Decision Analysis

- **Objective**
  - To introduce a particular, effective technique for evaluating alternatives in uncertain situations
- **3 conclusions brought out by Decision Analysis:**
  1. Strategies for altering choices as unknowns become known, rather than optimal choices against a set of specifications
  2. Second best choices which offer
     - ✓ insurance against downside
     - ✓ opportunity to exploit upside
  3. Education of client especially about range and distribution of possible results (Value at Risk)

Motivation

- People, when acting on intuition, deal poorly with complex, uncertain situations
  - They process probabilistic information poorly
  - They simplify complexity in ways which alter reality
    - Focus on extremes
    - Focus on end states rather than process
- Need for structured, efficient means to deal with situation
- Decision Analysis is the way

General Features of DA

- Simple way of defining the wide range of choices
- Over several Periods
- Includes Uncertainties
- Standard Method
- Can Include Levels of Consumer Satisfaction (utility assessment)

Identifying Issues

- What's the Important Uncertainty for Situation?
- What Factors Define this Uncertainty?
- What Management Decisions Relate to it?
- How do we represent the
  - Range of possible decisions,
  - Uncertainties, and
  - Outcomes?

Decision Tree

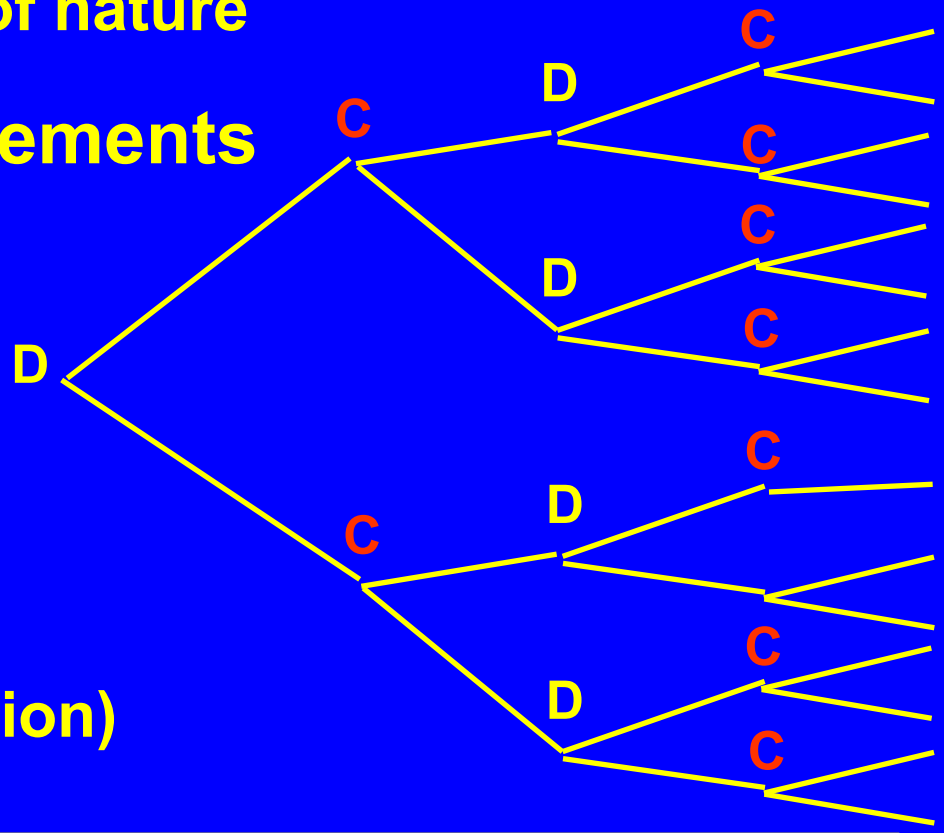
- Representing the Analysis -- Decision Tree
  - Shows Wide Range of Choices
  - Several Periods
  - Permits Identification of Plans that
    - Exploit Opportunities
    - Avoid Losses
- Components of Decision Tree
  - Structure
    - Choices; Possible Outcomes
  - Data
    - Uncertainties; Value of Each Possible Outcome

Constructing Decision Tree (1)

