PA 4010
Public Affairs Decision Making

SESSION 7: RATIONAL CHOICE UNDER UNCERTAINTY

EXTENSIONS AND PRACTICE WITH DECISION TREES

TUESDAY, SEPTEMBER 10, 2024

Agenda for Today

- Freebie Quiz
- Decision tree practice

Quiz...

Things I can change:

- Speed of new material
- Difficulty of material / assignments
- Structure of lecture
- Reality of examples
- Communication

Things I cannot change:

- Time or location of class
- General content of course
- Grading structure
- Two instructors

Quiz…

https://forms.gle/J3EmpaLcqmmBRBC1A

Practice and Extensions of Decision Trees

Example 0:

Tom is graduating college and has been looking for jobs. He has three job offers.

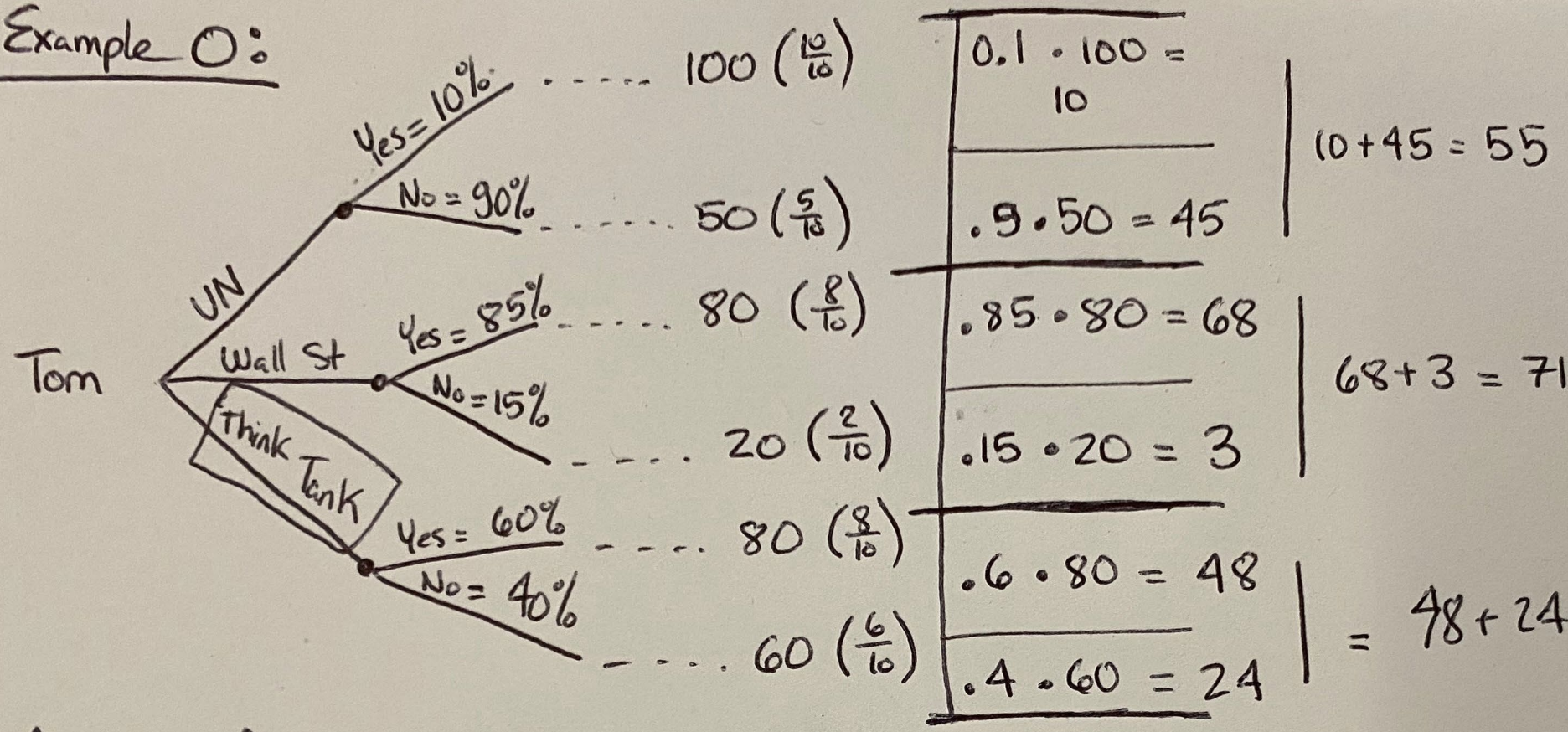
Job 1 is at the UN, but Tom believes there is only a 10% chance that he will be promoted to become a director. If he becomes director, he will be 10/10 happy because he will be doing something he loves and will be paid well. If he stays as associate, he will be 5/10 happy because he loves the work but won't earn very much money.

