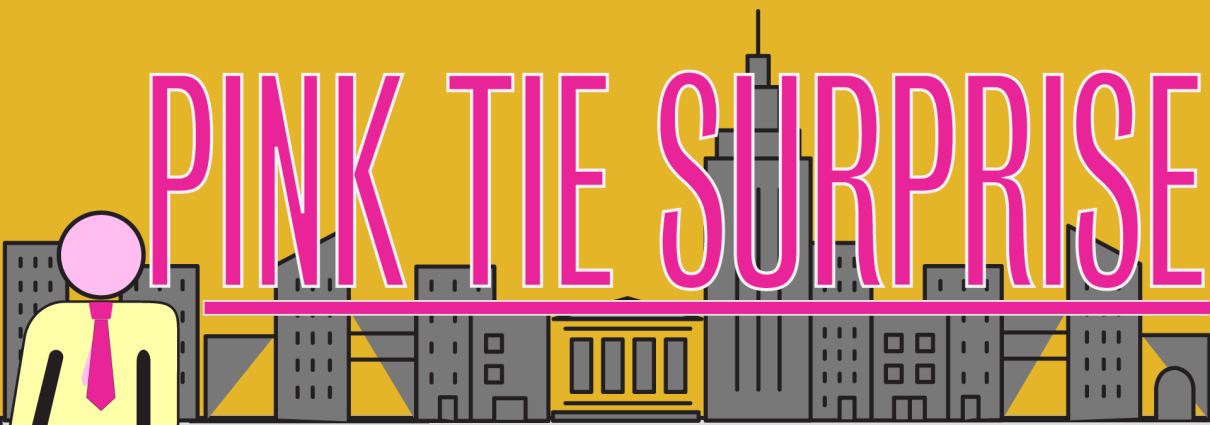
Dynamic Treatment Regimes with Measurement Error

A Non-Technical Overview (where we mostly talk about video games!)

D. Spicker

September 28, 2019

PINK TIE SURPRISE



PLAY

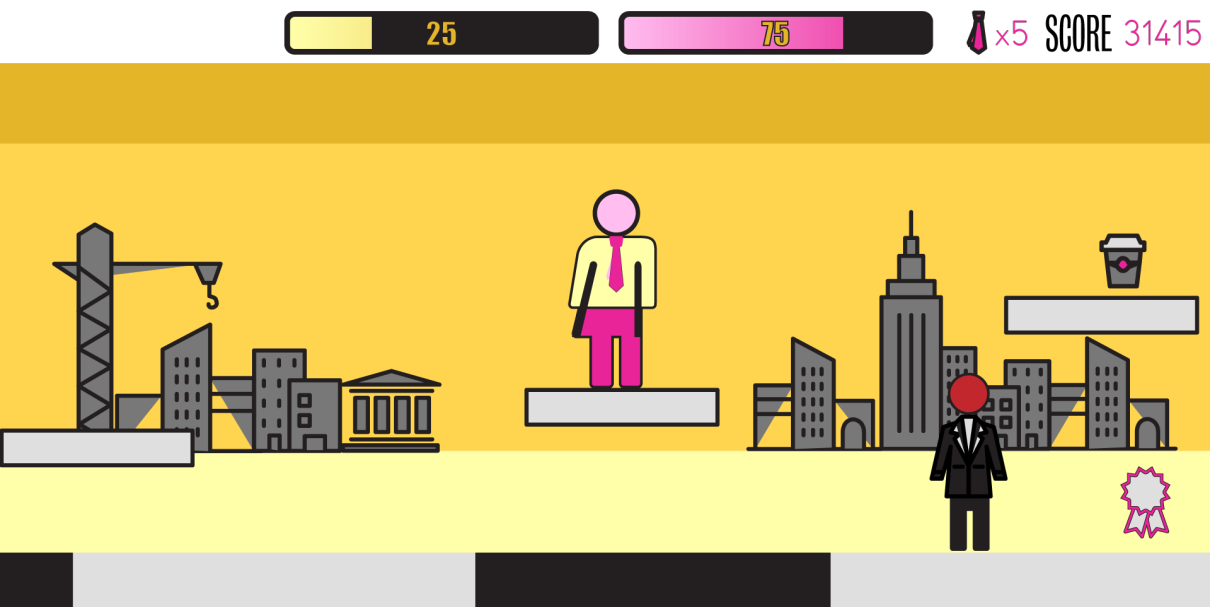
HELP

Let's Play!

Our Challenge

To algorithmically learn to *optimally* play a video game.

The Setup of Our Game



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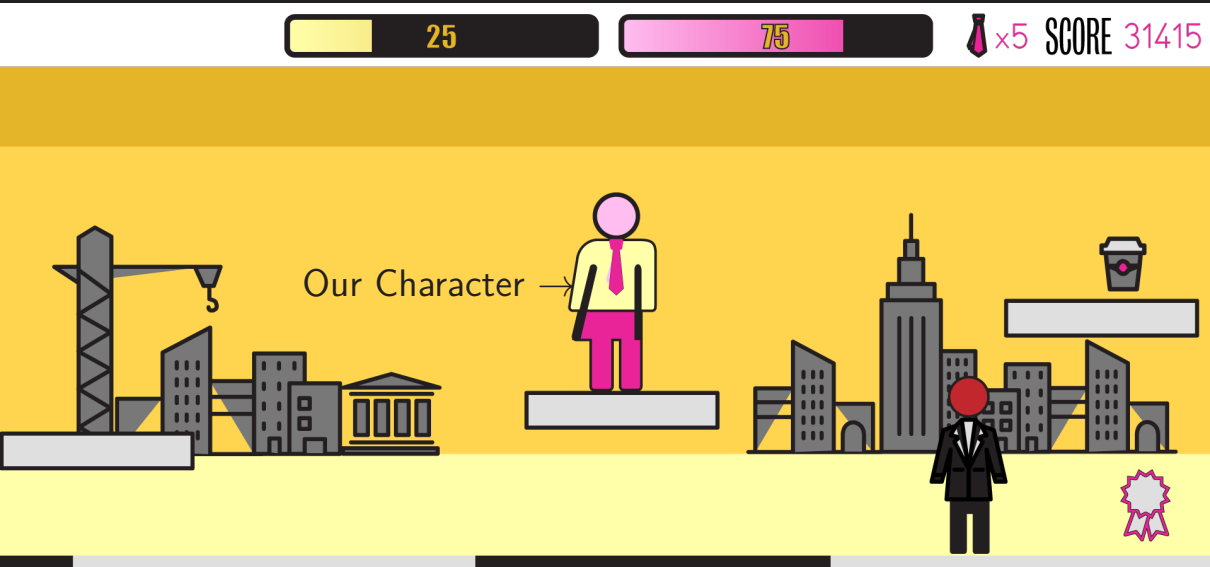

