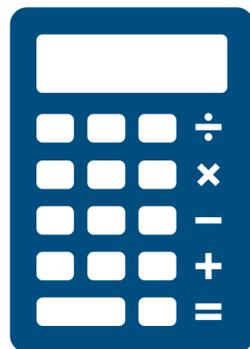


Universalidade:
Sobre bêbados, cafés e queimadas

Guilherme Silva
FAPESP / ICMC-USP

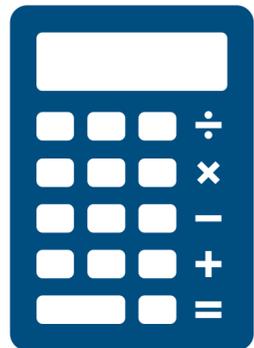
O que é matemática?

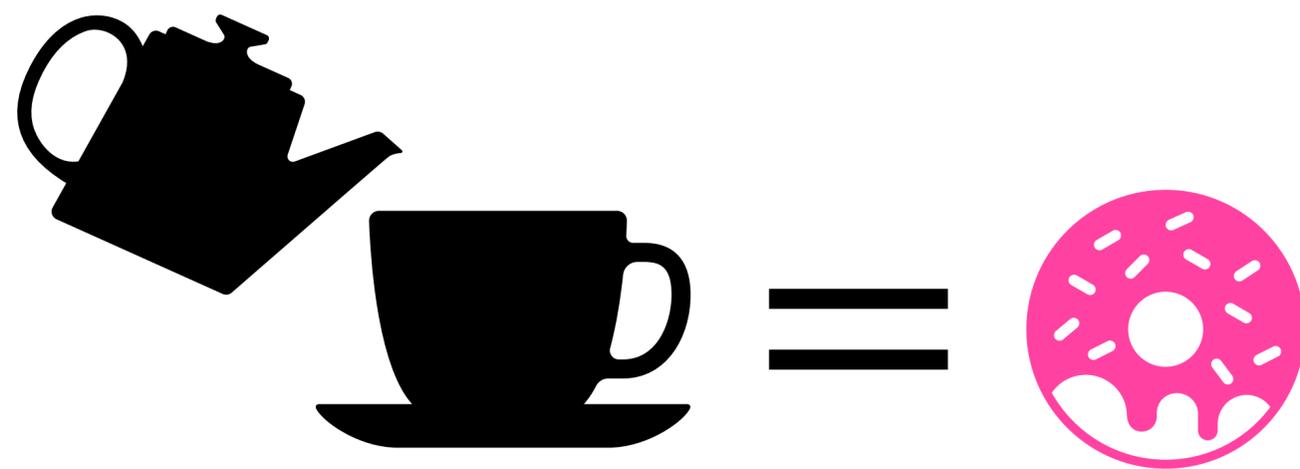
O que é matemática?



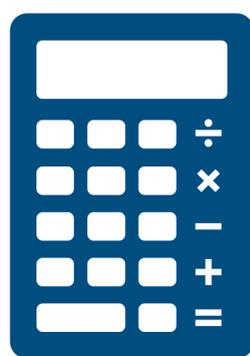


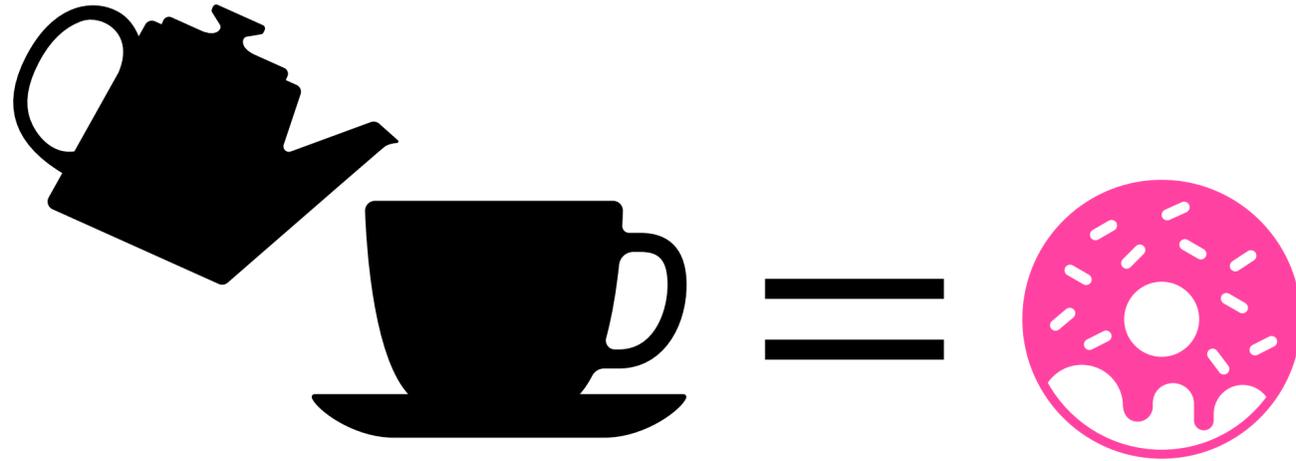
O que é matemática?



