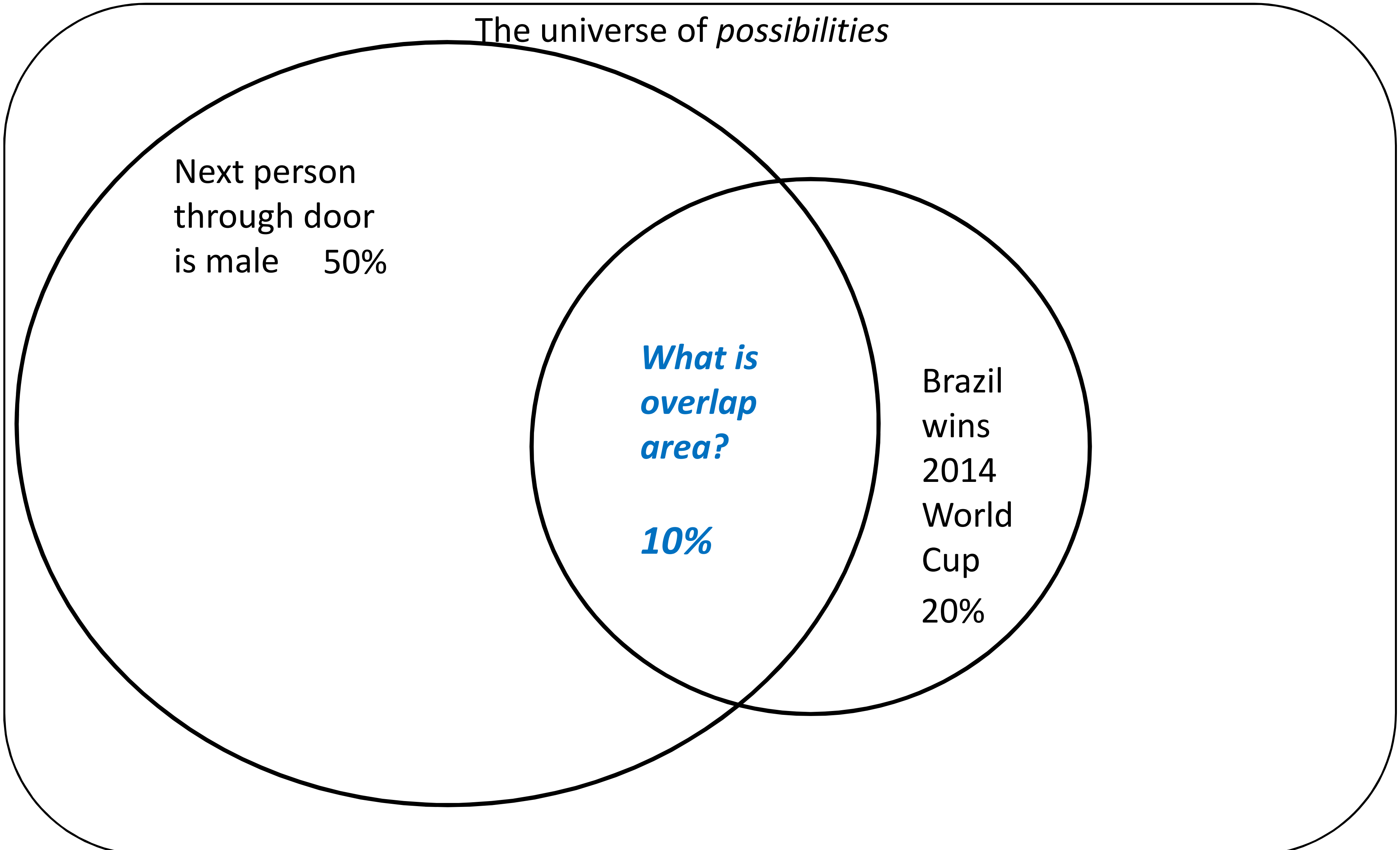
Bayesian Logic for Fun and Profit

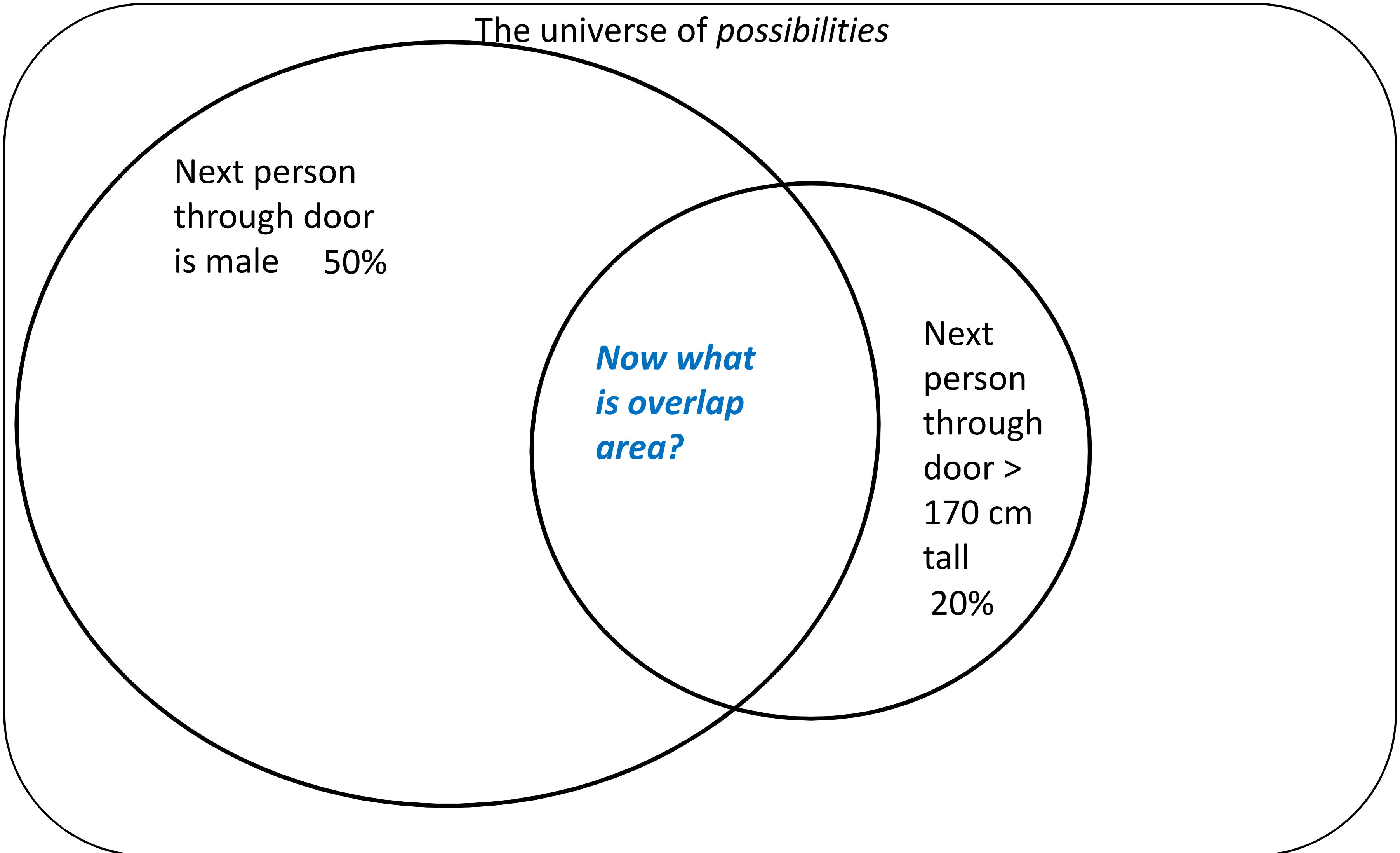
How to incorporate new information appropriately