- **Structure**
  - The Decision Tree as an organized, disciplined means to present alternatives and possible states of nature
- **Two graphical elements**

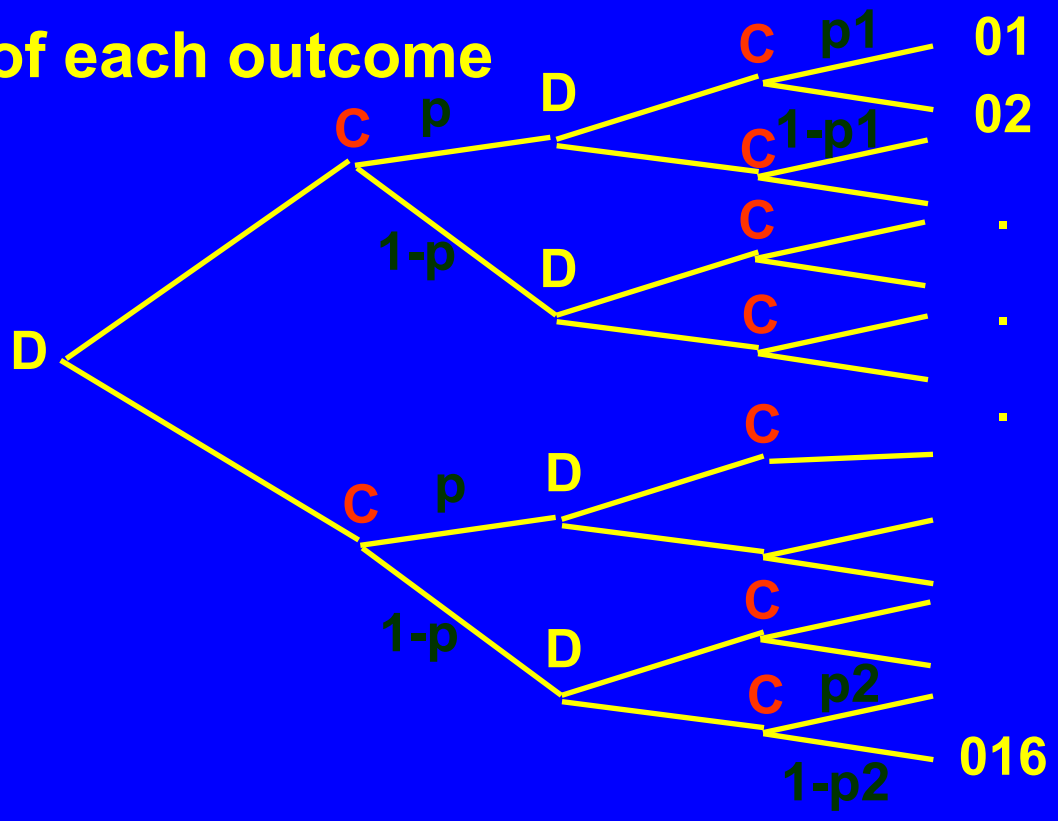
1. Decision Points

2. Chance Points (after each decision)



Constructing Decision Tree (2)

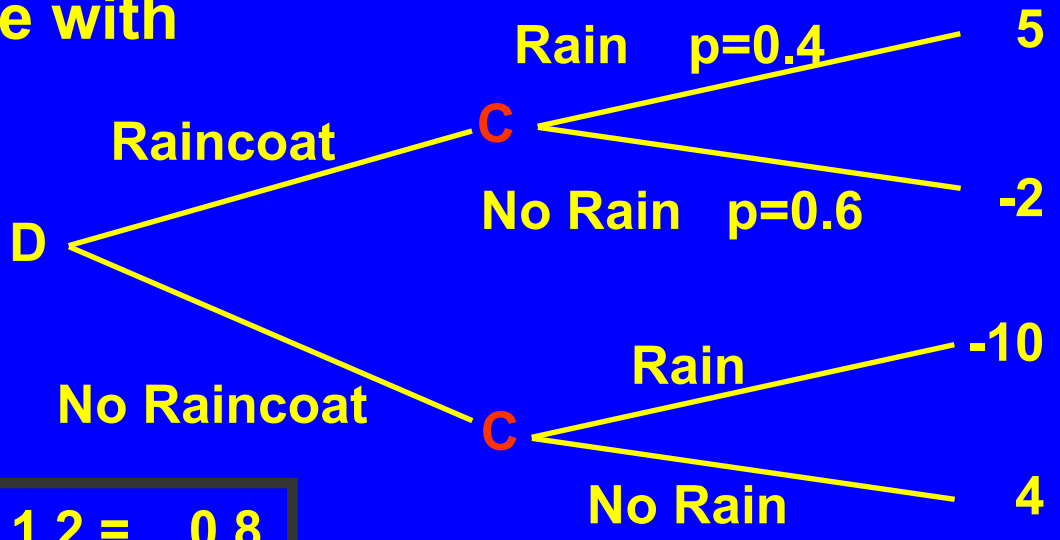
- **Two data elements**
  1. Probability
  2. Value of each outcome



