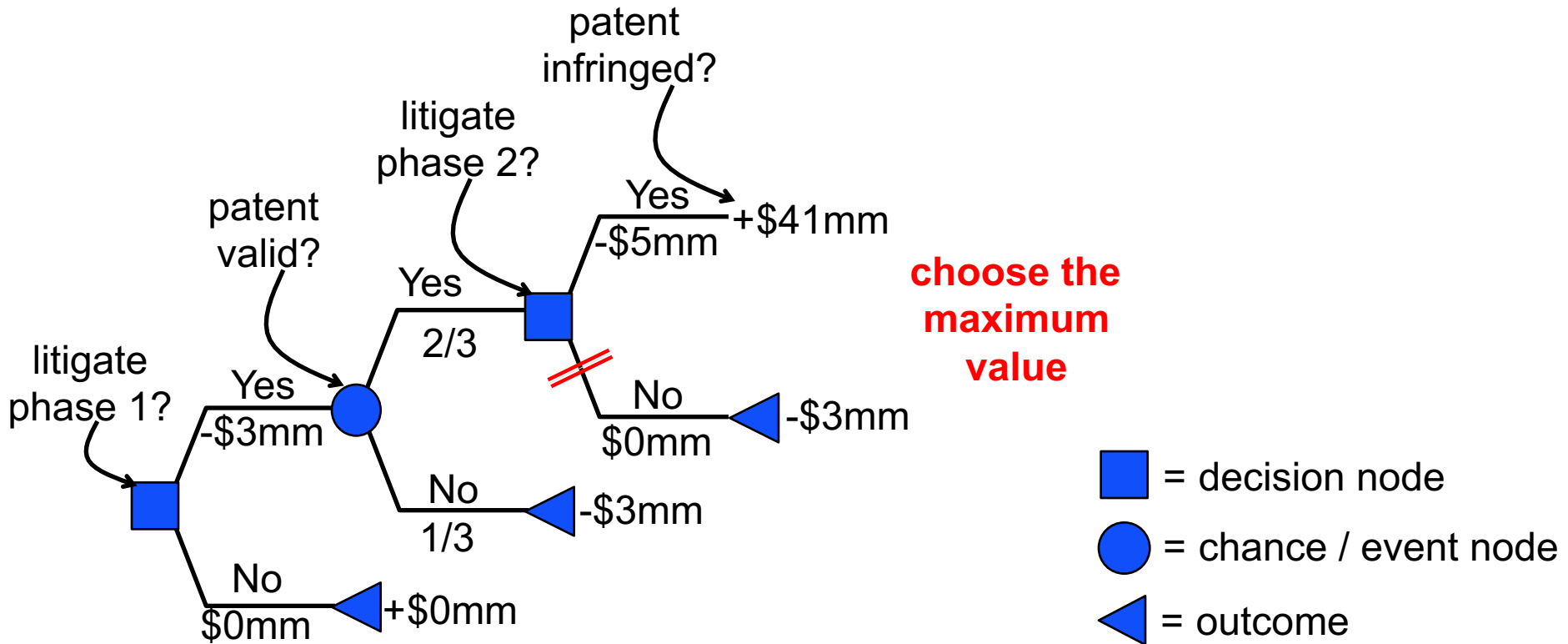
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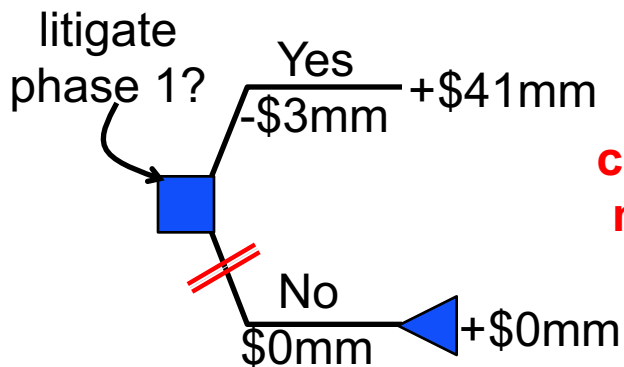
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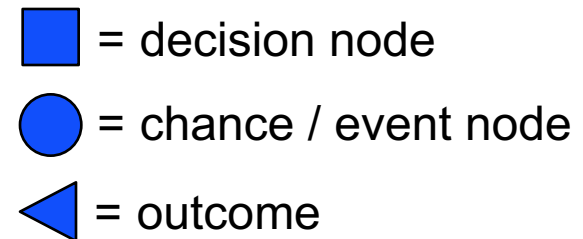
Q2: analyze Collectis's decision tree

- ◆ What is Collectis's maxi-max set of decisions?