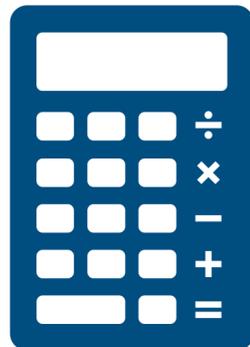


O que é matemática?





O que é matemática?



Esportes

FUTEBOL · JOGOS OLÍMPICOS · ATLETISMO · TÊNIS · GOLFE · F

FUTEBOL >

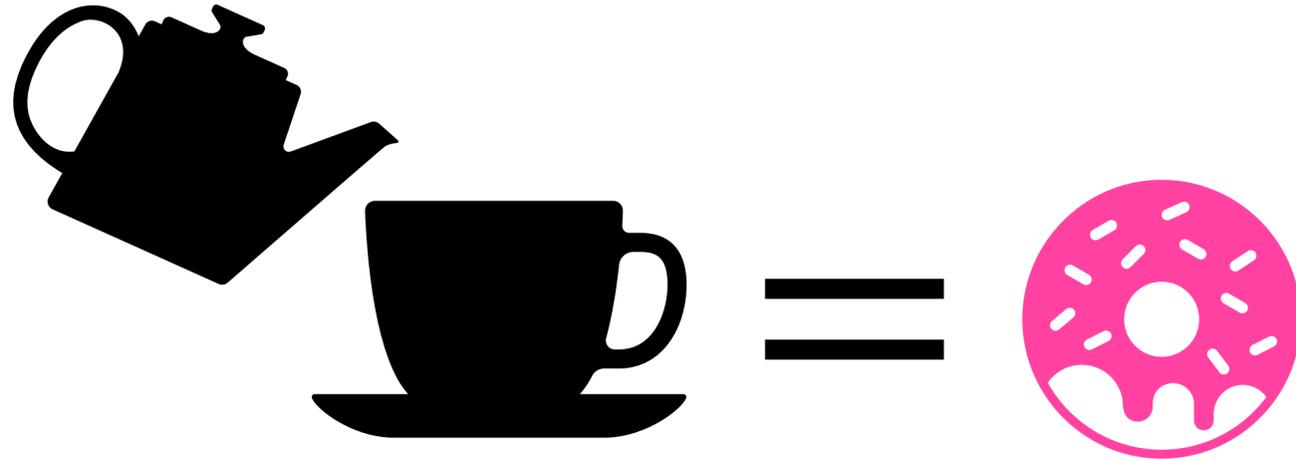
Da partícula de Deus à bola, quando a 'big data' encontra o futebol

Físicos teóricos, matemáticos e programadores lideram os departamentos de análise de dados de alguns dos principais clubes da Europa, que atribuem a eles a melhora nos jogos e nas contratações

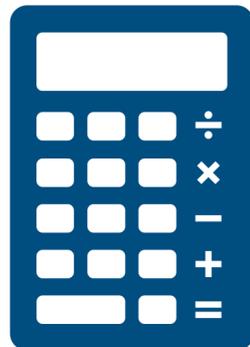


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O que é matemática?