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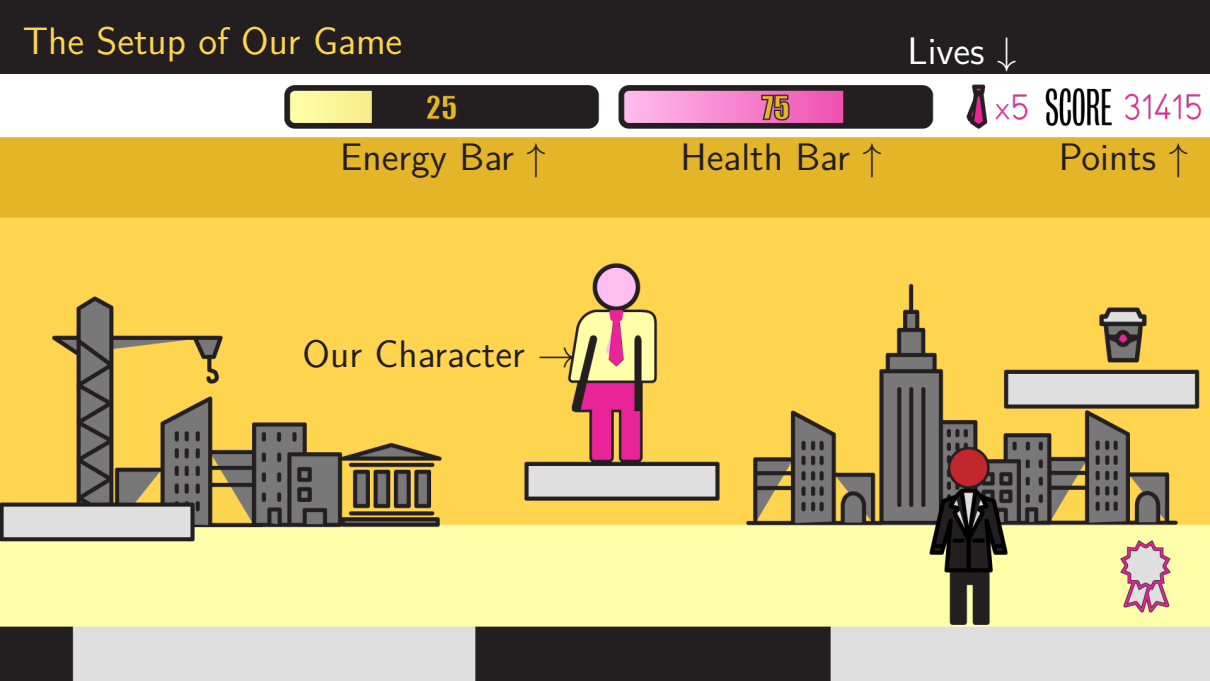

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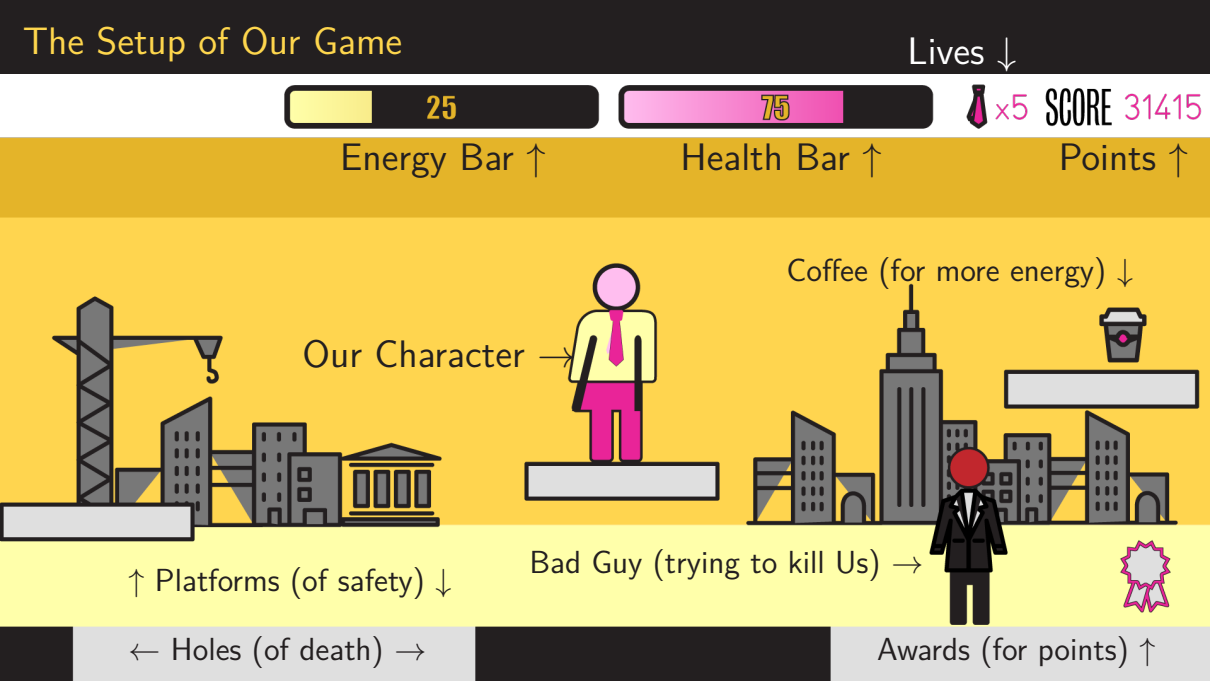

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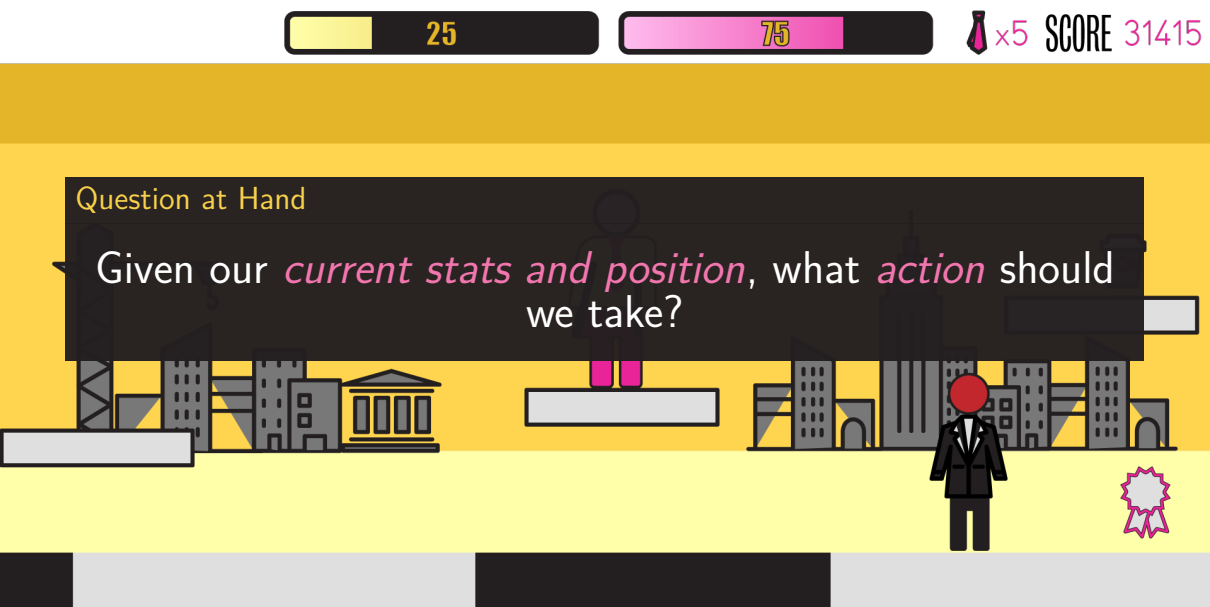

