Chapter 2:Decision-Making Tools
Decision Trees

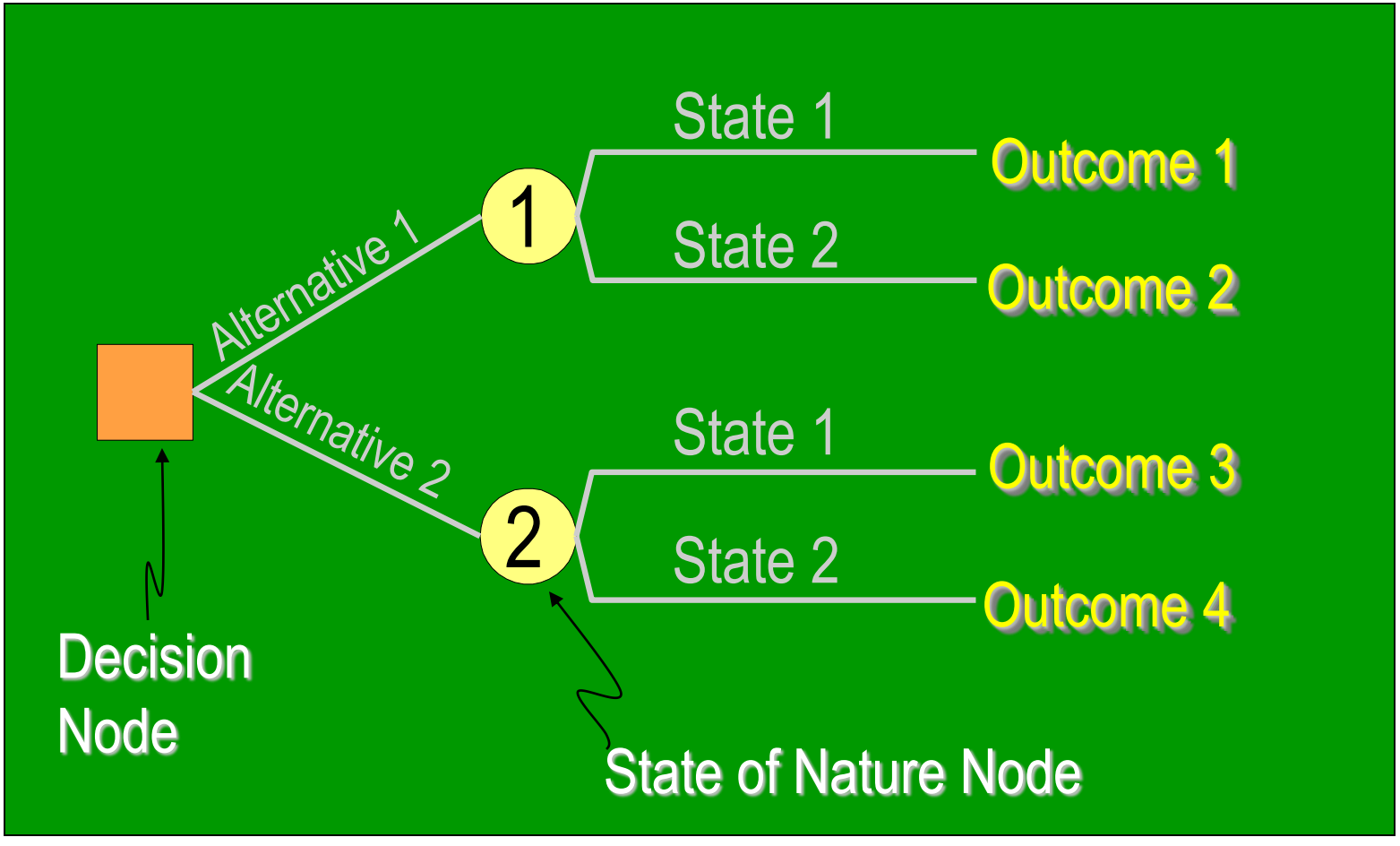
Decision Trees

- Can be used as visual aids to structure and solve sequential decision problems
- Especially beneficial when the complexity of the problem grows
- Symbols used in decision tree
- (Three types of "nodes")
  - Decision nodes - represented by squares (□)
  - State of nature or Chance nodes - represented by circles (O)
  - Terminal nodes - represented by triangles (optional)
- *Expected Value* criterion is used.