Esportes

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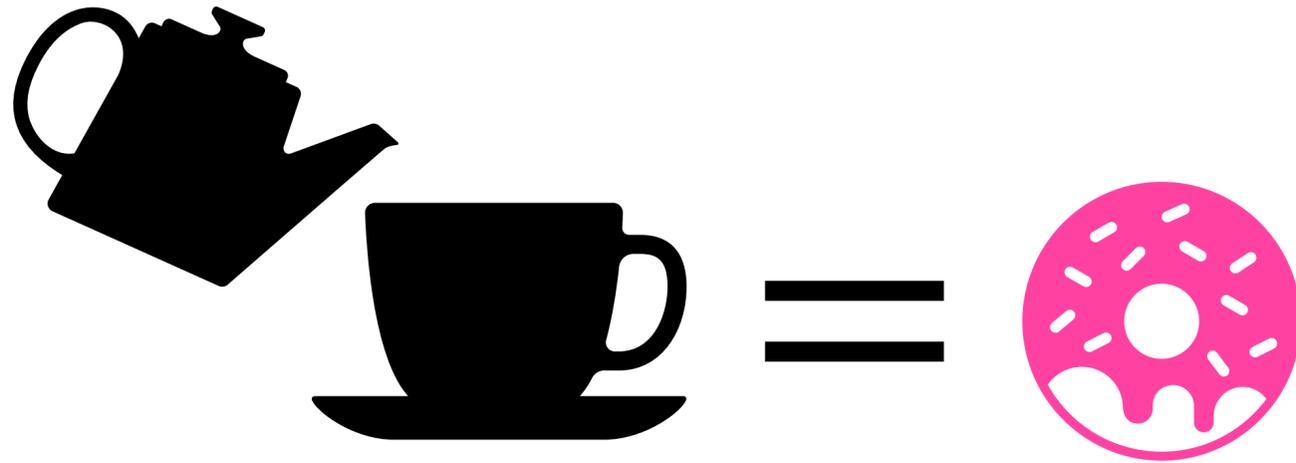
FUTEBOL >

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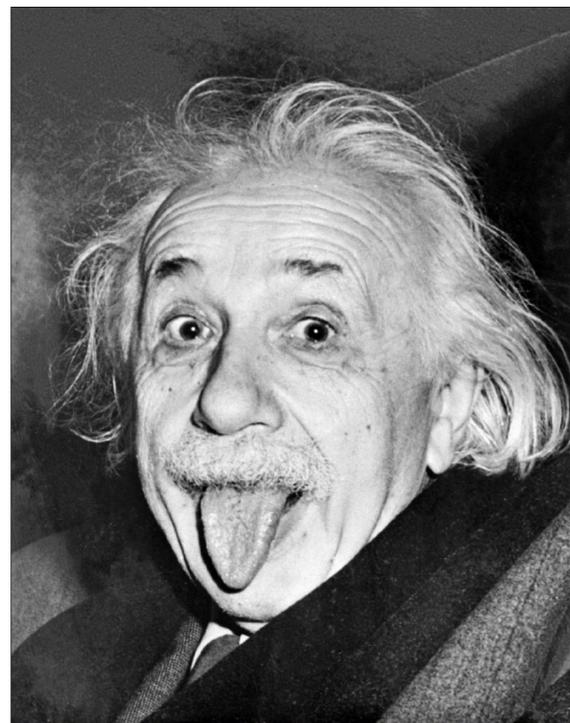
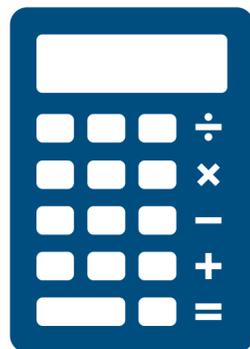
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O que é matemática?