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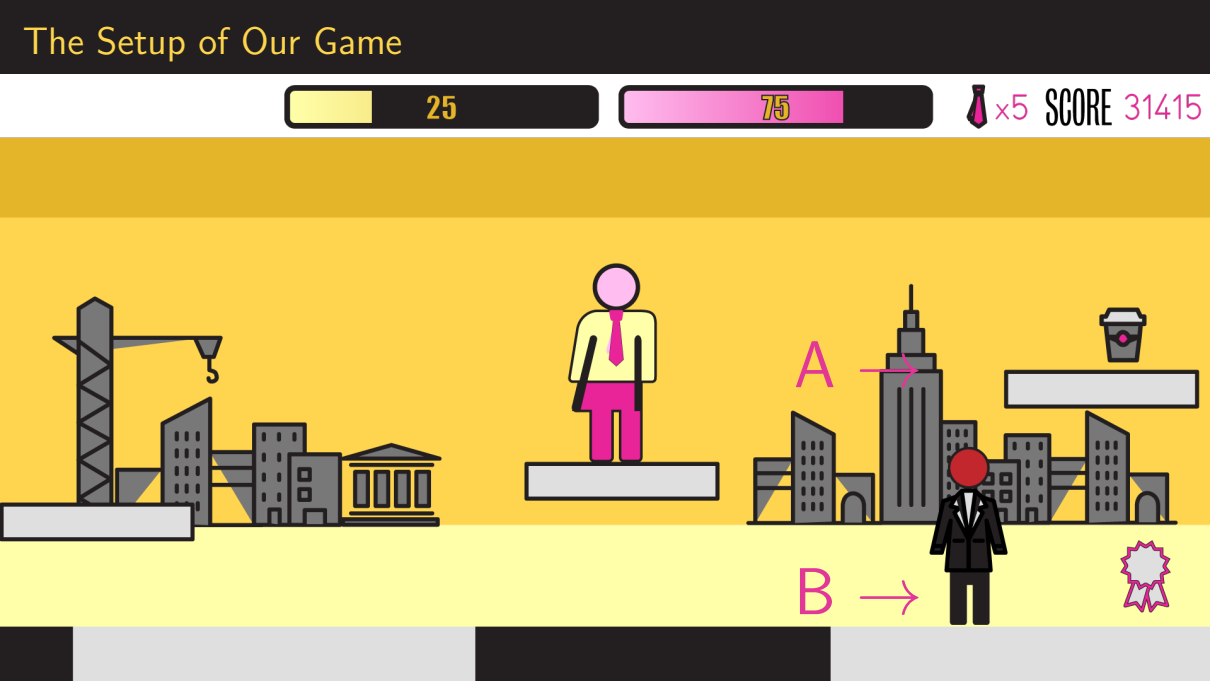


Start at the End!

50 33 x2 SCORE 62831

Start at the End!

50 33 x2 SCORE 62831

Should we try to collect this?

Collect this to win →

Start at the End!

50 33 x2 SCORE 62831

Should we try to collect this?

Starting at the End...

If we only have one decision left to make, and we know all of the information, it is easy!

Collect this to win →

Start at the End!

Should we try to collect this?

Starting at the End...

If we only have one decision left to make, and we know all of the information, it is easy!

Collect the award **IF** the amount of energy required is less than what we have.
Do not otherwise.

Collect this to win →

Start at the End!

50 | 33 | ×2 | SCORE 62831

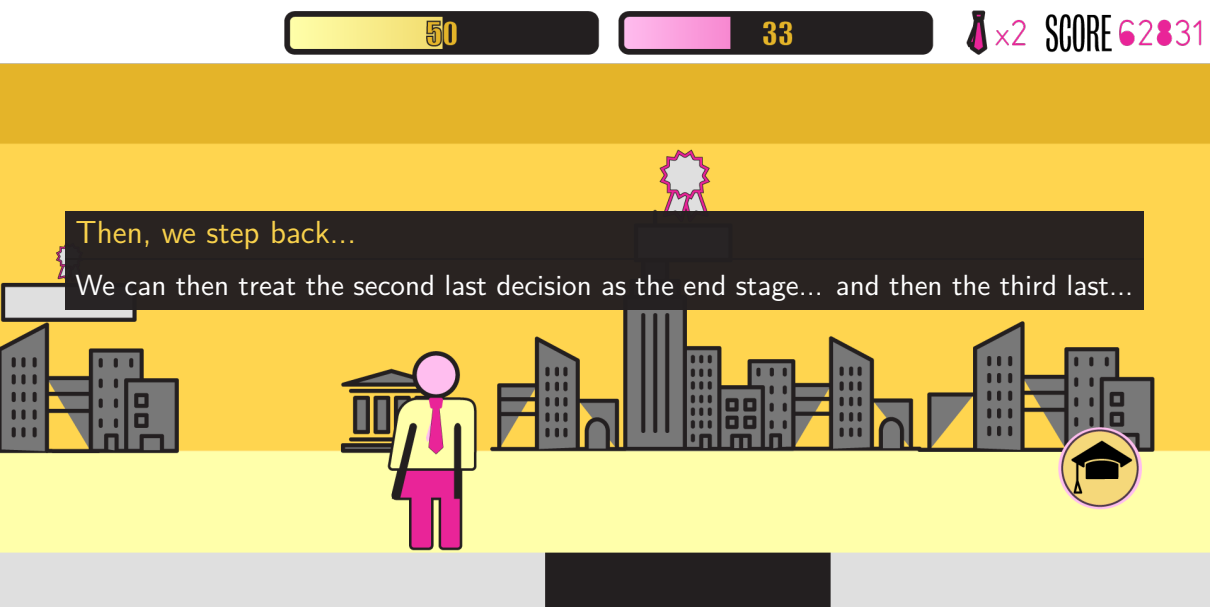
Should we try to collect this?

