## **E: Decision trees**

Core tool for analyzing decisions under uncertainty

Schematic diagram of choices, uncertainties, and payoffs

## Example:

Managing a Medicaid population (low income) with chronic conditions

Current approach (C):

- Focus on health care only
- Cost = \$20 M
- Benefit = \$100 M

Proposed alternate approach (A):

- Integrated delivery of health care and other services (e.g., housing)
- Cost = \$40 M
- Benefits uncertain:

Probability	State	Benefit
40%	Succeeds and works well (S)	\$200M
60%	Does not work well (F)	\$60M

Decision: which approach?

## Analysis:

- 1. Construct a **decision tree** to represent the alternatives
- 2. Evaluate the tree to find the action with the highest payoff

## Constructing the tree:

- Start with the initial choice
- Then draw **left** to **right** (→) in causality
- Use choice nodes to represent decisions
- Use chance nodes to represent random events



Without all the annotations:



Analyzing the tree:

Evaluate from **right** to **left** ( ) repeatedly applying two rules:

Rule	Node type	Evaluation rule
1	Choice	Pick action with highest payoff
2	Chance	Replace node with its expected value

Recall expected value (EV):

$$EV = \sum_{i=1}^{N} \rho_i x_i$$

N = number of states  $\rho_i$  = probability of state i $x_i$  = payoff in state i

Applying to the example:

Evaluating the right-most node:

EV = 0.4 \* \$160M + 0.6 \* \$20M = \$76M

Revising the tree:



Evaluating the new right-most node:

Pick action with best payoff: C, \$80M

Exercise on GC