Job 2 is Wall Street Bank. Tom believes here he will have a 85% chance of being promoted. He hates the job but the pay is amazing. If he is promoted, he will be 8/10 happy. If he is not promoted, he will be 2/10 happy.

Job 3 is at a think tank. Tom doesn't hate the work, and there is a 60% chance he will be promoted. The pay is better than the UN but worse than Wall Street Bank. If he is promoted, he will be 8/10 happy. If he is not promoted, he will be 6/10 happy.

What should Tom choose?

Example 0:



↑ Who is making decision?

↑ What are his options?

↑ Prob. of each branch (ie prob of promotion)

↑ Outcome if Tom goes down branch.

↑ Expected outcome given likelihood of being on branch

↑ Expected outcome of each option (ie weighted avg)

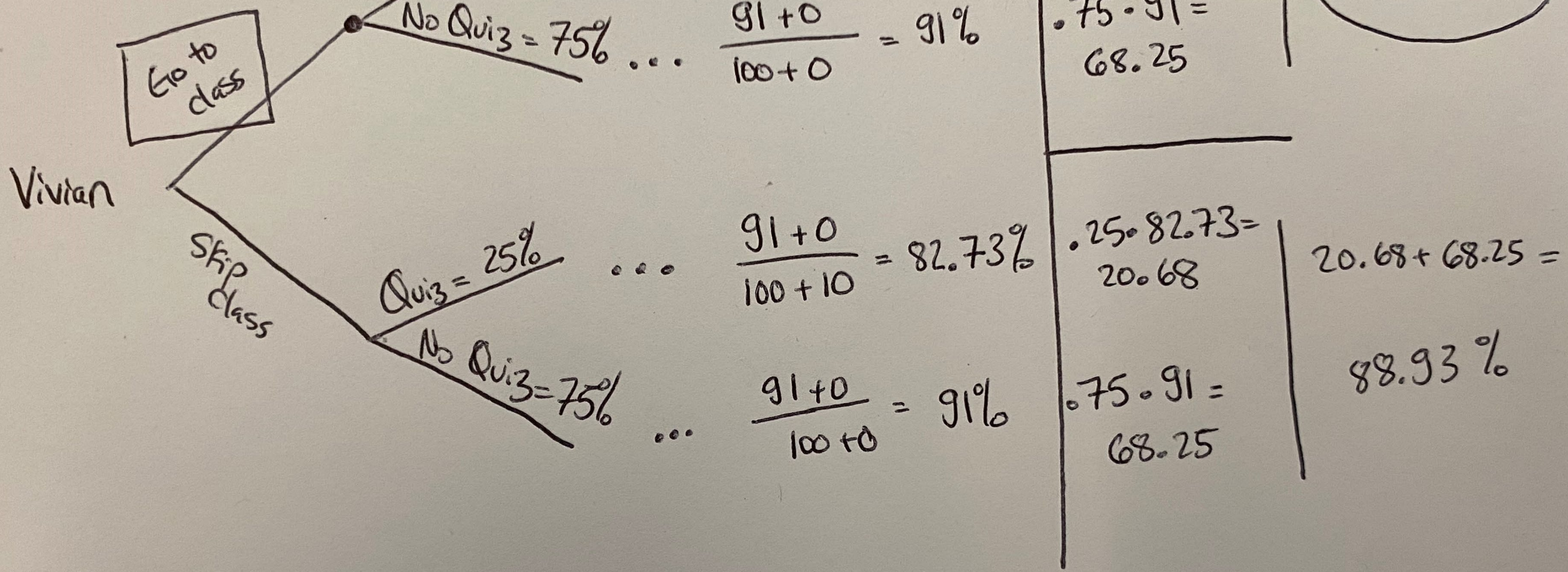
↑ Choose best option

Example 1:

Vivian wakes up and is deciding if she wants to attend class today or not. She is doing well, but her parents will be upset with her if her grade falls below an A- (90%) in the class. The professor said at the beginning of the semester that there will be 5 quizzes throughout the 25 classes in the semester, and that a missed quiz will result in a 0. There are no make-up quizzes and no dropped quizzes. The quizzes are completely randomly-timed. Each quiz is 10 points. Of course, Vivian would rather do something else than go to class, and if she knew there was no quiz, she would not go.

So far, there have been 100 points in the class and Vivian has achieved 91 of the possible 100 points. If she goes to class and there is a quiz, she expects to get 95% on the quiz (or 9.5 points). What should Vivian do? Set up a decision tree and formulate a response.

Example 1:


Vivian
Go to class
Skip class
Quiz = 25%
No Quiz = 75%
Quiz = 25%
No Quiz = 75%
91 + 95 / 100 + 10 = 91.36 %
91 + 0 / 100 + 0 = 91 %
91 + 0 / 100 + 10 = 82.73%
91 + 0 / 100 + 0 = 91%
.25 · 91.36 = 22.84
.75 · 91 = 68.25
.25 · 82.73 = 20.68
.75 · 91 = 68.25
22.84 + 68.25 = 91.09 %
20.68 + 68.25 = 88.93 %

Example 2:

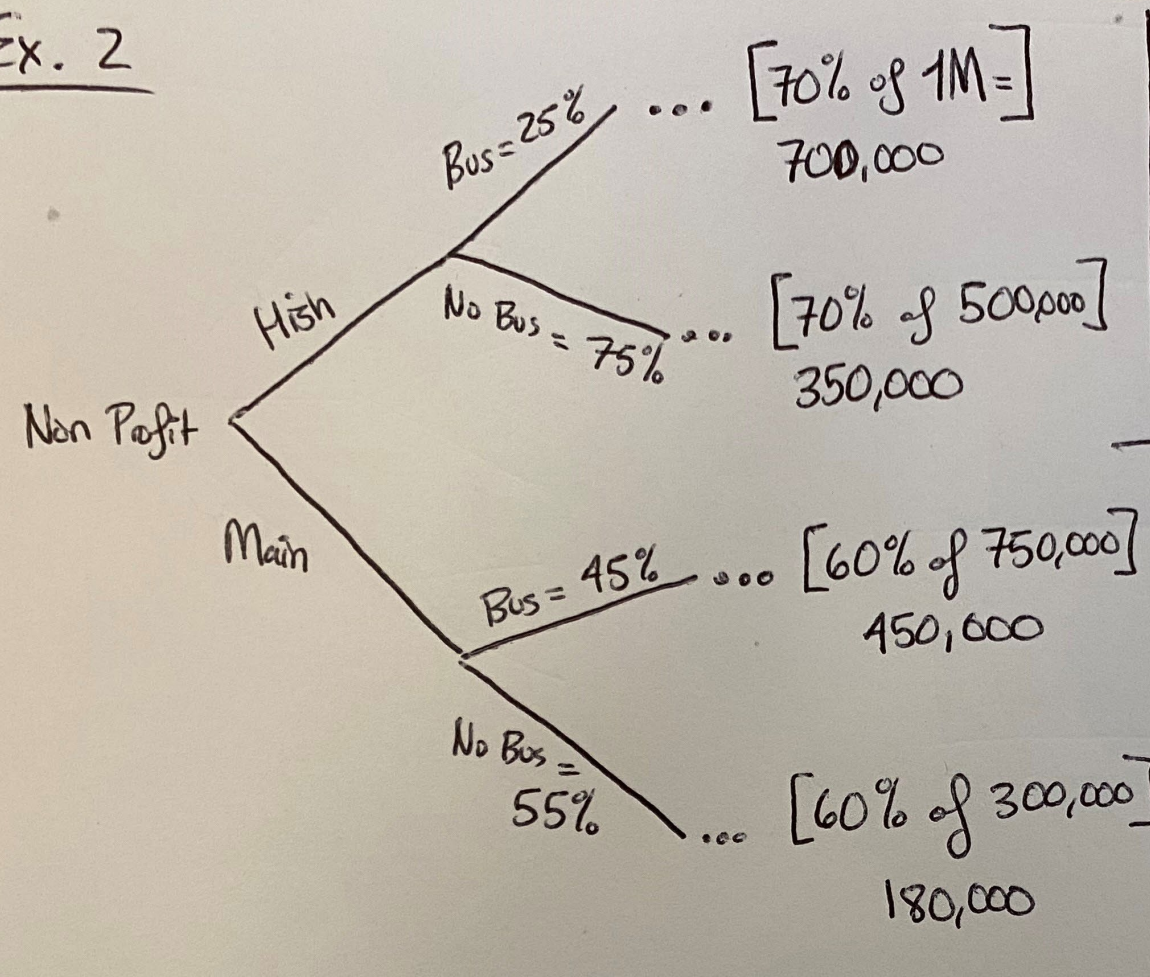
A non-profit is deciding whether to open a new location or not. It can afford to do so only if the maximum population that it serves is greater than 450,000 people (if it serves less, it will be ineligible for a grant, so this is critical). The city is currently re-designing the bus routes, and the traffic from the bus routes would be a huge boost to the client population that the non-profit could serve.

If there was a bus stop that opened on High St., 1M clients would walk past the non-profit's doors each day and they estimate that 70% of the people would be interested in their services. If there was no bus stop, the potential cliental would be 500,000 (and still 70% would be interested). There is a 25% chance that the city puts the bus line on High St.

If there was a bus stop that opened on Main St., 750,000 clients would walk past the non-profit's doors, and they estimate that 60% would be interested in the services. If there was no bus stop, the potential cliental would be 300,000 (and still 60% would be interested). There is a 45% chance that the bus route would run on Main St.

Which location (if any) should the non-profit choose?