- **When does Tree become a "messy bush"?**

Decision Analysis -- 1 stage

- Calculation
  - Maximize Expected Value of Outcomes
- For each set of alternatives
  - Calculate Expect Value
  - Choose alternative with maximum EV



EV (raincoat) = 2.0 - 1.2 = 0.8

EV (no raincoat = - 4.0 + 2.4 = - 1.6

… In Excel Layout

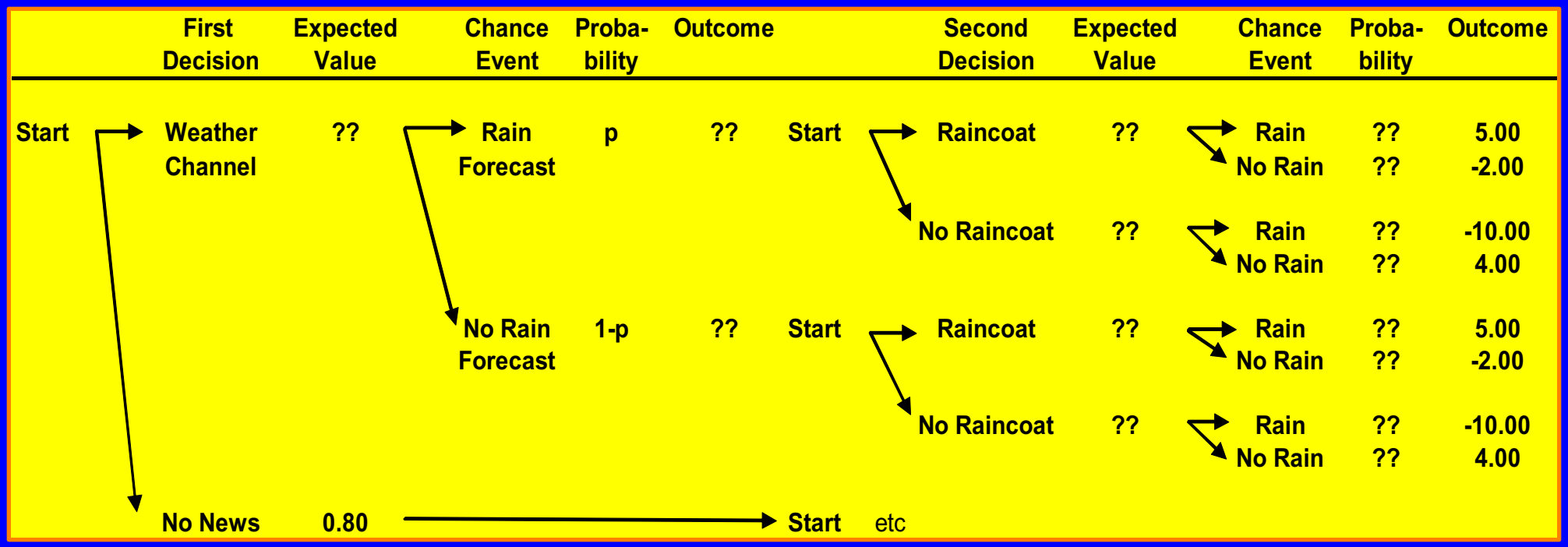
	First Decision	Expected Value	Chance Event	Proba-bility	Outcome
Start	Raincoat	0.80	Rain	0.40	5.00
			No Rain	0.60	-2.00
	No Raincoat	-1.60	Rain	0.40	-10.00
			No Rain	0.60	4.00