Using Decision Trees

- Define the problem.
- Draw the decision tree.
- Assign probabilities to all states of nature.
- Estimate payoffs for each combination of alternatives and states of nature.
- Solve the problem:
  - Compute expected values for each state-of-nature node moving right to left.
  - Select decisions that maximize expected value.

Decision Tree



Example 1

A firm has two options for expanding production of a product: (1) construct a large plant; or (2) construct a small plant. Whether or not the firm expands, the future market for the product will be either favorable or unfavorable.

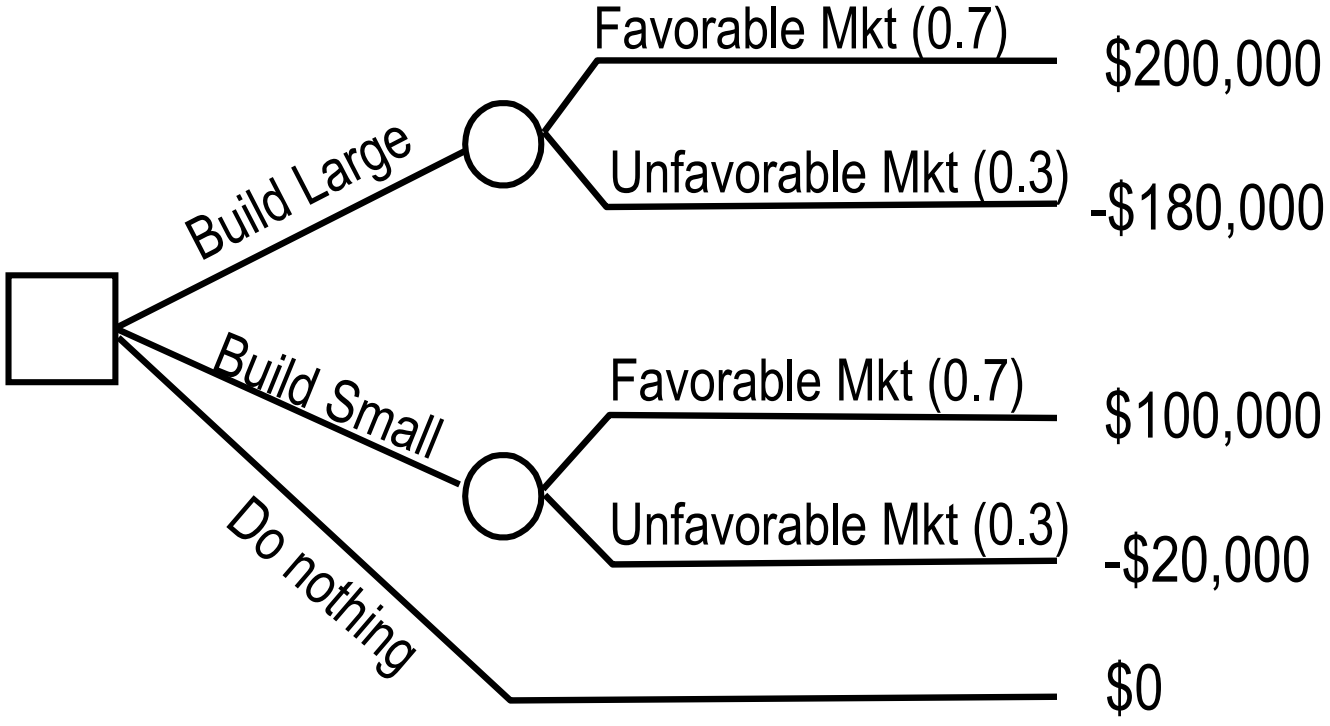
If a large plant is constructed and the market is favorable, then the result is a profit of $200,000. If a large plant is constructed and the market is unfavorable, then the result is a loss of $180,000.

If a small plant is constructed and the market is favorable, then the result is a profit of $100,000. If a small plant is constructed and the market is unfavorable, then the result is a loss of $20,000. Of course, the firm may also choose to "do nothing", which produces no profit or loss.