To maximize its maximum payout, Collectis should proceed through all stages of litigation.



**choose the
maximum
value**



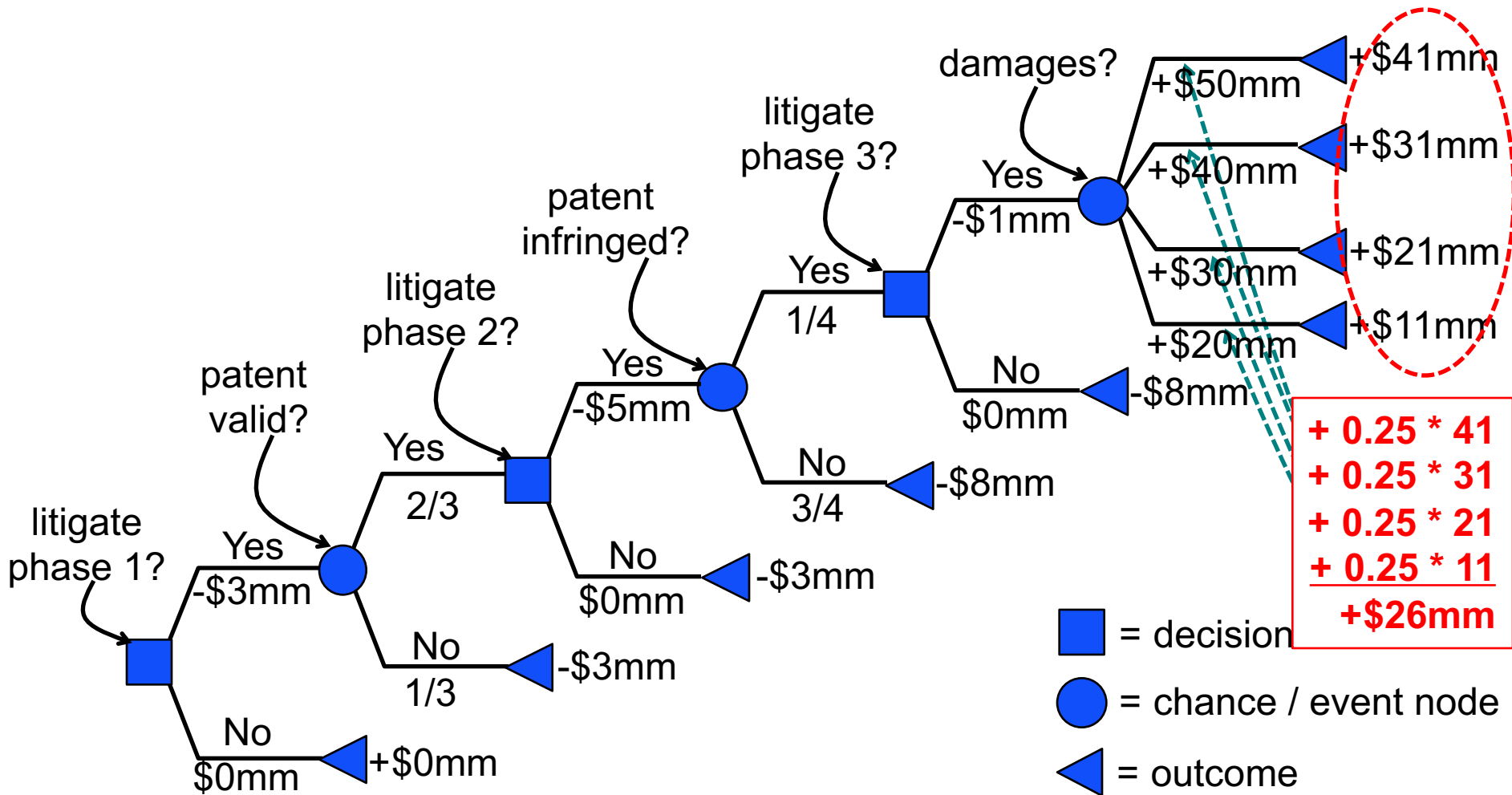
Q2: analyze Collectis's decision tree

- ◆ What set of decisions maximizes Collectis's expected value?
 - As before, we start at the tree's outcomes and work backward to its root
 - At each event node, we calculate the expected value of the outcomes
 - » That's the weighted average of the outcomes, with probabilities as weights.
 - At each decision node, we choose the expected-value-maximizing decision