EV (raincoat) = 2.0 - 1.2 = 0.8

EV (no raincoat = - 4.0 + 2.4 = - 1.6

To show Sequence of Alternatives

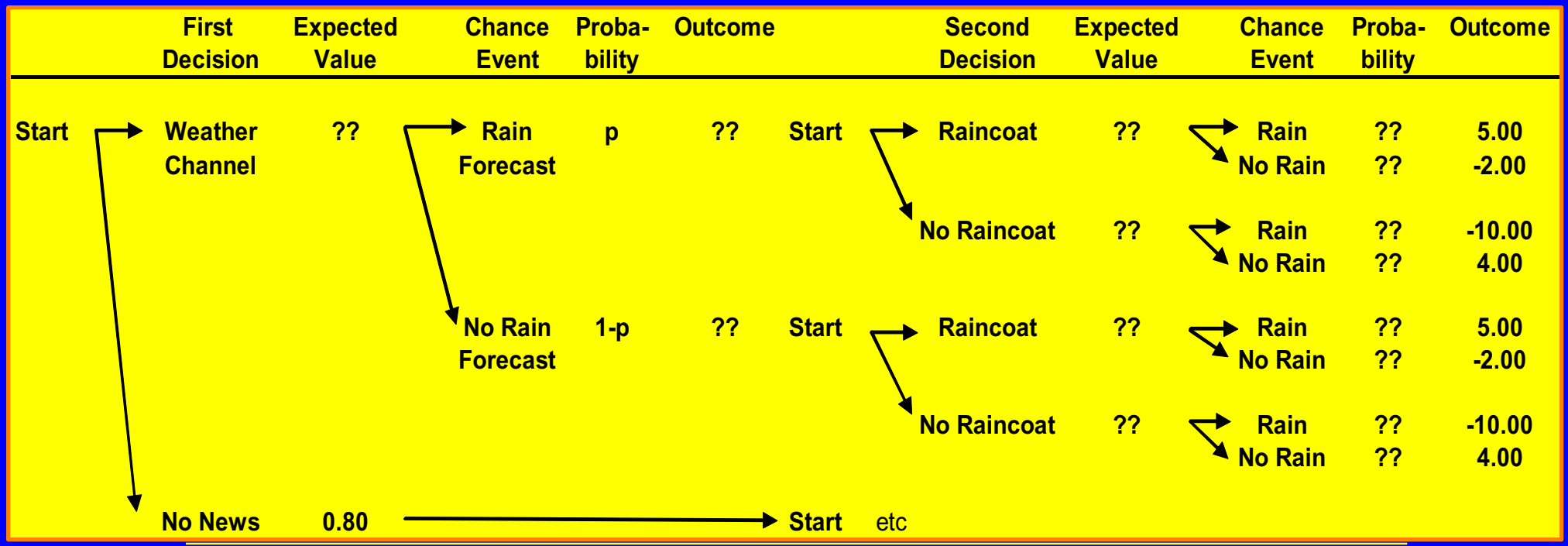
- We repeat basic block (changing entries)