Suppose: Probability of favorable market = 0.7

Probability of unfavorable market = 0.3

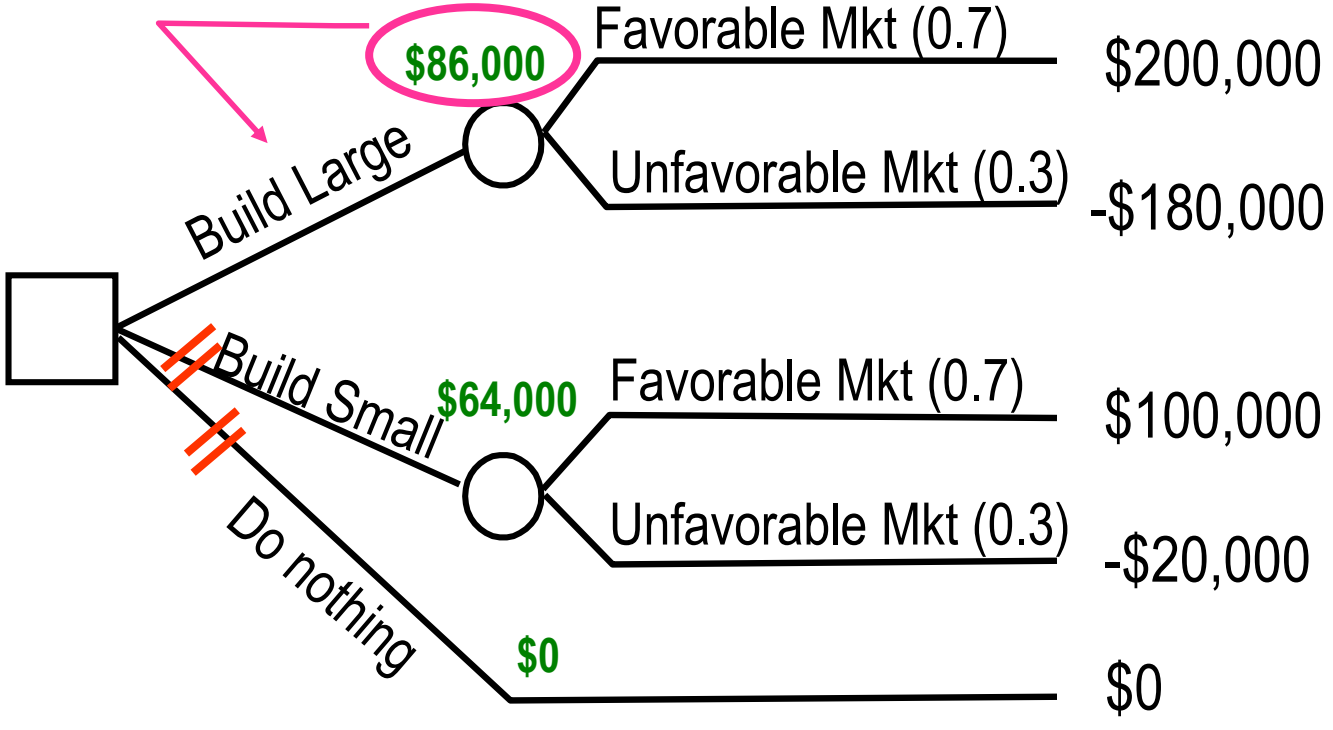
Decision Tree
Example 1



Solving decision Tree

- Solving the tree involves pruning all but the best decisions at decision nodes, and finding expected values of all possible states of nature at chance nodes
- Create the tree from left to right
- Solve the tree from right to left

Decision Tree
Example 1- Solution



Decision Tree
Example 2

A firm can build a large plant or small plant initially (for a new product). Demand for the new product will be high or low initially. The probability of high demand is 0.6. (The probability of low demand is 0.4.)

If they build “small” and demand is “low”, the payoff is $40 million. If they build “small” and demand is “high”, they can do nothing and payoff is $45 million, or they can expand. If they expand, there is a 30% chance the demand drops off and the payoff will be $35 million, and a 70% chance the demand grows and the payoff is $48 million.

If they build “large” and demand is “high”, the payoff is $60 million. If they build “large” and demand is “low”, they can do nothing and payoff is -$10 million, or they can reduce prices and payoff is $20 million. Determine the best decision(s) using a decision tree.