Q2: analyze Collectis's decision tree

- ◆ What set of decisions maximizes Collectis's expected value?

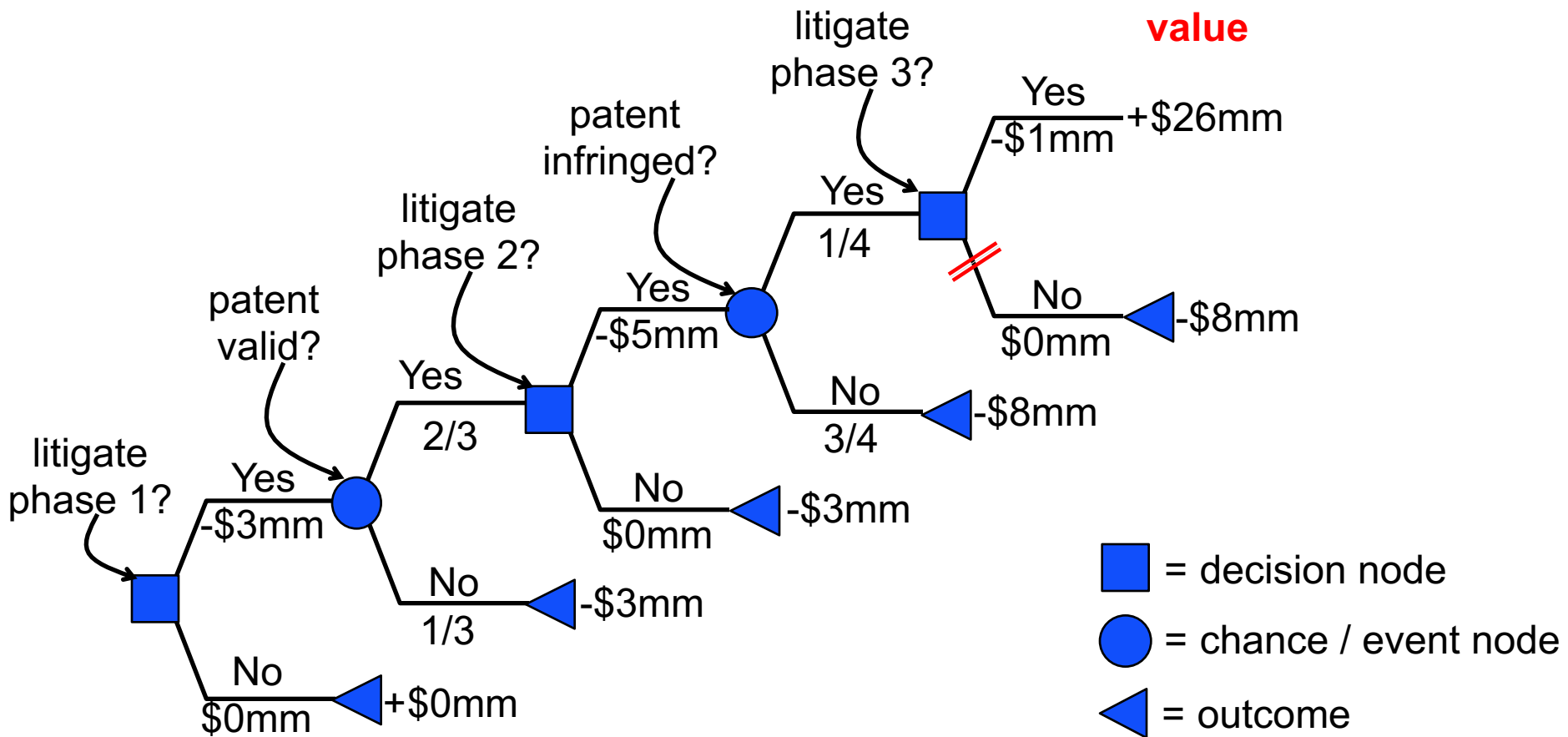
calculate the expected value?