DECISION STRATEGIES

Venn Diagrams (a.k.a. Set Theory)



Venn Diagrams

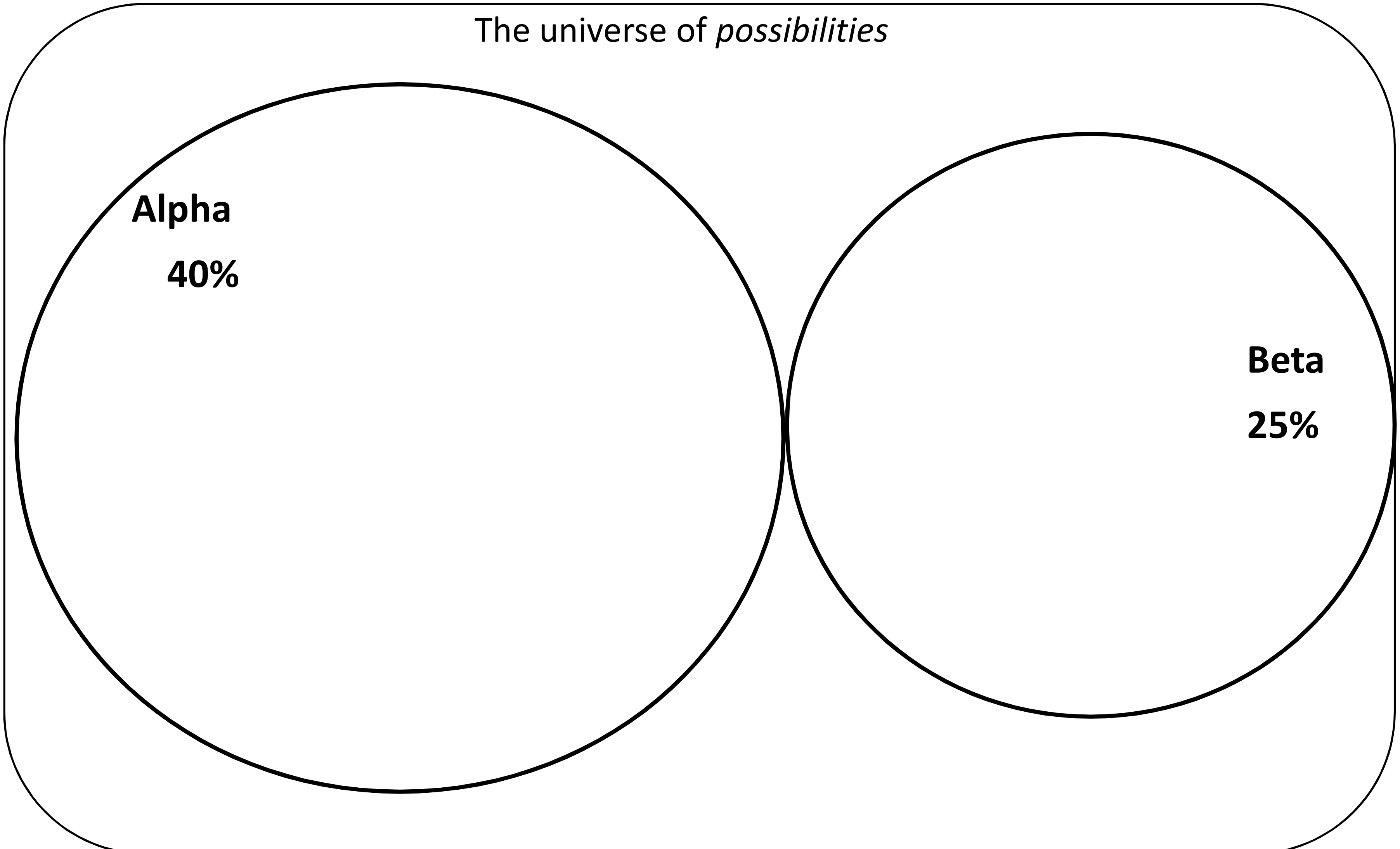


Two Fault Blocks Example

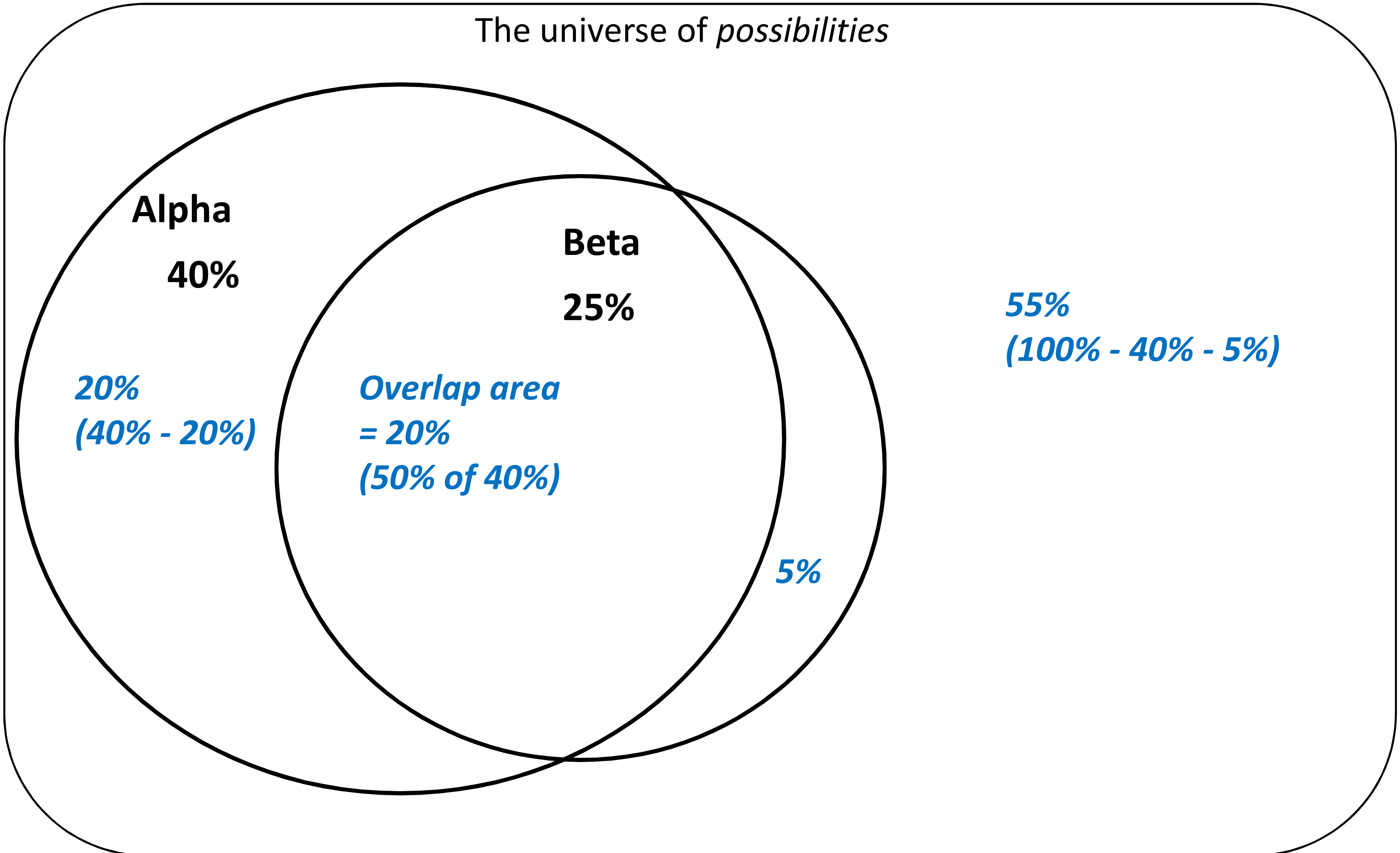
- The situation: You have two untested fault blocks, Alpha and Beta, adjacent to your producing field.
- Your current assessment of Alpha is that it has a 40% chance of being hydrocarbon bearing
- Your current assessment of Beta is that it has a 25% chance of being hydrocarbon bearing
  - However, if Alpha works, you believe that Beta's chance of success goes up to 50%

- You drill Alpha, and it fails. ***What is your revised estimate for Beta's chance of success?***