Esportes

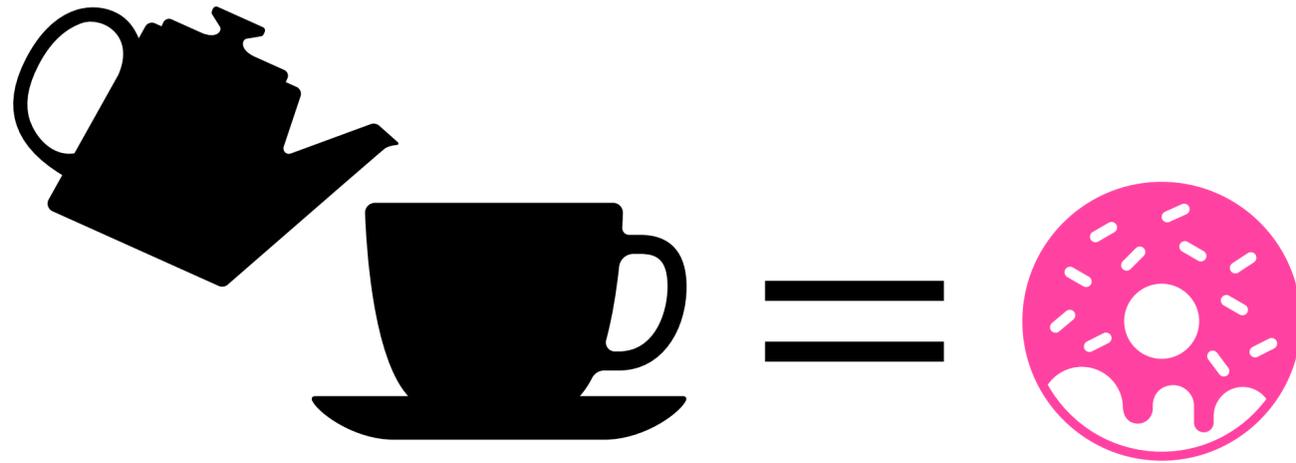
FUTEBOL · JOGOS OLÍMPICOS · ATLETISMO · TÊNIS · GOLFE · F

FUTEBOL >

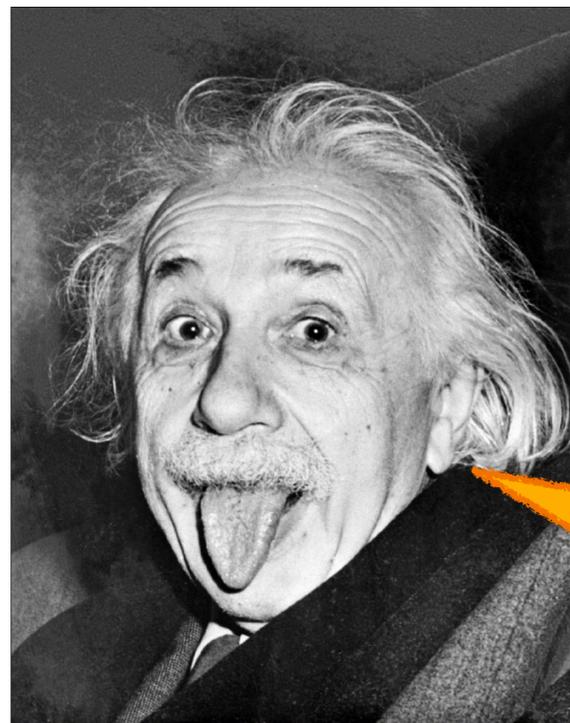
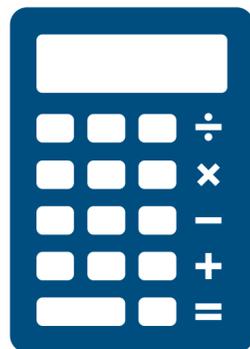
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O que é matemática?