Q2: analyze Collectis's decision tree

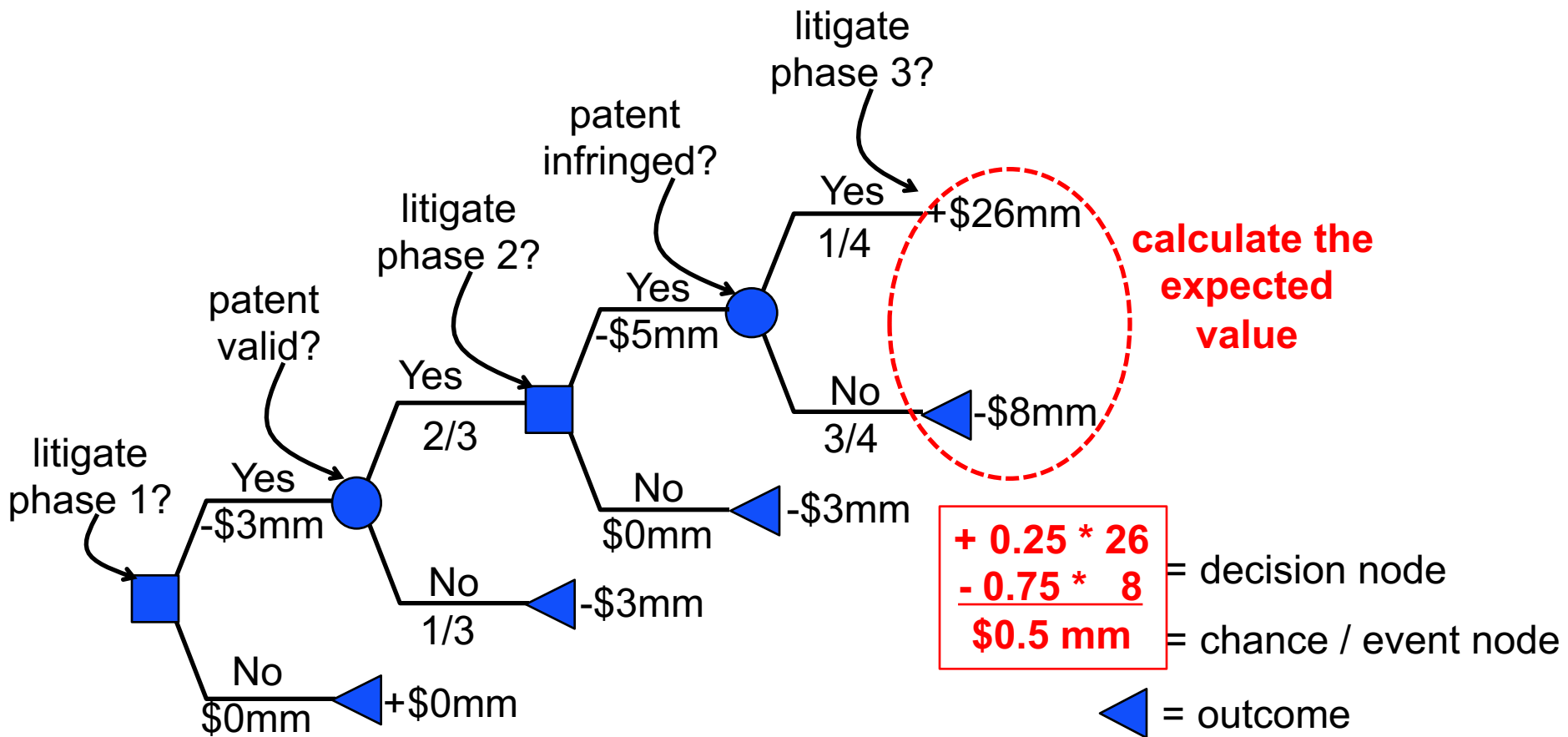
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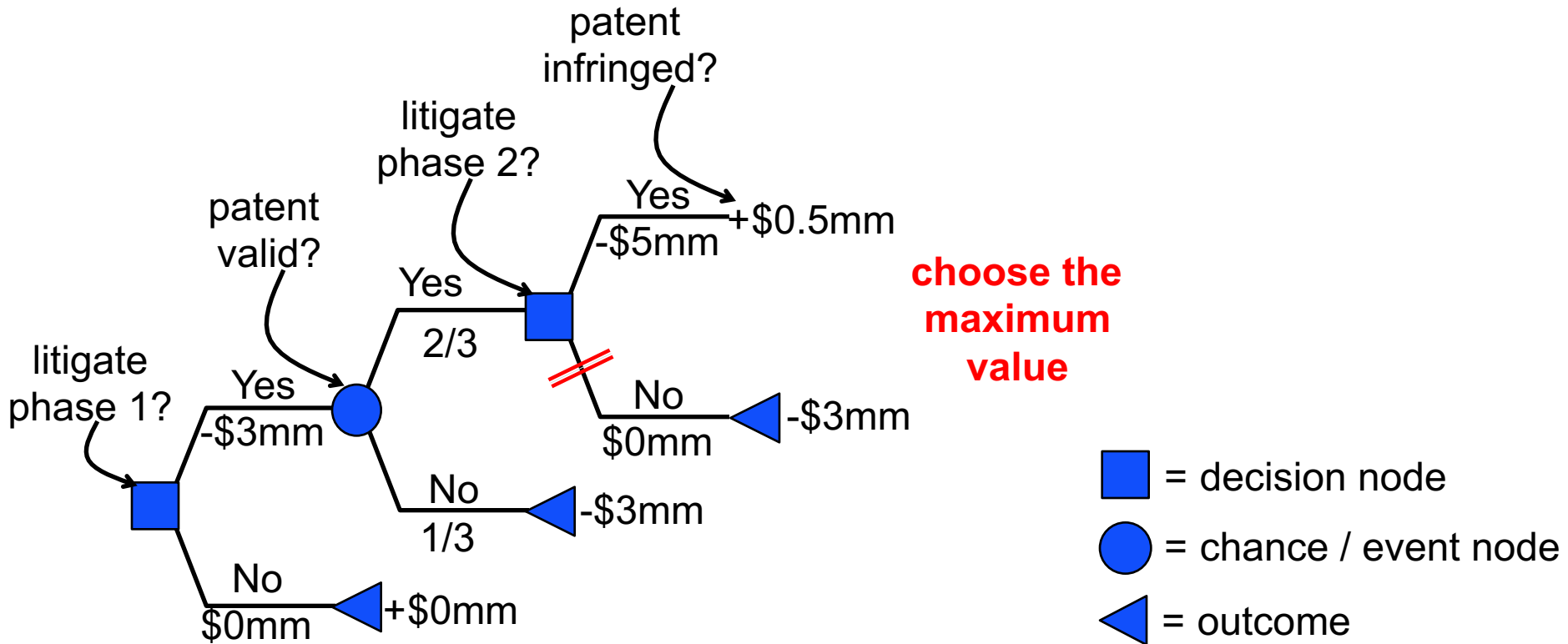