Decision Tree
Example 2

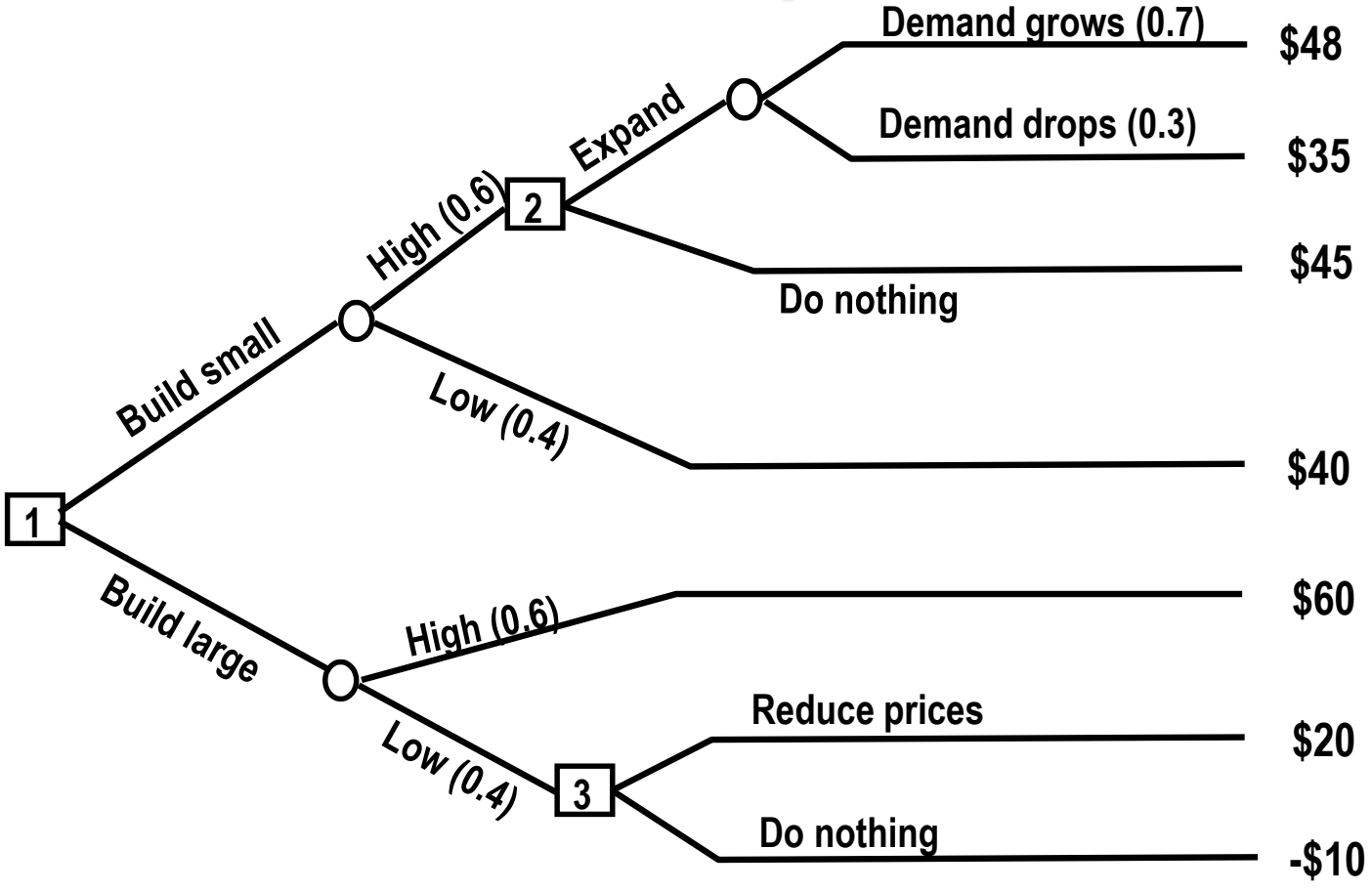
Three decisions:

1. Build "Large" or "Small" plant initially.
2. If build "Small" and demand is "High", then "Expand" or "Do nothing".
3. If build "Large" and demand is "Low", then decide to "Reduce prices" or "Do nothing".