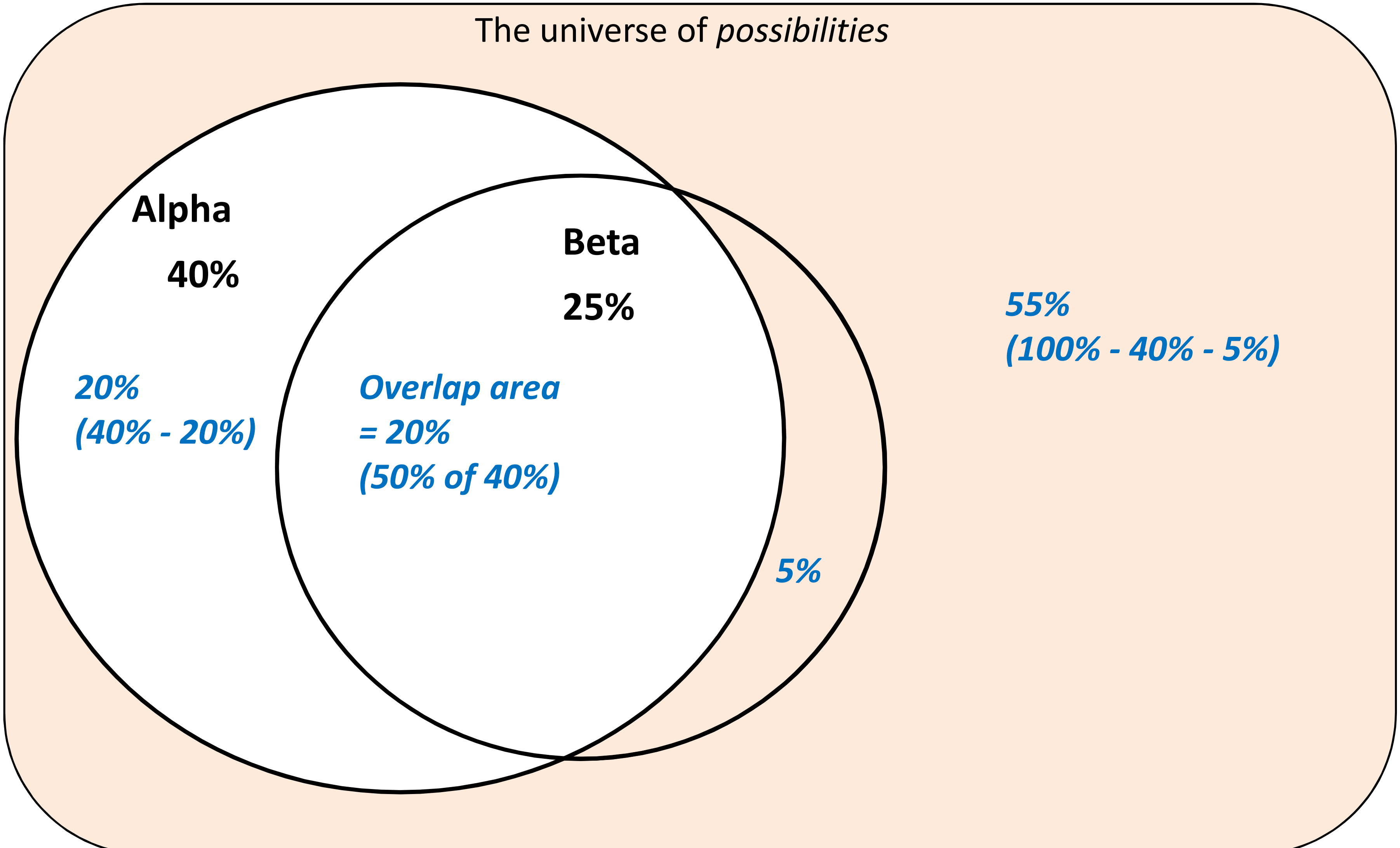
Fault Blocks Alpha and Beta



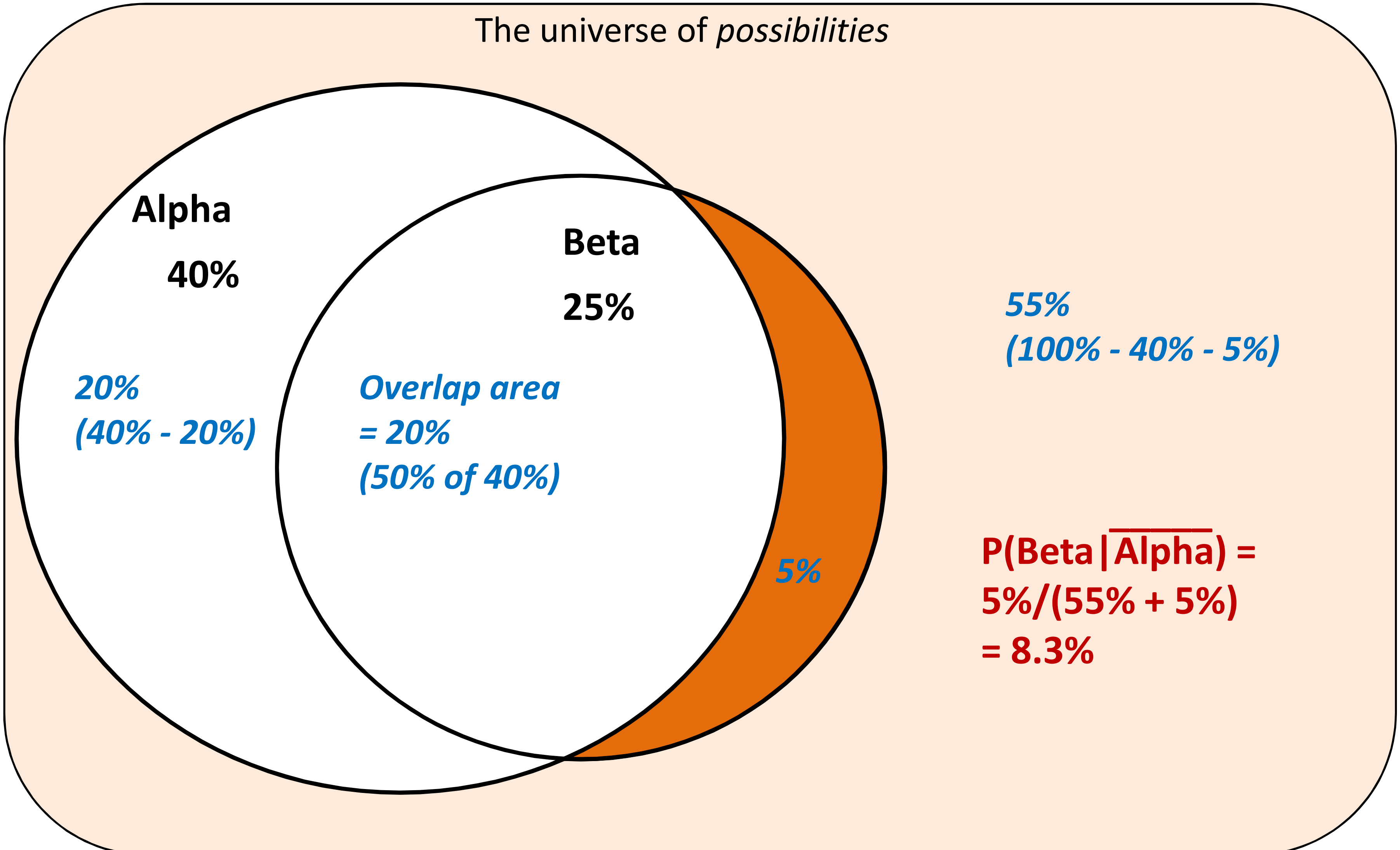
Fault Blocks Alpha and Beta



Fault Blocks Alpha and Beta



Fault Blocks Alpha and Beta



Key Bayesian concepts

- The order in which things happen in the real world is not necessarily the order in which they happen in “our” world
  - Acquiring seismic and drilling a well
- P(A|B) does not usually equal P(B|A)
  - “The probability of A given that B happened does not usually equal the probability of B given that A happened”
- We only know today what we know today
  - Any analysis we do speculating about how things may change if we get new information must preserve our current world view
  - Only after we ***actually have*** new information may we change our estimates; until then, we must preserve them

Well test example

- The situation: You are going to conduct a well test in a fault block to get a better idea of the size of the block.
  - You currently estimate that there is a 70% chance that the block is large (bigger than the economic threshold), and a 30% chance it is small (uneconomic).
- Given the duration of the test, you estimate the reliability to be as follows:
  - If, in fact, the block is large, you expect that ***60% of the time***, the test will allow you to correctly interpret that it is large
  - If, in fact, the block is small, you expect that ***90% of the time***, the test will indicate that it is small

Well test example (cont.)

- You run the well test and it indicates that the block is too small to be economic

What is the probability that this fault block actually holds an economic volume?