Ex. 2



.25 · 700,000 = 175,000

.75 · 350,000 = 262,500

.45 · 450,000 = 202,500

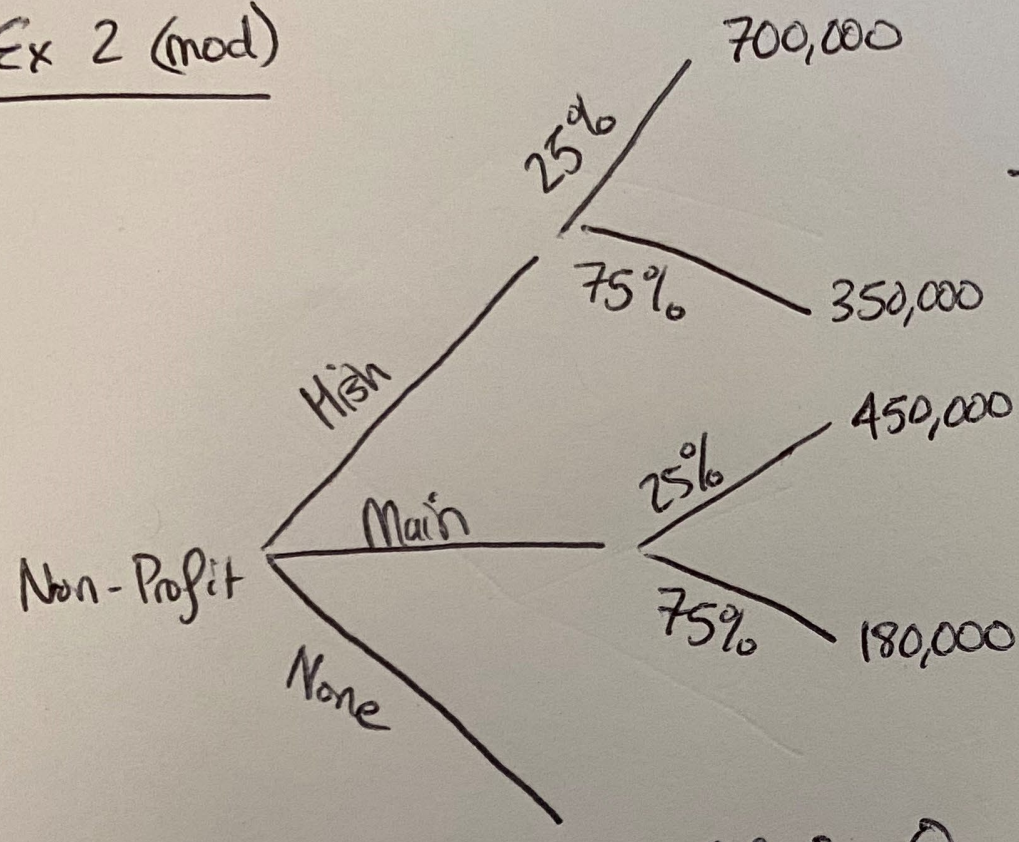
.55 · 180,000 = 99,000

175,000 + 262,500 = 437,500

202,500 + 99,000 = 301,500

→ would prefer High St. to Main St., but neither is expected to serve more than 450,000, so choose neither.

Ex 2 (mod)



Expected Clients

437,500

301,500

0

"Cost" to Non Profit

↳ if Expected clients is > 450,000, cost is $0 due to grant.

→ If Expected clients is < 450,000, cost is > $0 b/c no grant

cost > $0

cost > $0

cost = $0 (didn't open)

Pick this b/c it minimizes cost

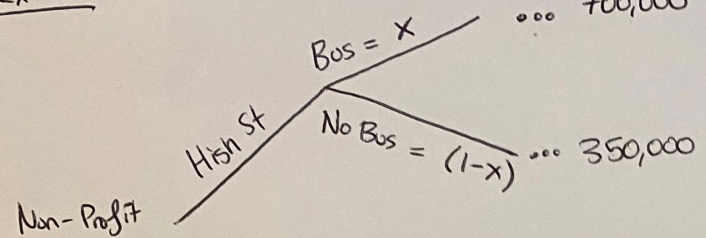
Example 3: (modified example 2)

A non-profit is deciding whether to open a new location or not. It can afford to do so only if the maximum population that it serves is greater than 450,000 people (if it serves less, it will be ineligible for a grant, so this is critical). The city is currently re-designing the bus routes, and the traffic from the bus routes would be a huge boost to the client population that the non-profit could serve.

If there was a bus stop that opened on High St., 1M clients would walk past the non-profit's doors each day and they estimate that 70% of the people would be interested in their services. If there was no bus stop, the potential cliental would be 500,000 (and still 70% would be interested). There is a **x**% chance that the city puts the bus line on High St.