Notice: Data seen in early stages
=> changes later probabilities, results

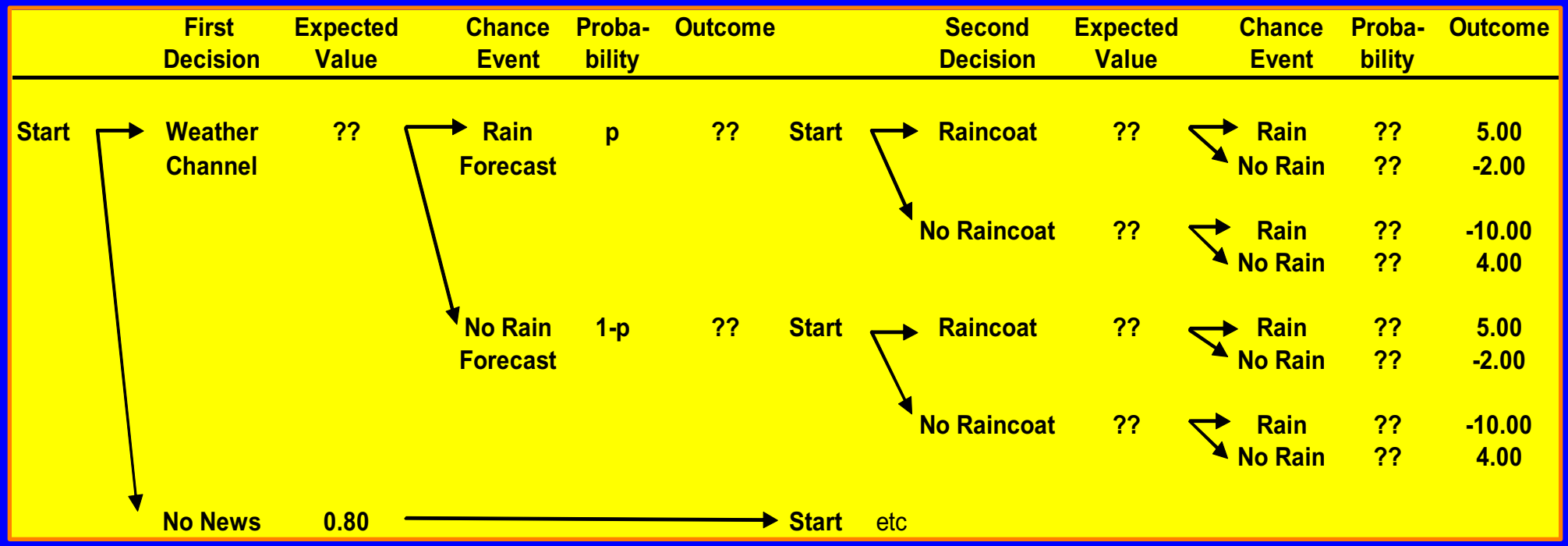
Analysis of Two or More Stages

- **Idea 1: Look Forward: Early observations change prior estimates of events**
  => changes in decisions you might have made without information



Analysis of Two or More Stages

- **Idea 2: Look Look Back: Analysis from last stages going toward front => "folding back"**



Results of Decision Analysis

- NOT a Simple Plan
  - Do A in Period 1; Do B in Period 2; etc.

- A DYNAMIC PLAN
  - Do A in Period 1,
  - BUT in Period 2:
    - If Growth, do B
    - If Stagnation, do C
    - If Loss, do D

Decision Analysis Consequences

- Education of client, discipline of decision tree encourages perception of possibilities
  - A *strategy* as a preferred solution
  - NOT a single sequence or a Master Plan

- In general, Second Best strategies not optimal for any one outcome, but preferable because they offer flexibility to do well in a range of outcomes

In short: It is best to buy insurance!

It can be best to buy insurance

- You can choose
  - Drive a car
  - Don't drive
- You may have an accident - or not
  - If accident
    - Drive — Worst
    - Don't Drive — Best
  - If no accident
    - Drive — Best
    - Don't Drive — Worst
- Optimal Solution: Drive with insurance
  Never best - but never worst

Practice Decision Analysis Problem

16.1 *Election Campaign*

As a politician you can end your campaign for election either in City A or B. You estimate that a speech in A will gain you either 2000 votes or, if local students protest, 4000 votes more than your opponent. However, if your opponent also comes to A you will have to cancel the speech and debate, in which case you will get 1000 votes less than your opponent. Your manager estimates that the probability of your opponent showing up is 0.5. The probability that the students will protest is 0.3.

Alternatively, you can go to B, where there are no students and your opponent has already been, where you may either gain 2000 votes (probability 0.3) or 600 votes (probability 0.7).

(*a*) Which city would you go to if you are trying to maximize your votes?

(*b*) Which city should you go to if current polls show you are losing by 800 votes?

Source: Applied Systems Analysis, McGraw-Hill, R. de Neufville
http://ardent.mit.edu/real_options/ASA_Text/asa_ch16.pdf