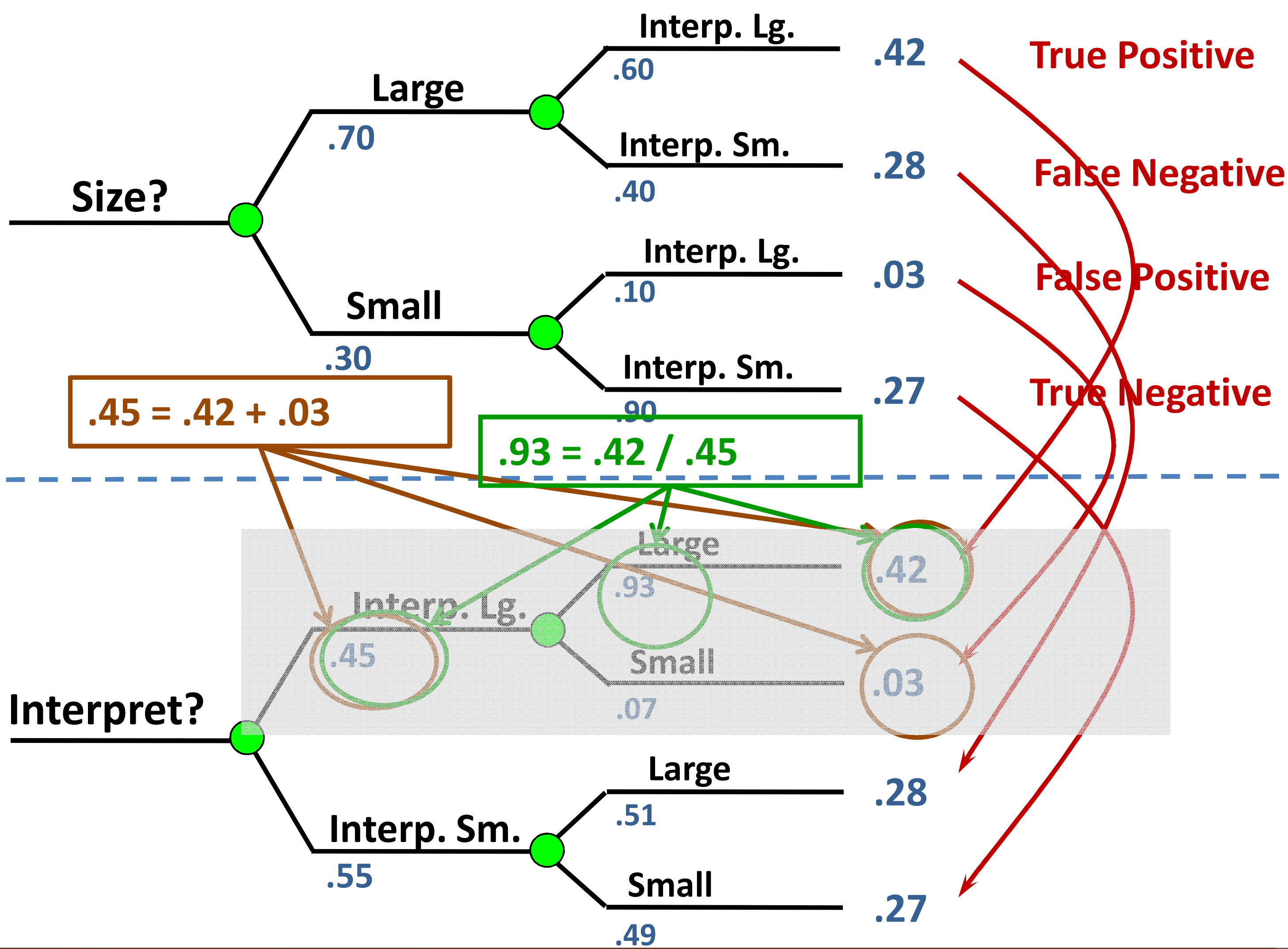
Well test example – Matrix Approach

		Compartment size		
		Small	Large	Indication Totals
Test Indication	Small	27%	28%	55%
	Large	3%	42%	45%
Compartment size totals		30%	70%	100%

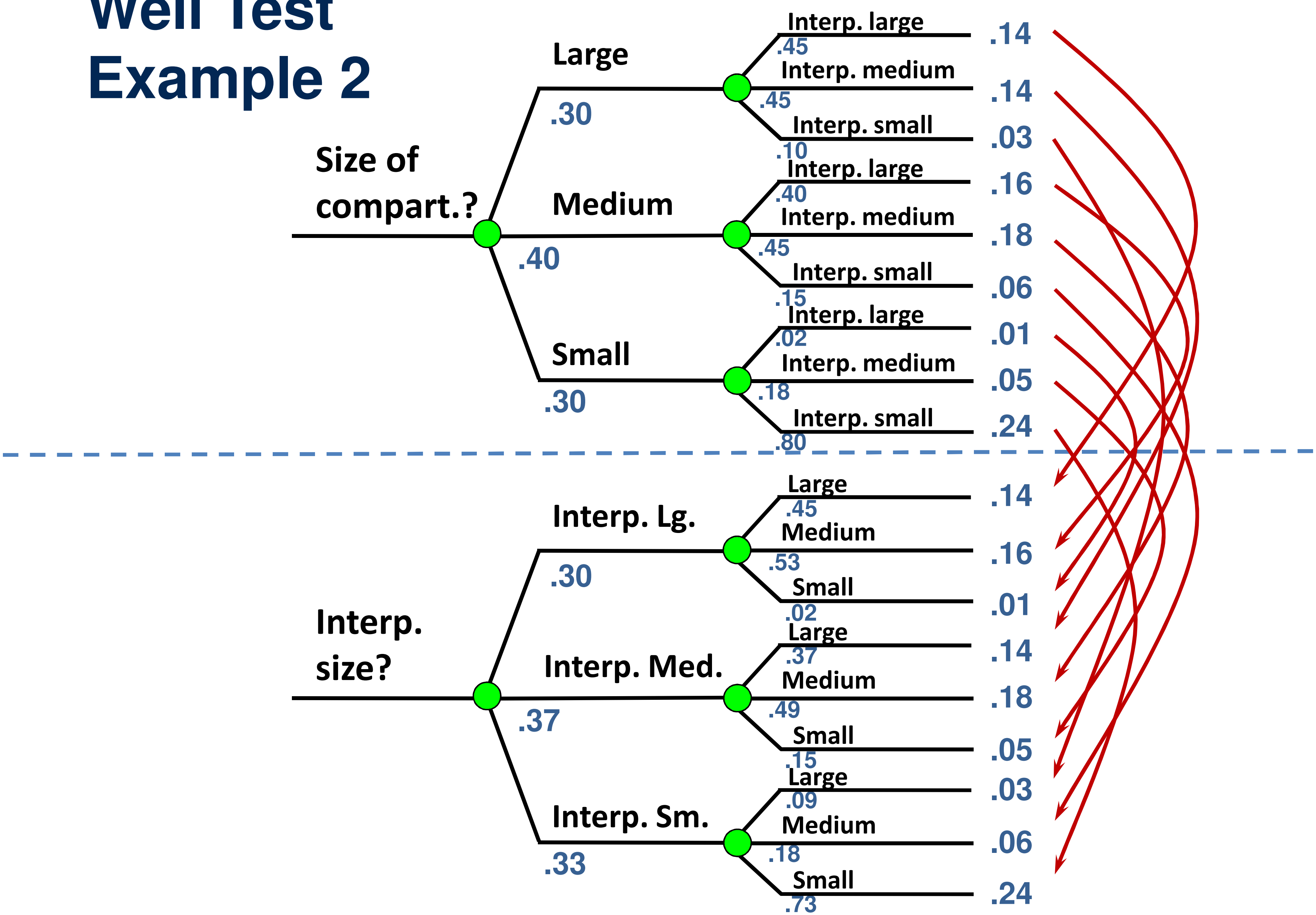
So if the interpretation of our test is "Small," all we know is we are in this row.