1. What must be the likelihood of a new bus route (on High St) be for the non-profit to open a center on High St.?

Ex 3



$700{,}000x + 350{,}000(1-x) \geq 450{,}000$

$\Leftrightarrow (700{,}000x) + 350{,}000 (-350{,}000x) \geq 450{,}000$

$\Leftrightarrow 350{,}000x + 350{,}000 \geq 450{,}000$

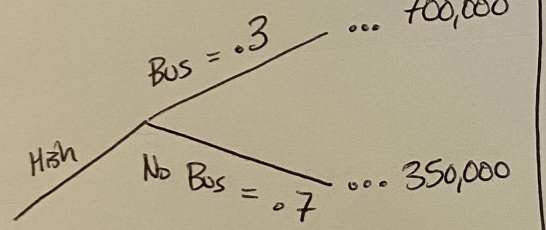
$\Leftrightarrow (350{,}000)x \geq (100{,}000)$

$\Leftrightarrow x \geq \frac{100{,}000}{350{,}000} \approx 28\%$

→ If the probability of a bus opening on High St. is ~28% or greater, then expected clients is max than 450,000. If less, then less than 450,000.

Try:

Let $x = 30\%$



$.3 \cdot 700{,}000 = 210{,}000$

$.7 \cdot 350{,}000 = 245{,}000$

$210{,}000 + 245{,}000 =$

$455{,}000$!

(woot)

Let $x = 25\%$ → same as problem #2

Example 4:

Don was pulled over for speeding. He was going 27 MPH in a 25 MPH zone, and he think it was ridiculous that he received a $300 ticket for such a minor infraction.

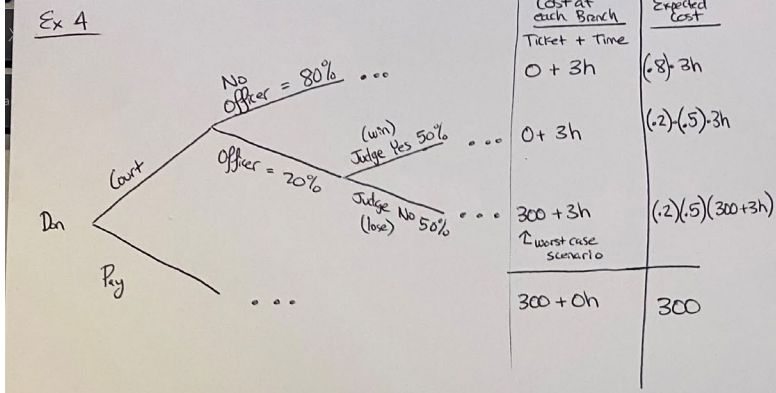
Don has two options. He can go to court and fight the ticket. Or he can pay the ticket and move on. For simplicity, we'll ignore the effect of the ticket on his insurance rates, and only consider his time and money.

If Don goes to court, there is an 80% chance that the officer does not show up, and he wins. If the officer does show up, then there is a 50% chance that the judge will side with Don anyway. If Don wins, he does not have to pay the $300 ticket. However, if he loses, he must pay the ticket. Court also "costs" 3 hours of Don's time, which he could have used to work and earn money.

If Don pays, the ticket, he sacrifices $300, but he saves 3 hours which he could use to work.

What must Don's hourly wage be to choose to go to court and fight the ticket?

Ex 4



Cost at each Branch: Ticket + Time	Expected Cost
0 + 3h	(.8)·3h
0 + 3h	(.2)·(.5)·3h
300 + 3h ↑ worst case scenario	(.2)(.5)(300+3h)
300 + 0h	300

→ Now, as before, add up Expected costs at every branch for each decision, and make your choice on the best outcome.

If Court:

Total Expected Cost = $(.8)(3h) + (.2)(.5)(3h) + (.2)(.5)(300+3h)$

$= (.8)(3h) + (.1)(3h) + (.1)(300+3h)$

$= (.9)(3h) + (.1)(300+3h)$

$= (.9)(3h) + [30 + (.1)(3h)]$

$= (.9+.1)(3h) + 30$

$= 3h + 30$

If Pay:

Total Expected Cost = 300

→ What wage (h) is need so cost of Court is less than cost of Pay?

Court < Pay if $3h + 30 < 300$

$\Leftrightarrow 3h < 270$

$\Leftrightarrow h < \frac{270}{3} = 90$

$\therefore h < \$90$