−50 Energy
+200 Points

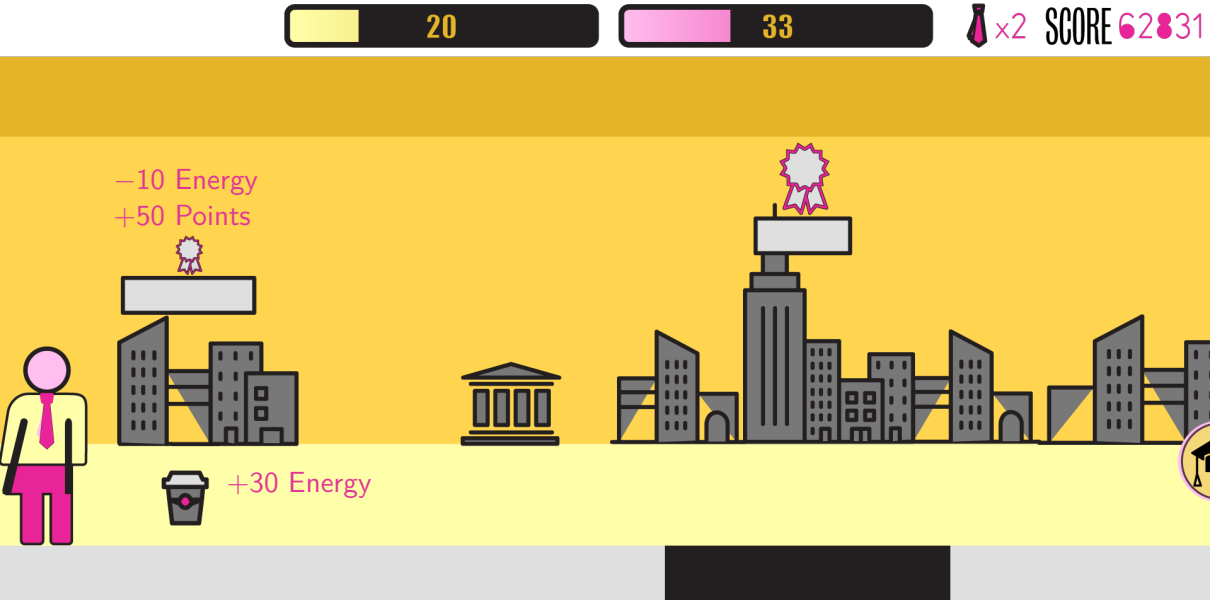
Collect this to win →

−1000 Points

Start at the End!



... this is the end now...



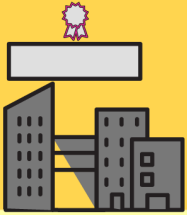
... this is the end now...

20

33

x2 SCORE 62831

−10 Energy Next Stage: +0 Points
+50 Points



+30 Energy Next Stage: +200 Points

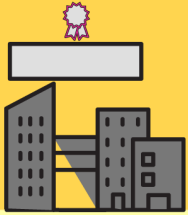
... this is the end now...

20

33

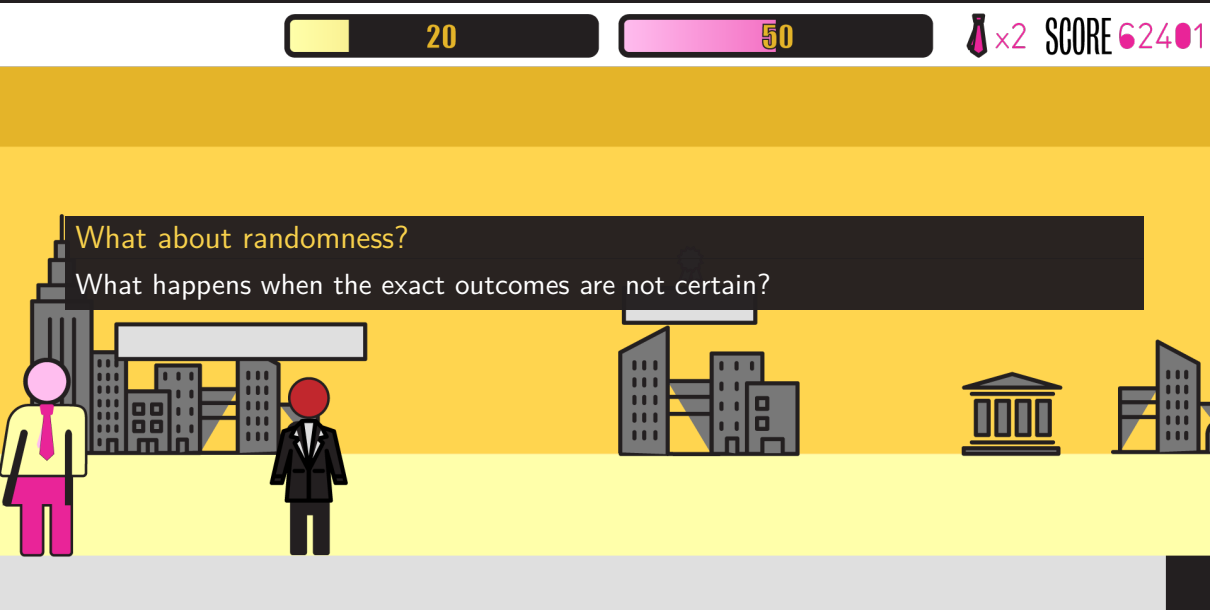
x2 SCORE 62831

−10 Energy
+50 Points



−20 Energy
+200 Points

... *this* is the end now...

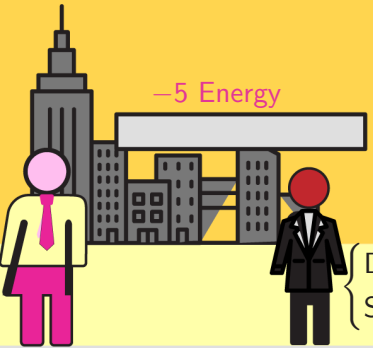


... *this* is the end now...