If we are in this row, the probability that the compartment is actually Large is 28%/55% = *51%*

Well test example – Tree Approach



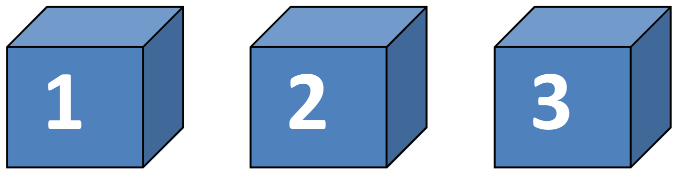
Well Test Example 2



The Prizemaster Problem

Rules of the game

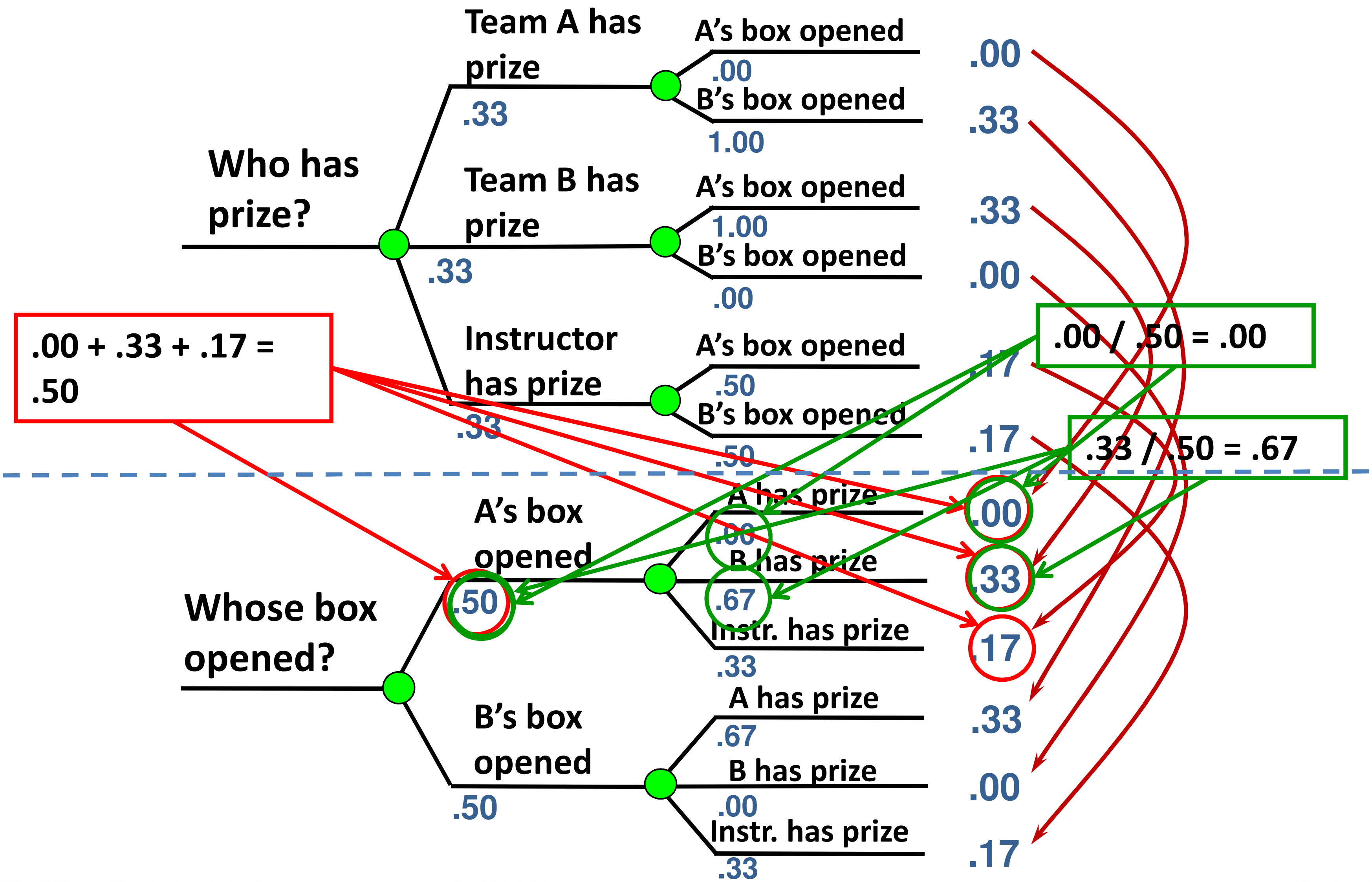
- Inside one of these three boxes is a valuable prize!



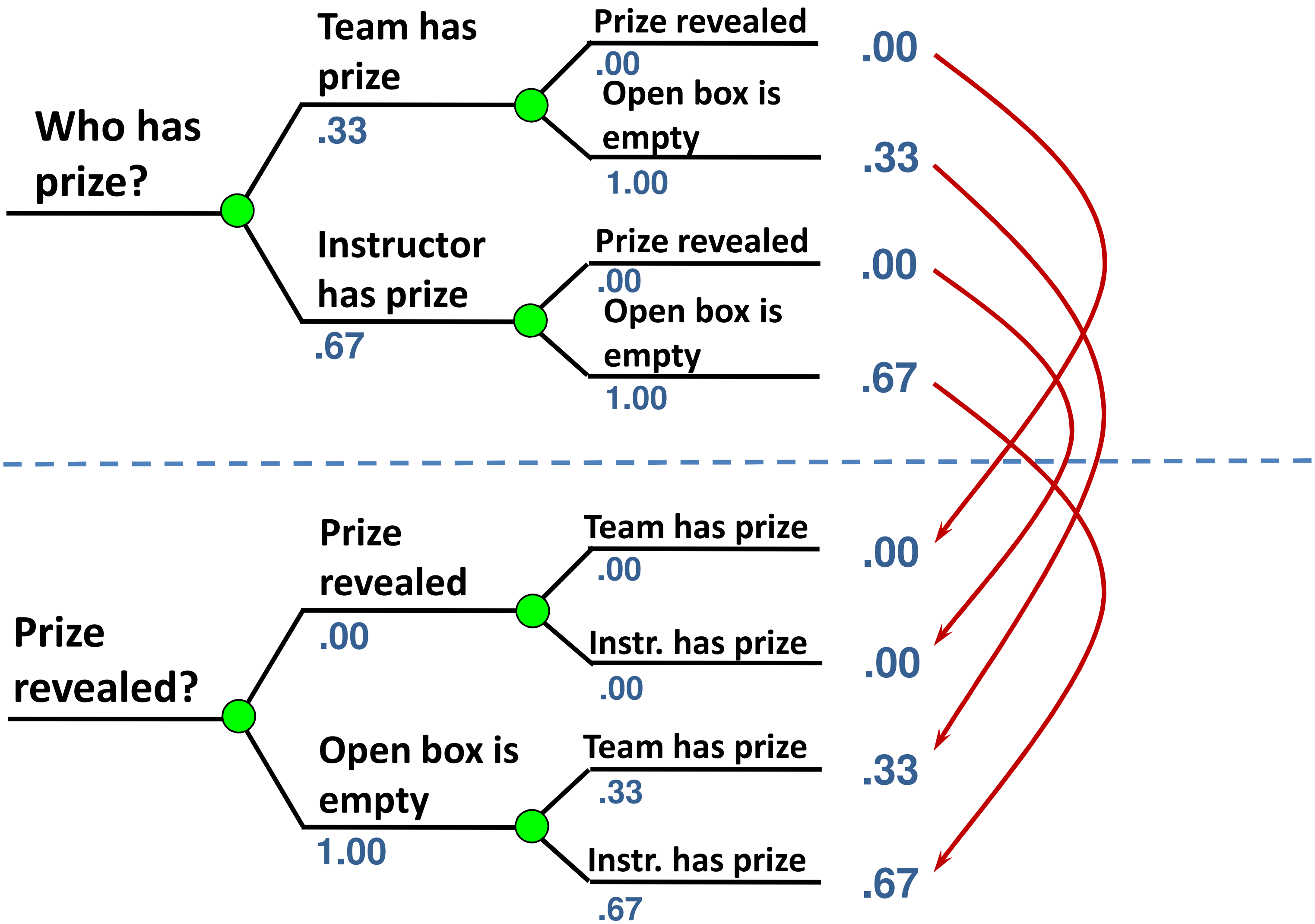
- The group will be divided into two teams
- Each team will select one of the three boxes
- The eccentric Prizemaster (me) will the reveal what is inside one team's box
- The box I open will ***never*** contain the prize
- The remaining team will have the option to
 trade for the Prizemaster's box