Matemática é,
a seu próprio modo,
a poesia das idéias lógicas

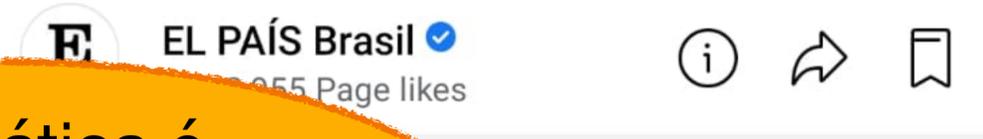
Esportes

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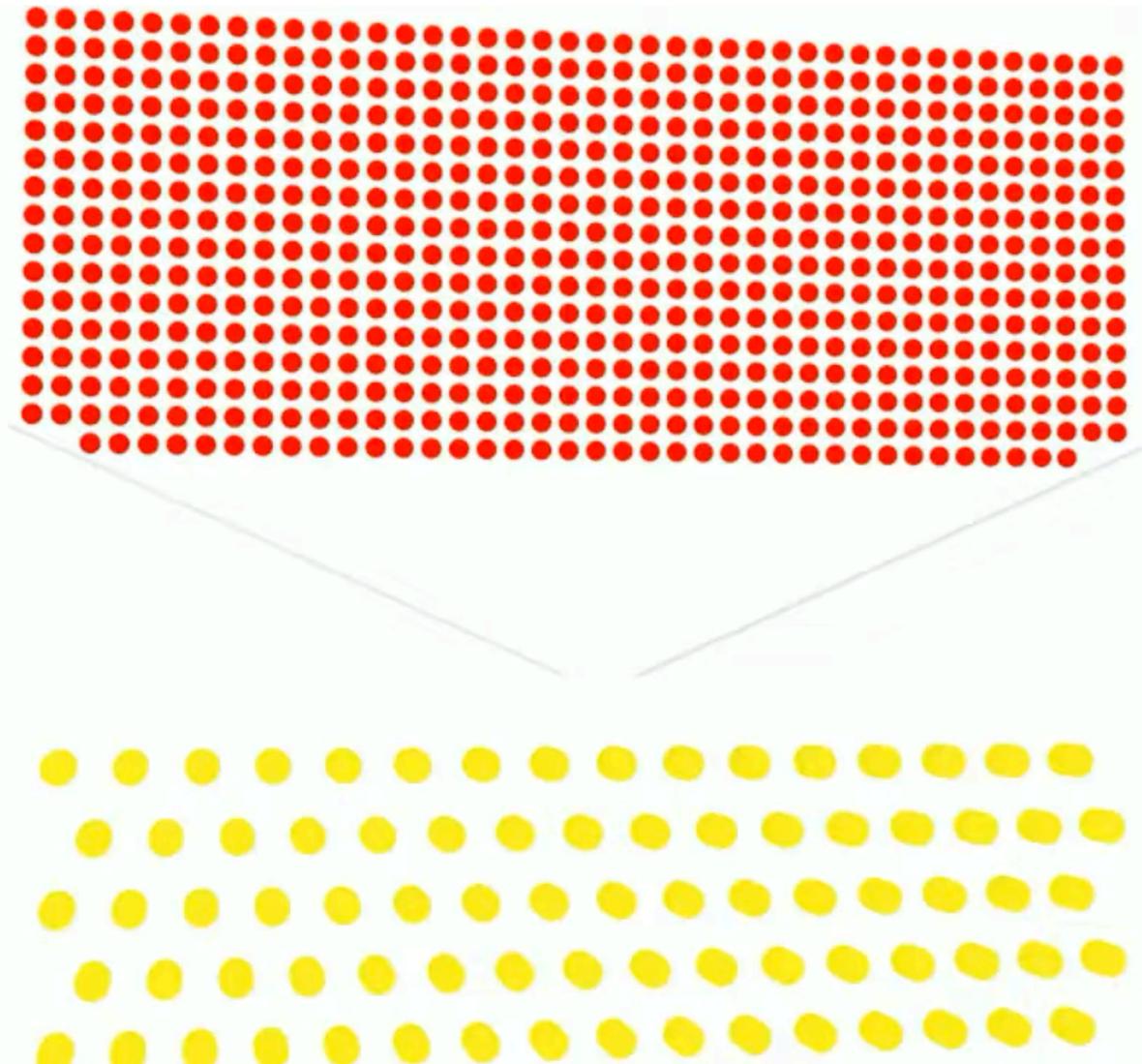
FUTEBOL >

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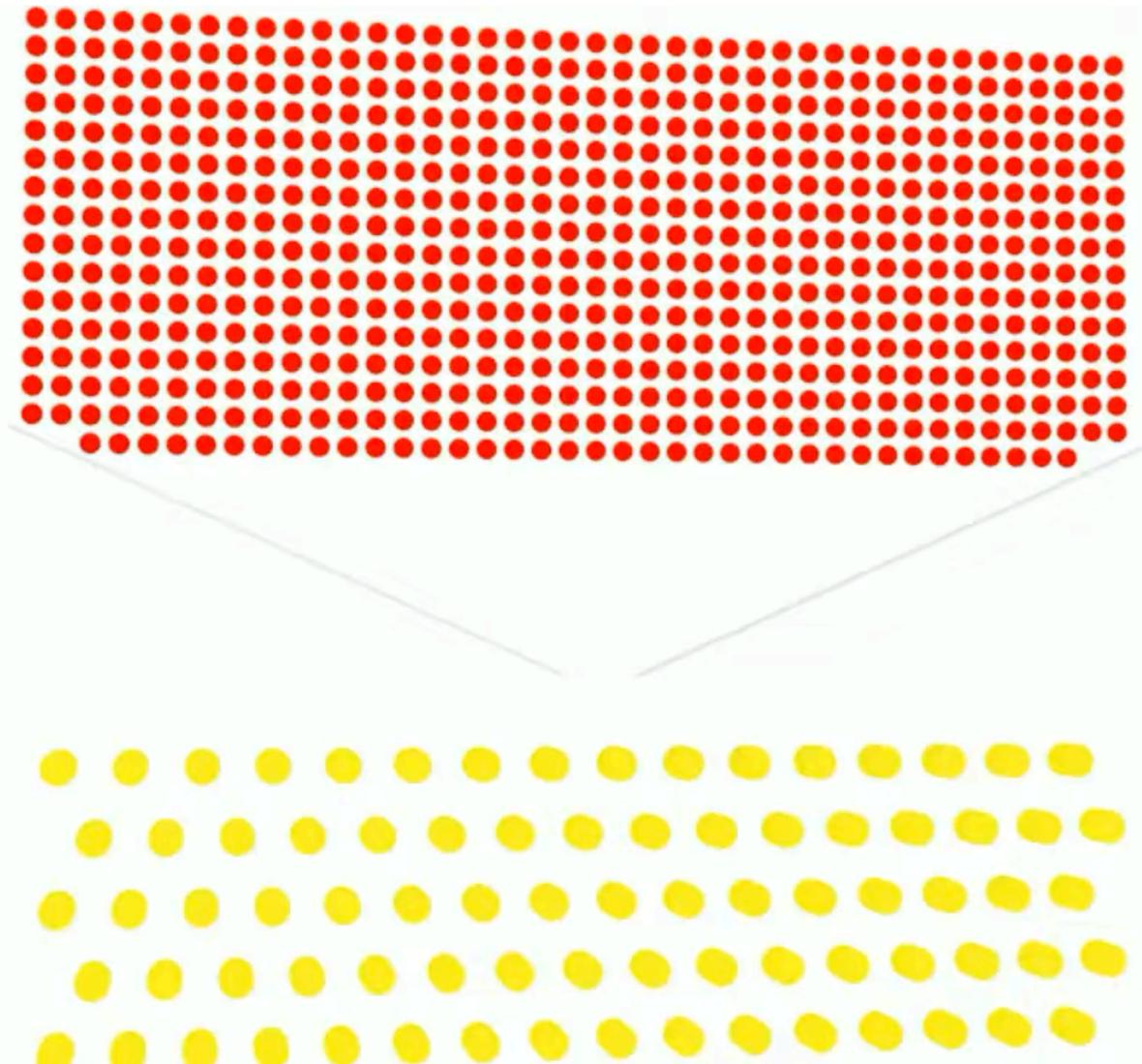