20

50

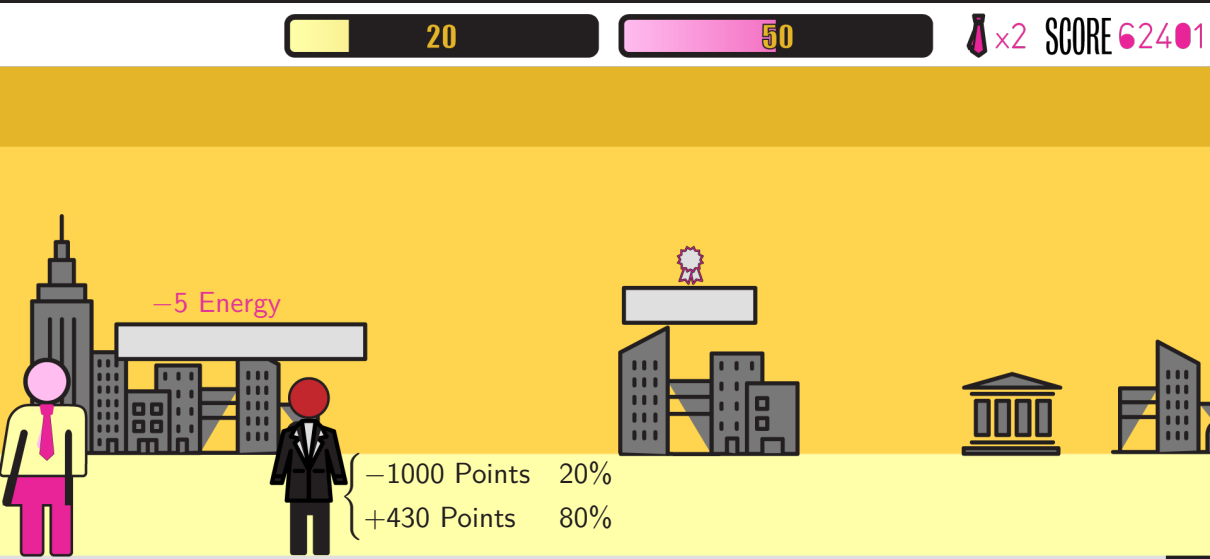
x2 SCORE 62401



Death 20%

Success 80%

... *this* is the end now...



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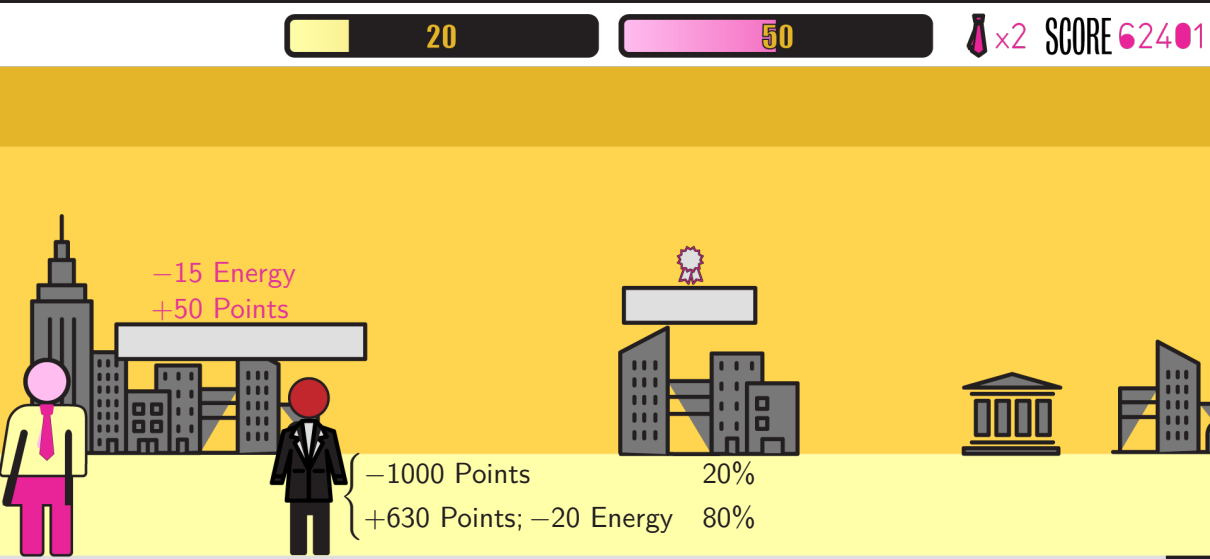

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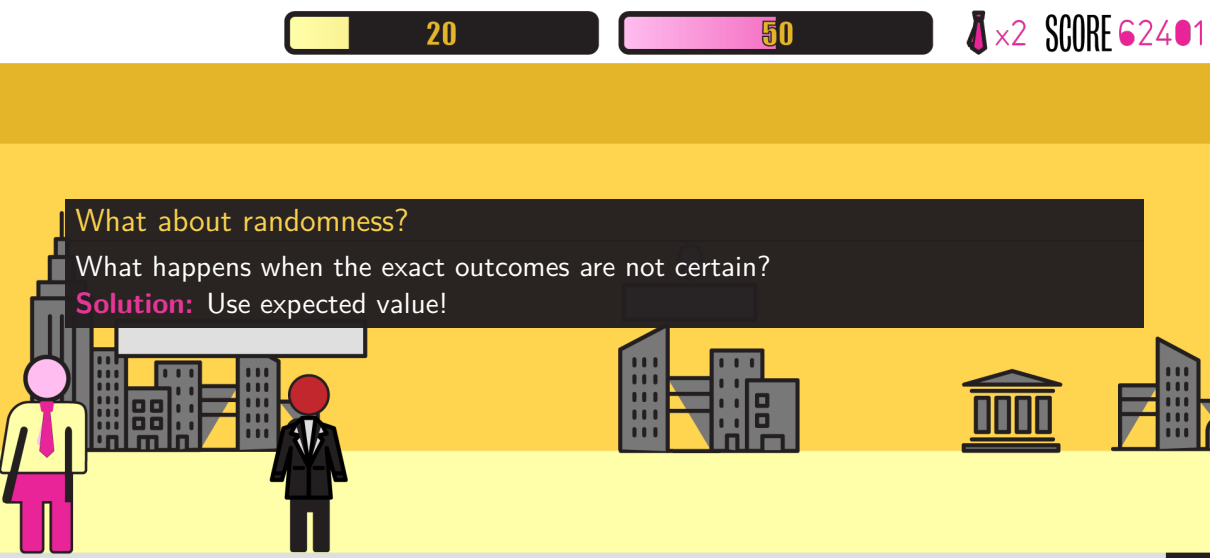
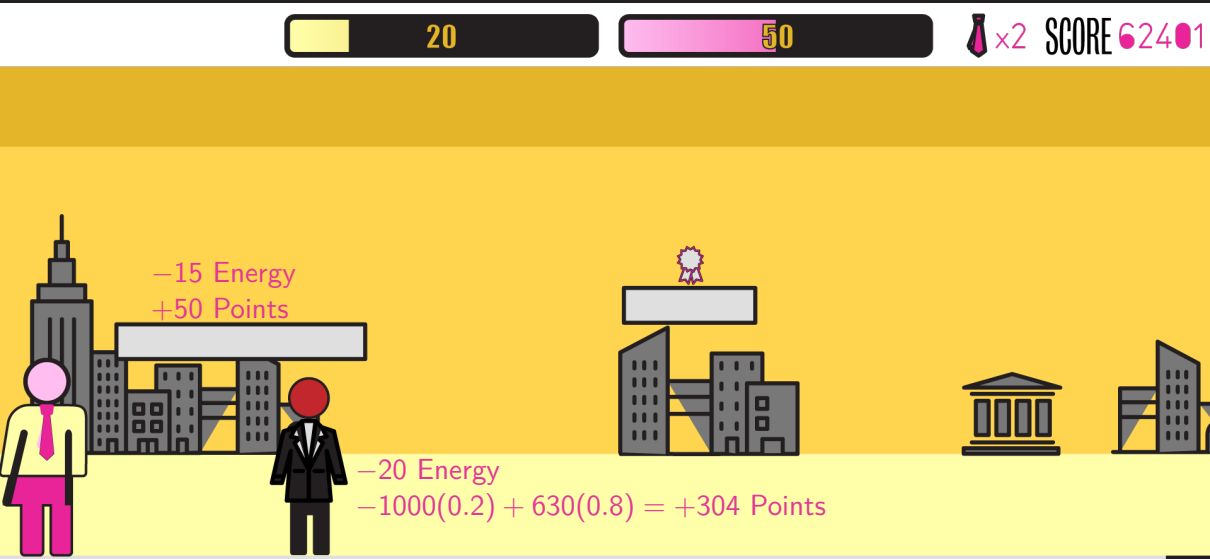