What should they do?

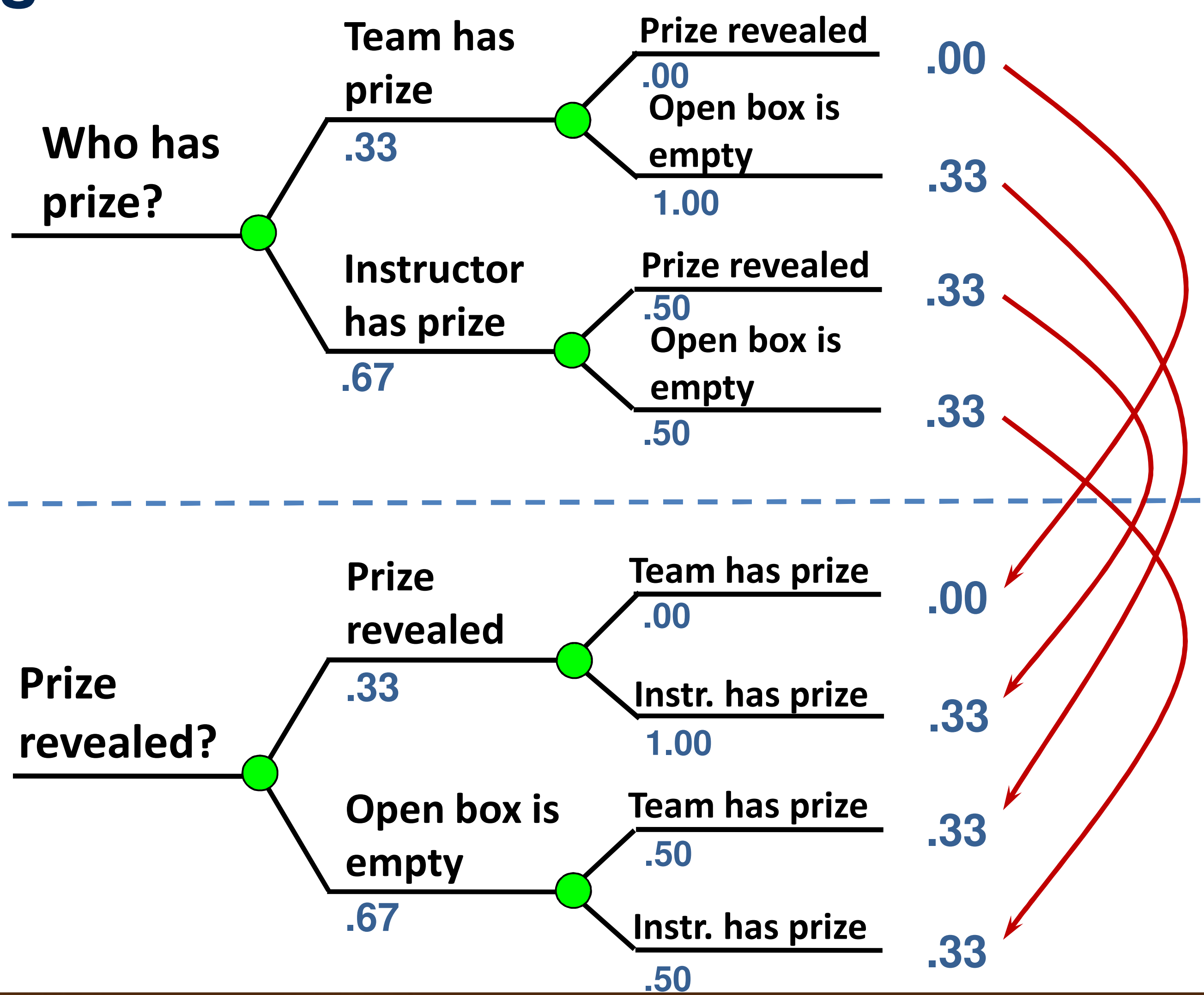
Prizemaster game with two teams choosing boxes: The solution