Two states of nature:

1. Demand is "High" (0.6) or "Low" (0.4) initially.
2. If build "Small", demand is "High", and decision is "Expand", then demand "Grows" (0.7) or demand "Drops" (0.3).

Decision Tree
Example 2



Decision Tree Solution
Example 2

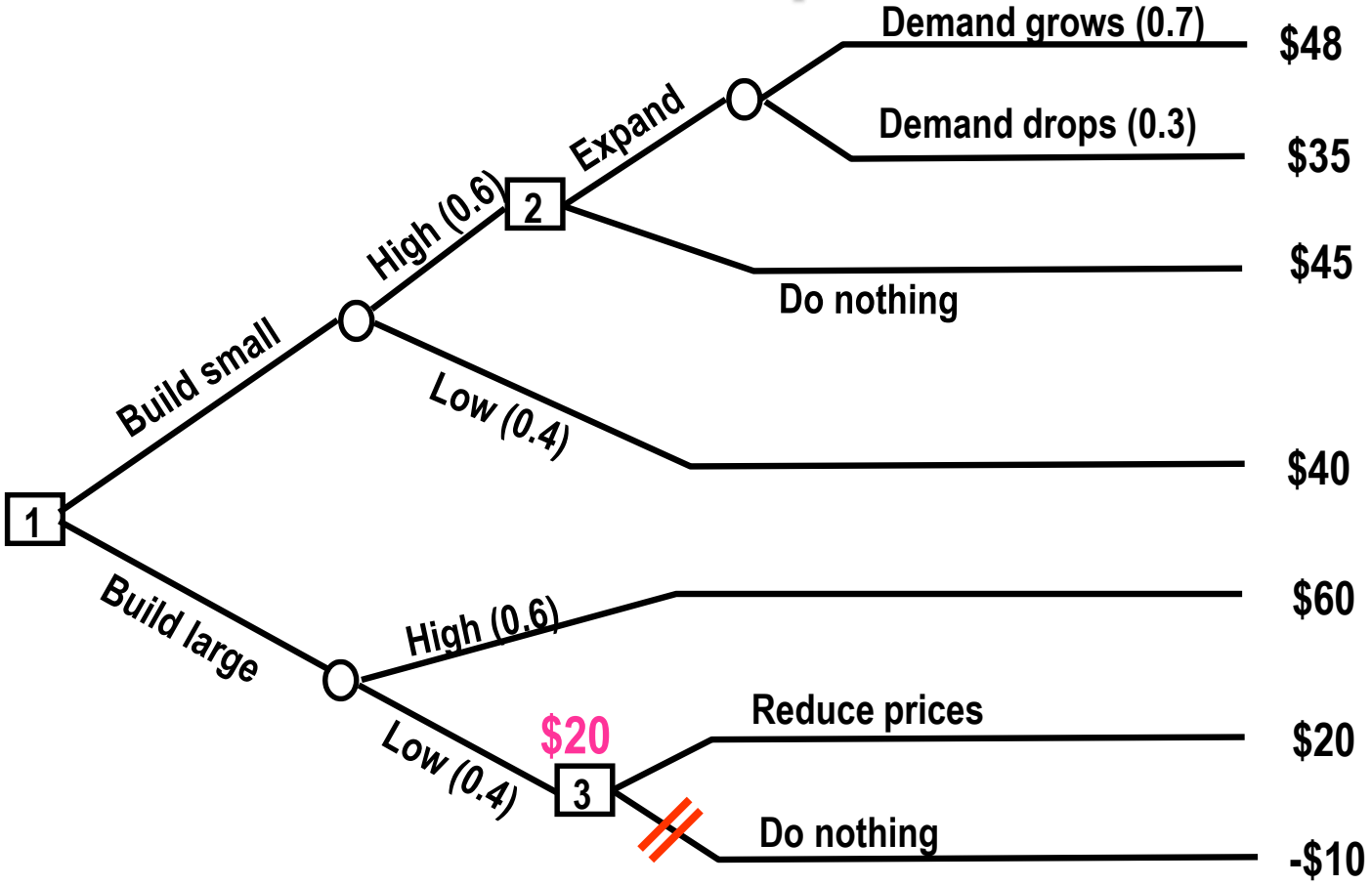
Work right to left (from end back to beginning).