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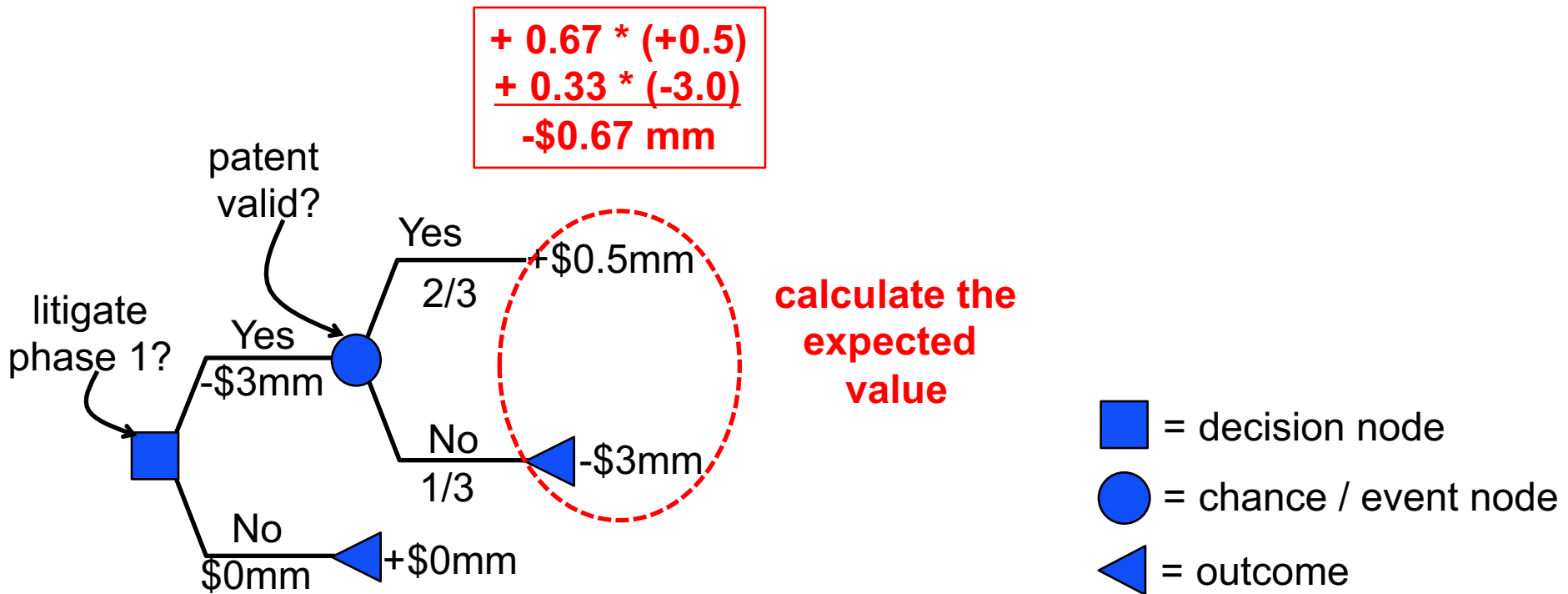
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Q2: analyze Collectis's decision tree