What about randomness?

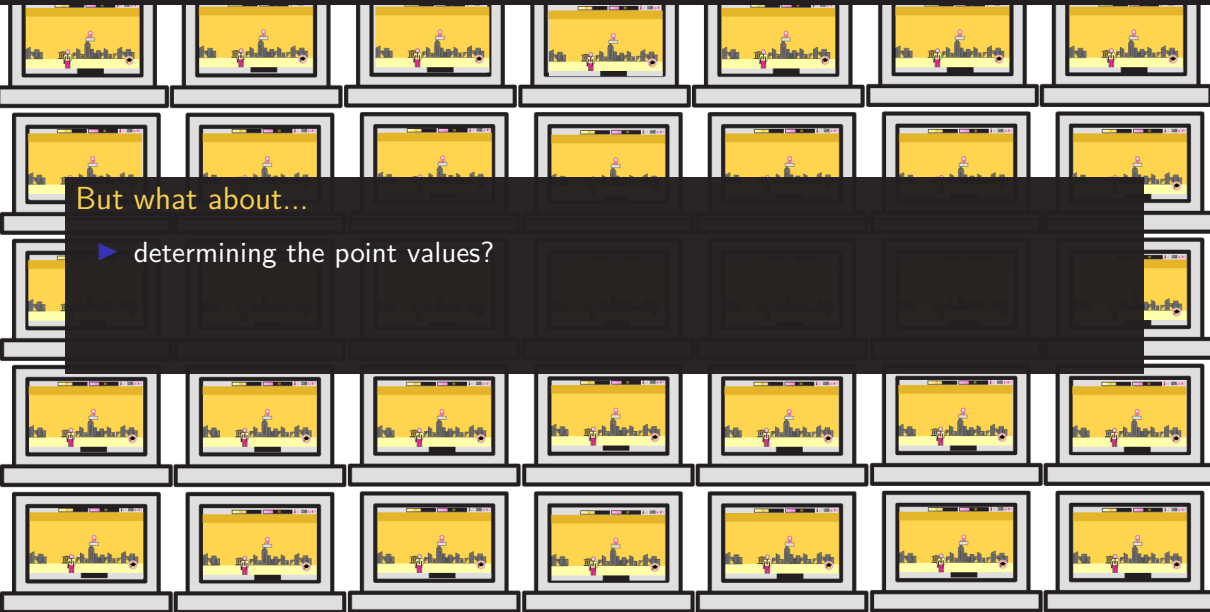
What happens when the exact outcomes are not certain?

Solution: Use expected value!

... *this* is the end now...



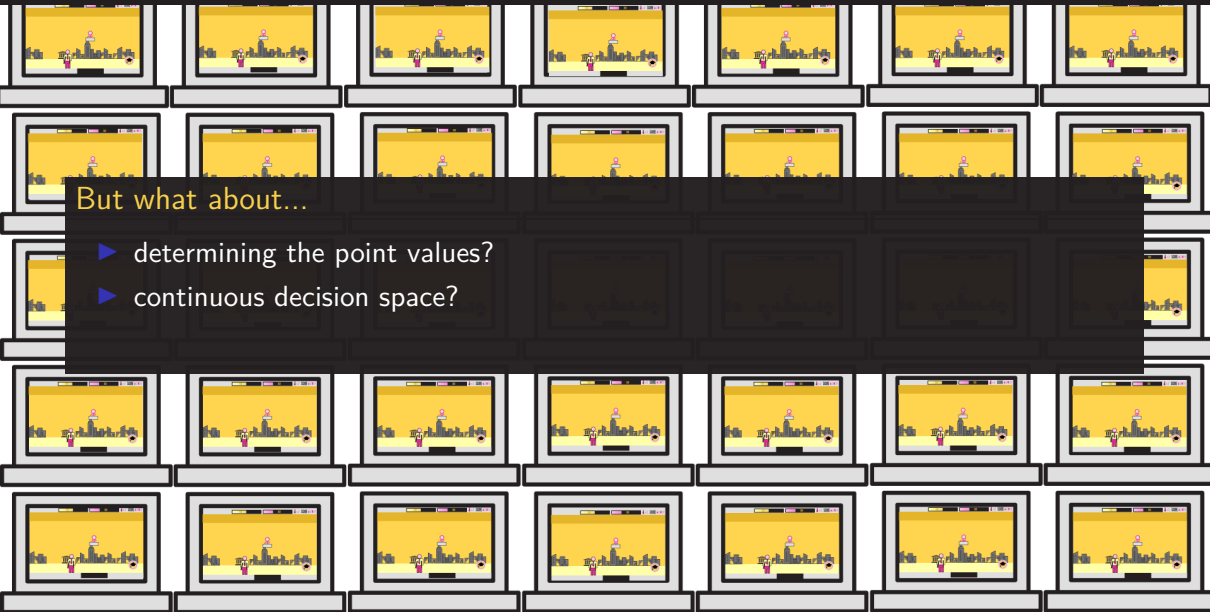
I Swept Some Stuff Under the Rug



But what about...

- determining the point values?