Start with Decision 3:

"Reduce prices" or "Do nothing".

Choose "Reduce prices" (20 > -10).

Decision Tree
Example 2



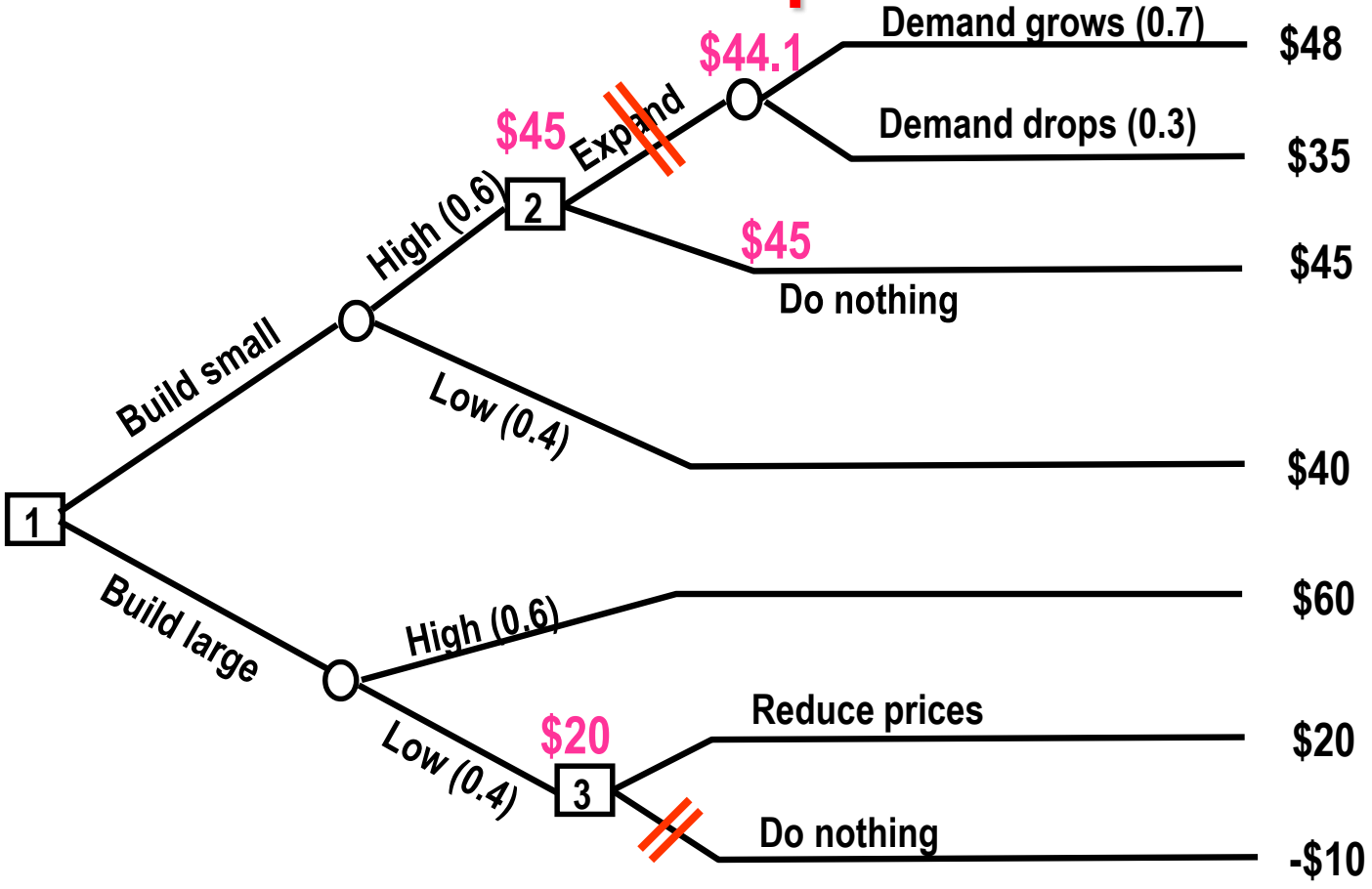
Decision Tree Solution
Example 2

Consider Decision 2: “Expand” or “Do nothing”.