O tabuleiro de Galton (Sir Francis Galton, 1822)



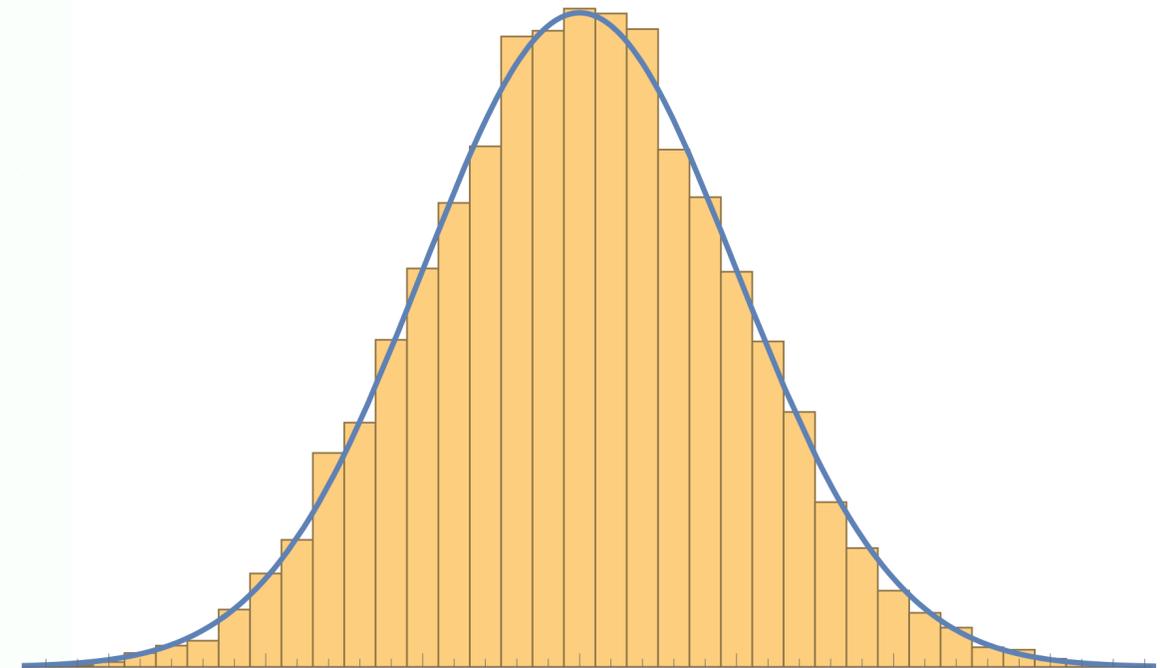
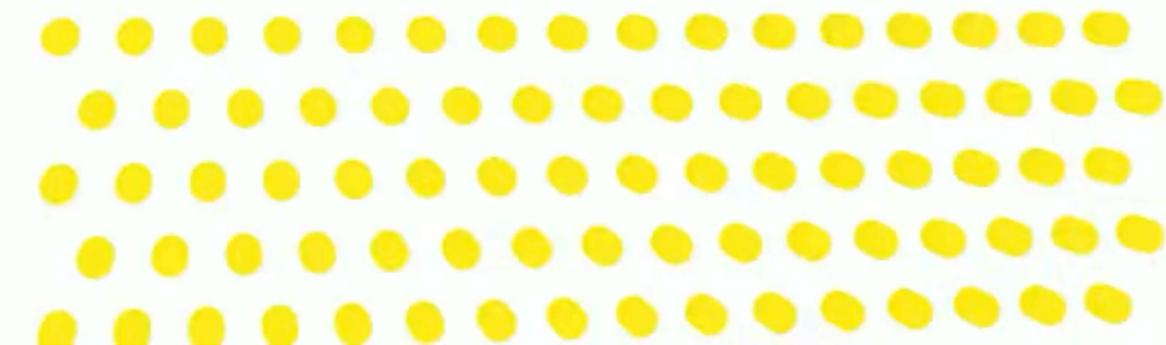
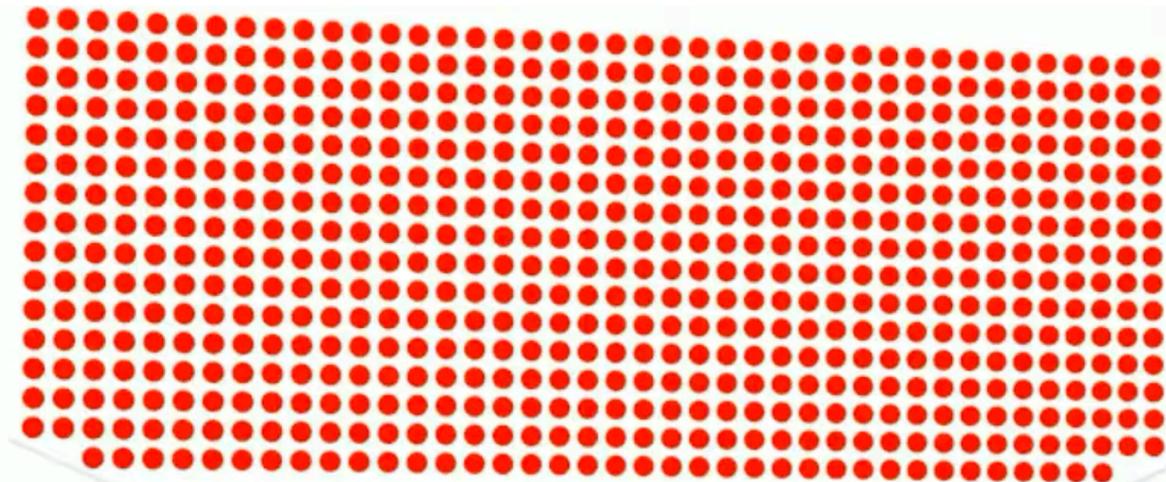
Extraído de <https://www.youtube.com/watch?v=SorB0CTWvws>

O tabuleiro de Galton (Sir Francis Galton, 1822)



Extraído de <https://www.youtube.com/watch?v=SorB0CTWvws>

O tabuleiro de Galton (Sir Francis Galton, 1822)