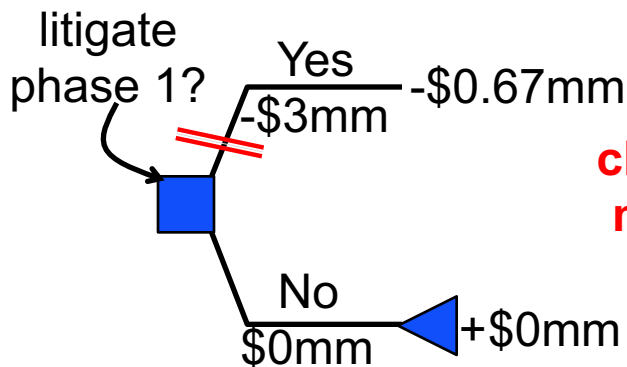
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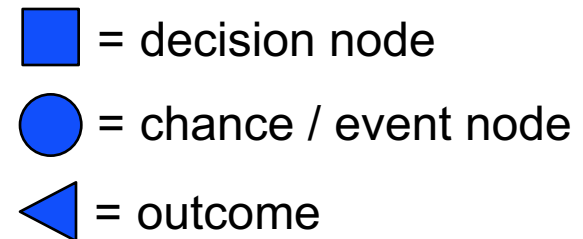
Q2: analyze Collectis's decision tree

- ◆ What is Collectis's maxi-max set of decisions?

To maximize its expected value,
Collectis should not enter into litigation at all.



choose the
maximum
value



Results for Collectis's decision problem

- ◆ We built a decision tree
 - Using decision nodes, event nodes, outcomes
 - Making sure that probabilities at event nodes summed to one
 - Adding up cash flows from the root to each leaf to calculate payouts
- ◆ We identified the following strategies
 - The maxi-min, max-max, and expected-value-maximizing strategies
- ◆ The initial maxi-min and expected-value-maximizing decisions coincided
 - Do not litigate and collect \$0mm
- ◆ The maxi-max strategy differed
 - To have a chance at collecting damages
 - Continue through all stages of litigation