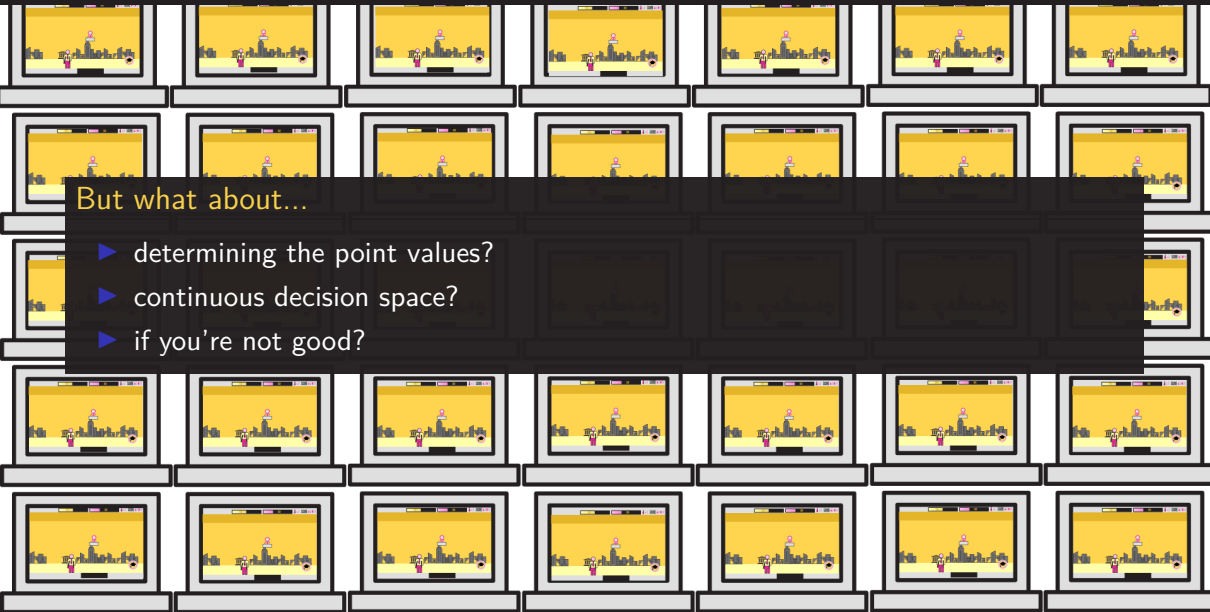
I Swept Some Stuff Under the Rug



But what about...

- determining the point values?
- continuous decision space?

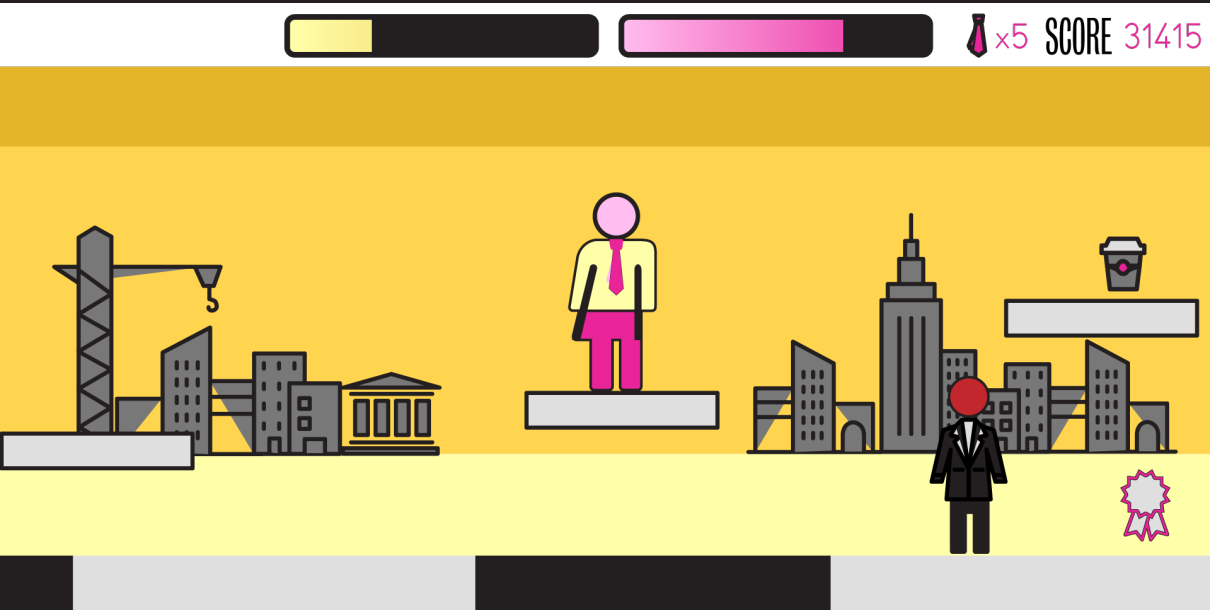
I Swept Some Stuff Under the Rug



But what about...

- determining the point values?
- continuous decision space?
- if you're not good?

That was cool (... in the '80s)



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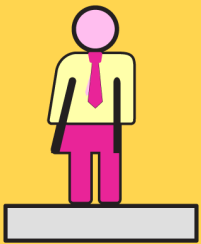
x5 SCORE 31415

Energy Bar (no value?) ↑ Health Bar (no value?!) ↑



How much energy?! ↓

How many points?! ↑

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x5 SCORE 31415

In my research...

- You have no way of getting precise values for health or energy...

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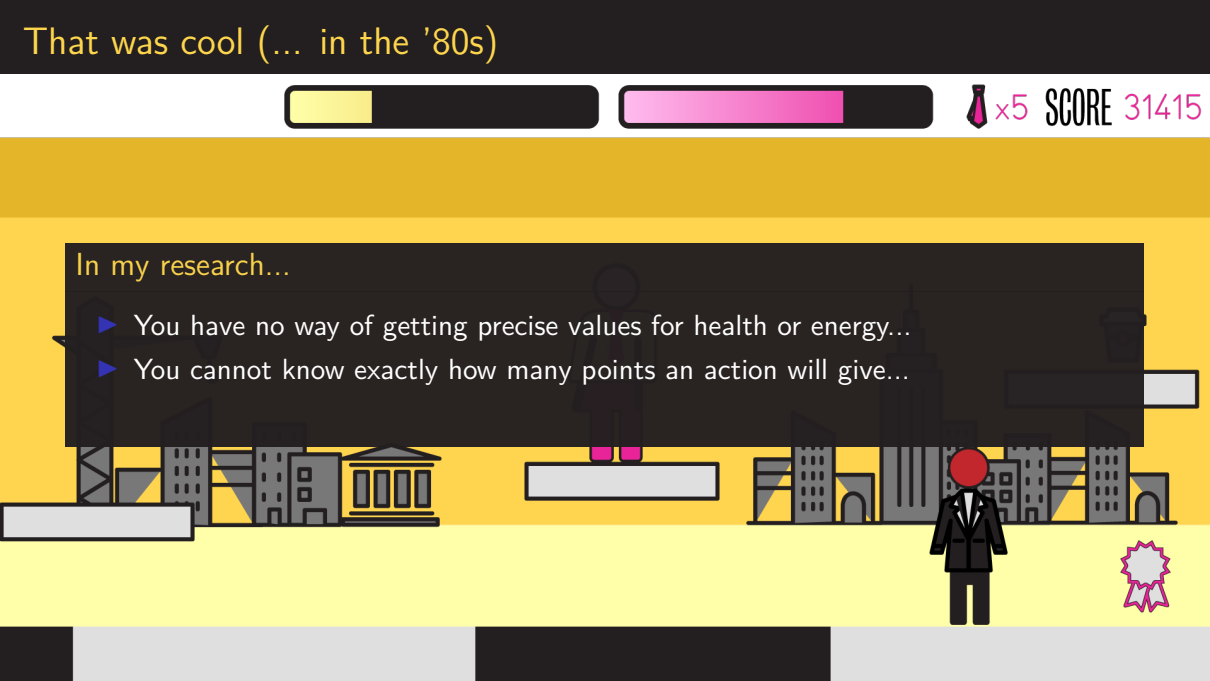
In my research...