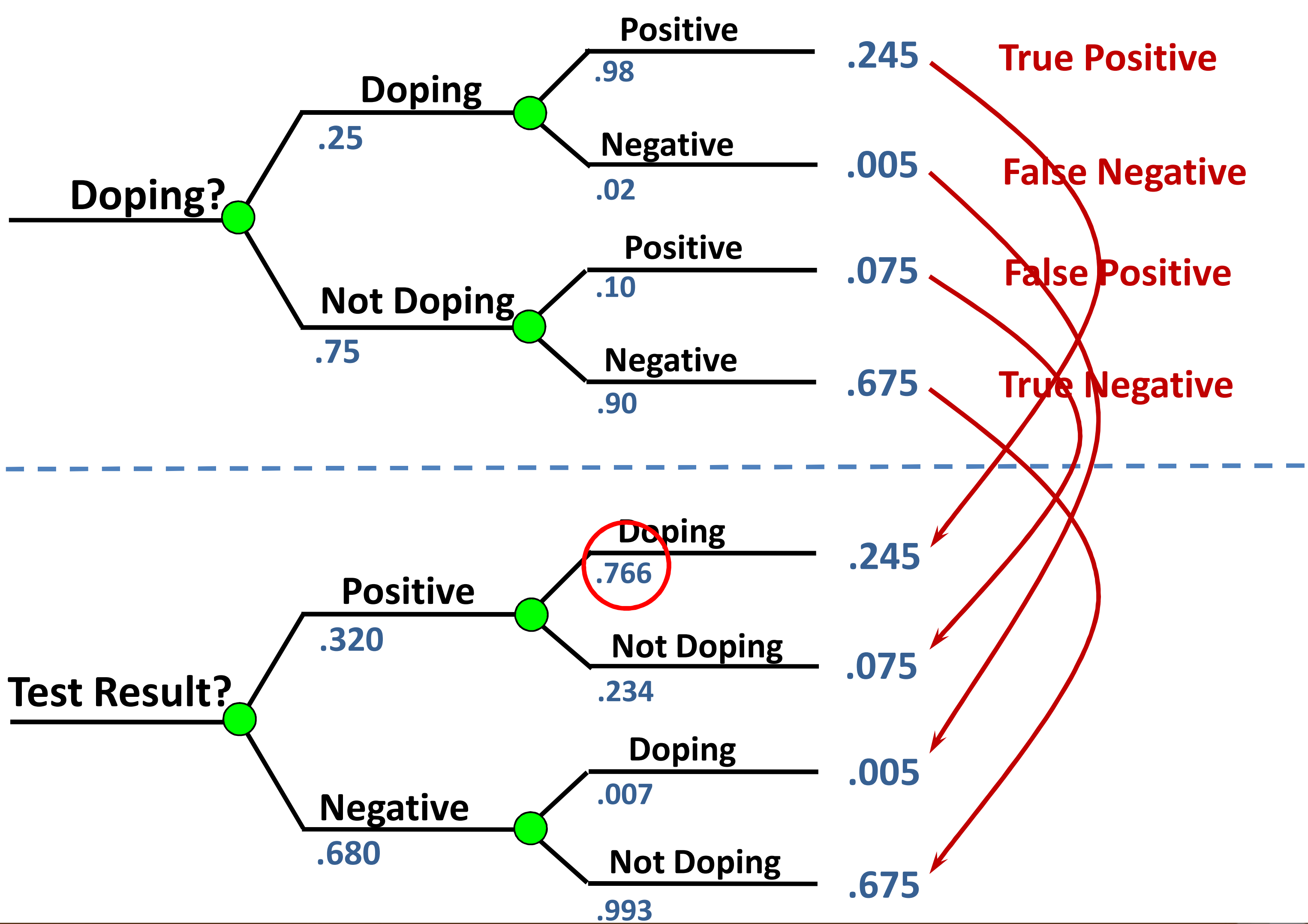
Prizemaster game: Version 2 (no second player)



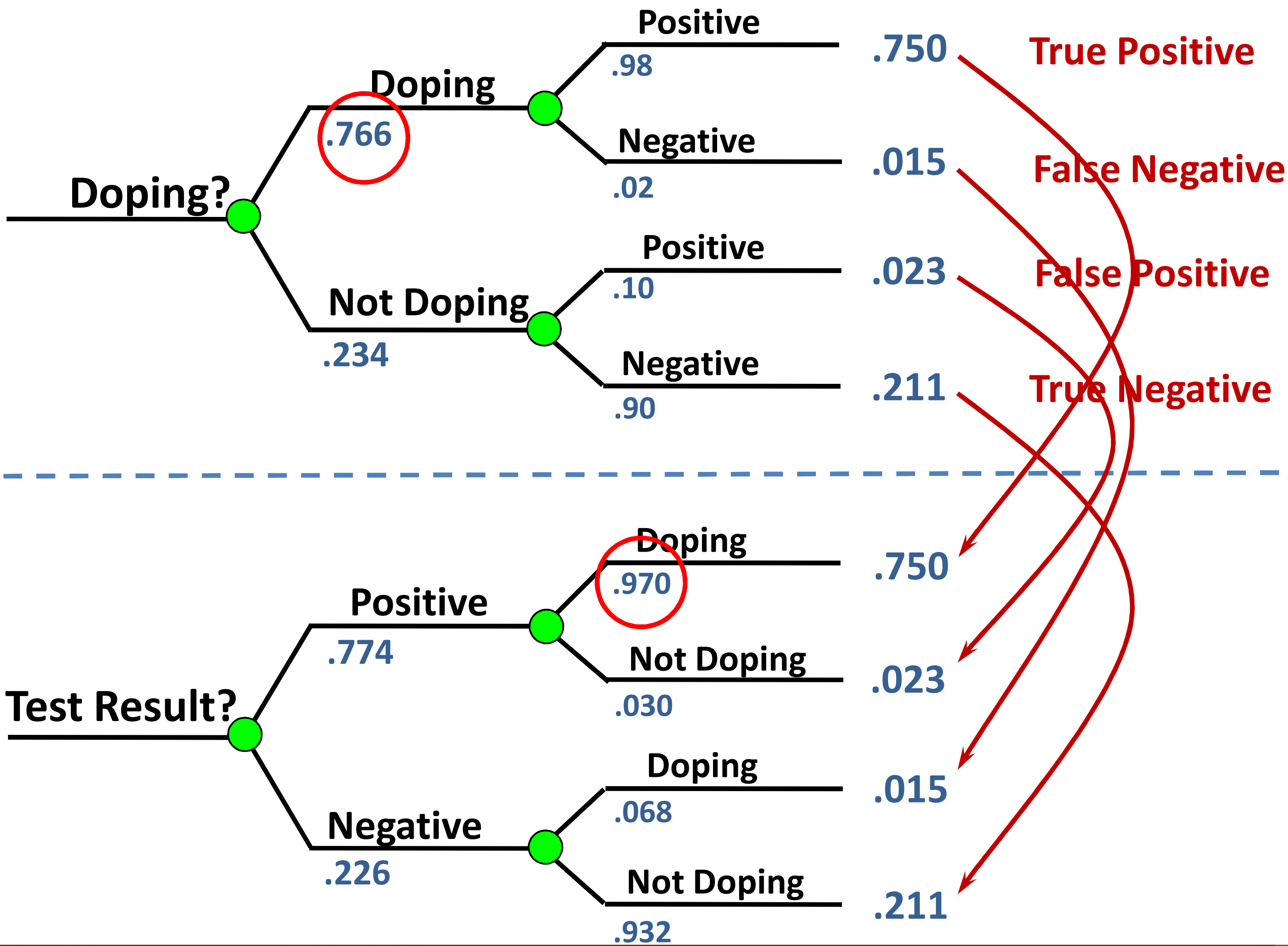
Prizemaster game: Version 3
Audience member opens one of the instructor's boxes



Athlete doping 1



Athlete doping 2



Summary

- ***Bayesian logic is not optional***
  - It is ***the*** correct way to incorporate new information
- It is important to capture the true cause-and-effect relationship
  - Then convert to “our time”
- This stuff gets messed up more than you would believe

Questions?