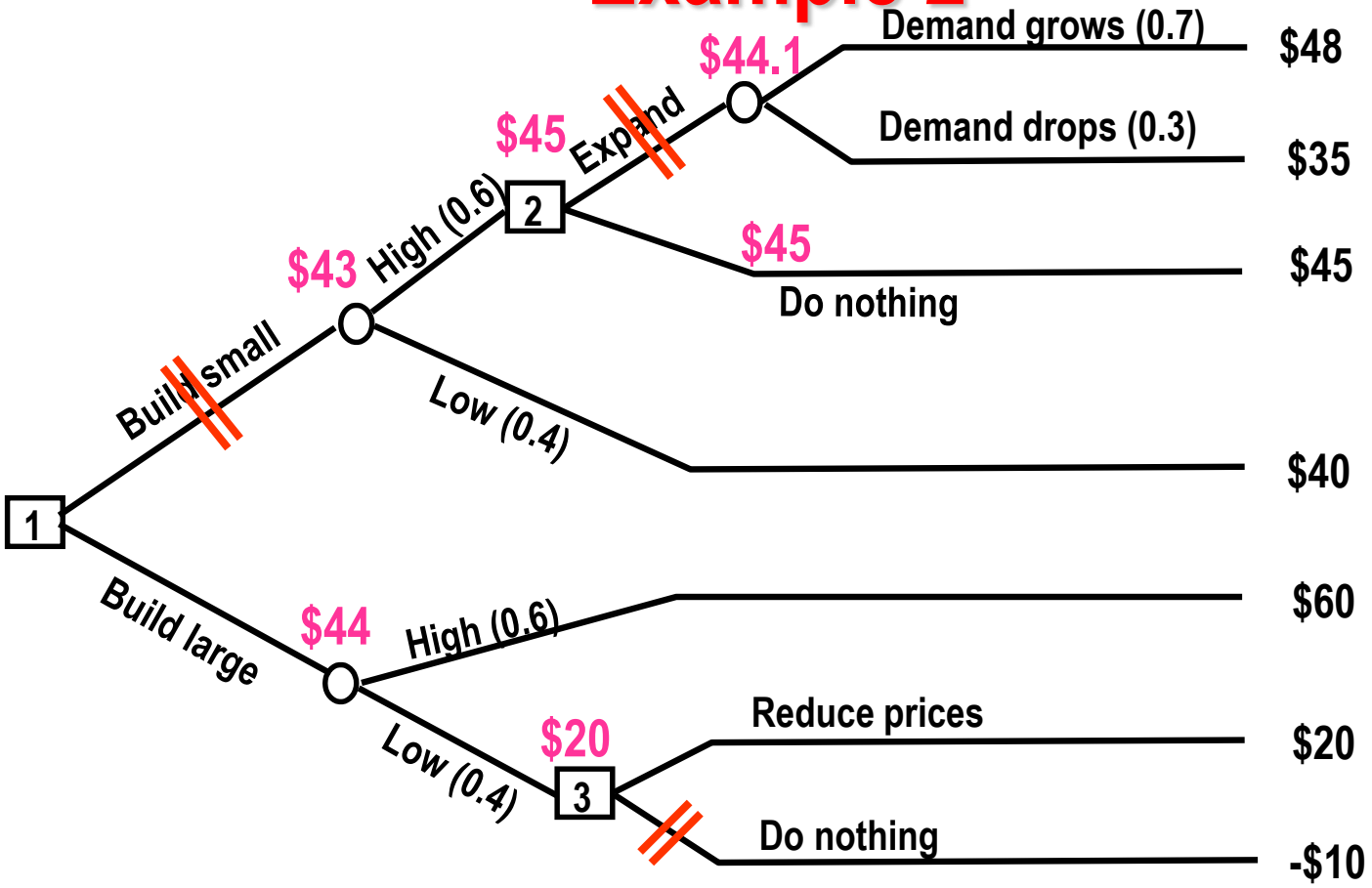
To compare outcomes we need expected value if we “Expand”: (48*0.7) + (35*0.3) = 44.1

Choose “Do nothing” (45 > 44.1).

Decision Tree
Example 2



Decision Tree Example 2



Decision Tree Final Solution
Example 2

Decisions:

1. Build “Large”.

2. If demand is “Low”, then “Reduce prices”.

Expected payoff = $44 million.