- You have no way of getting precise values for health or energy...
- You cannot know exactly how many points an action will give...



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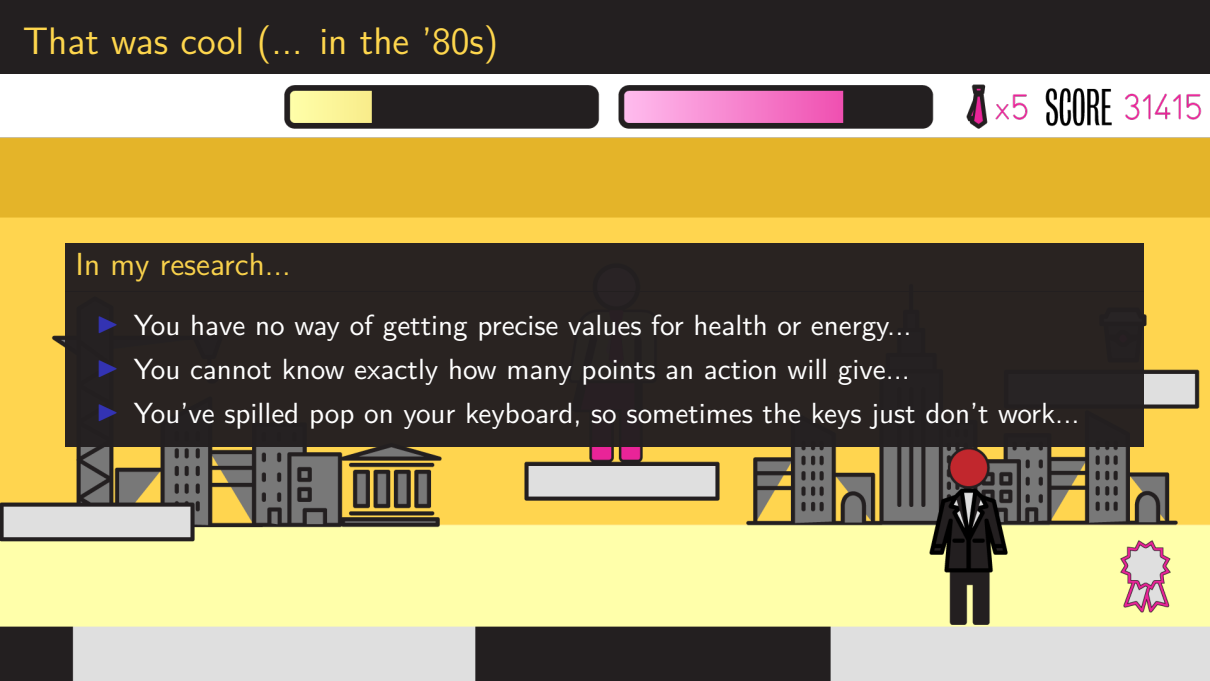
In my research...

- You have no way of getting precise values for health or energy...
- You cannot know exactly how many points an action will give...
- You've spilled pop on your keyboard, so sometimes the keys just don't work...



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x5 SCORE 31415

In my research...

- You have no way of getting precise values for health or energy...
- You cannot know exactly how many points an action will give...
- You've spilled pop on your keyboard, so sometimes the keys just don't work...

We call this Measurement Error

Can we even do anything about it?

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... Maybe?

Can we even do anything about it?

... ~~Maybe?~~ sometimes!!

Can we even do anything about it?

... ~~Maybe?~~ sometimes!!

But we need extra data ...

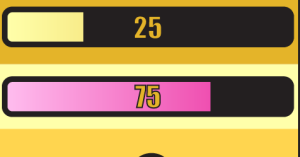
Can we even do anything about it?

... ~~Maybe?~~ sometimes!!

But we need extra data ...

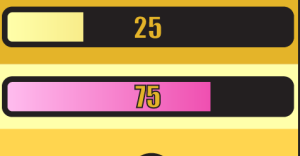
... and assumptions.

Moving to the “Real World”



Personal factors ($X_{1,j}$, $X_{2,j}$, . . .)

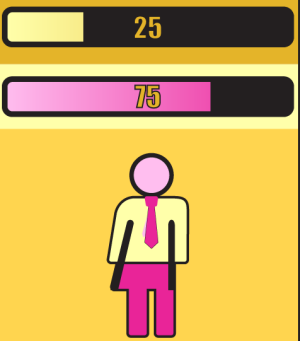
Moving to the “Real World”



Personal factors $(X_{1,j},\ X_{2,j}, \ldots)$

Health factors $(\ldots X_{m+1,j},\ X_{m+2,j}, \ldots)$

Moving to the “Real World”



Personal factors $(X_{1,j}, X_{2,j}, \ldots)$

Health factors $(\ldots X_{m+1,j}, X_{m+2,j}, \ldots)$

Different patients $(i = 1, \ldots, n)$

Moving to the “Real World”

Personal factors ($X_{1,j}$, $X_{2,j}$, . . .)

Health factors (. . . $X_{m+1,j}$, $X_{m+2,j}$, . . .)

Different patients ($i = 1, \ldots, n$)

Treatment options (A_1, A_2, . . .)

Moving to the "Real World"

Personal factors ($X_{1,j}$, $X_{2,j}$, ...)

Health factors (... $X_{m+1,j}$, $X_{m+2,j}$, ...)

Different patients ($i = 1, \ldots, n$)

Treatment options (A_1, A_2, ...)

Medical Outcome (Y)

Thank You!

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