$$f(x) = \frac{1}{\sqrt{2\pi}} e^{-\frac{x^2}{2}}$$

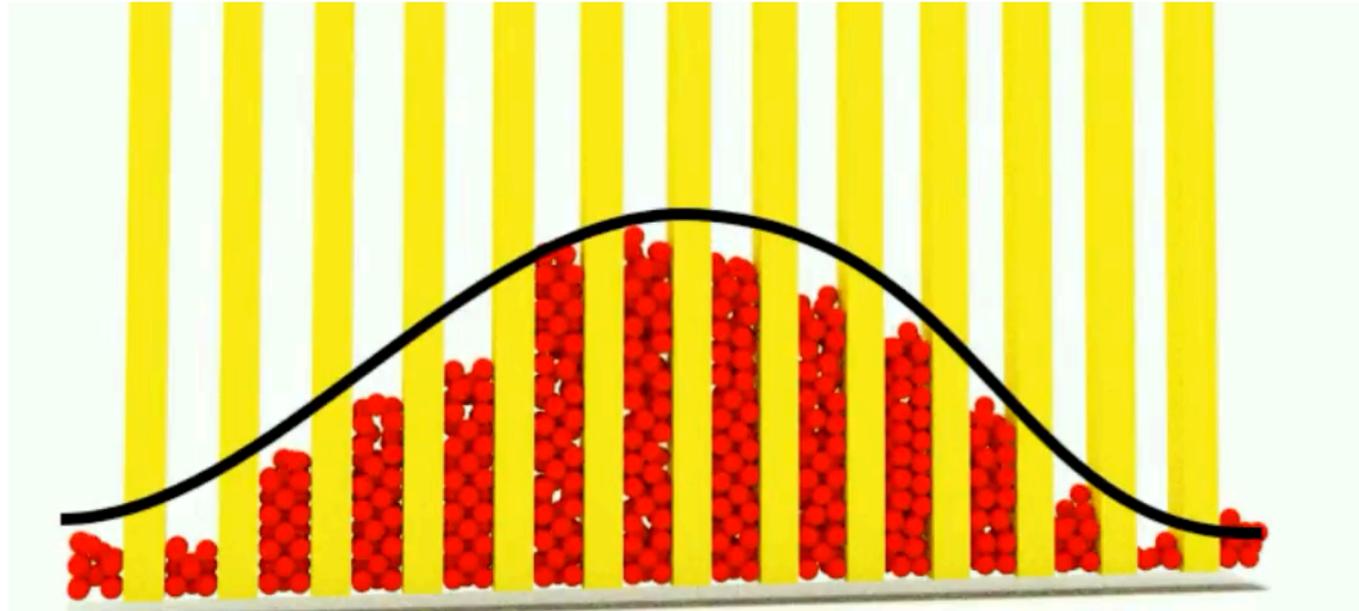
Tetris de neve



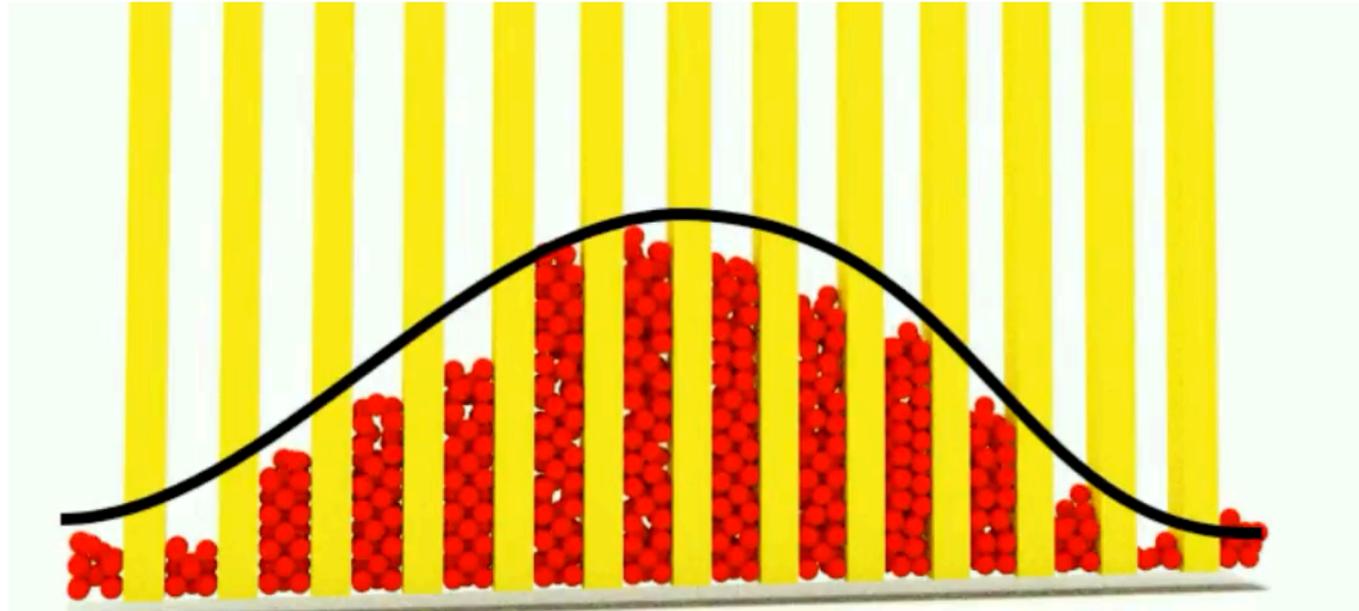
Tetris de neve



Qual a diferença?

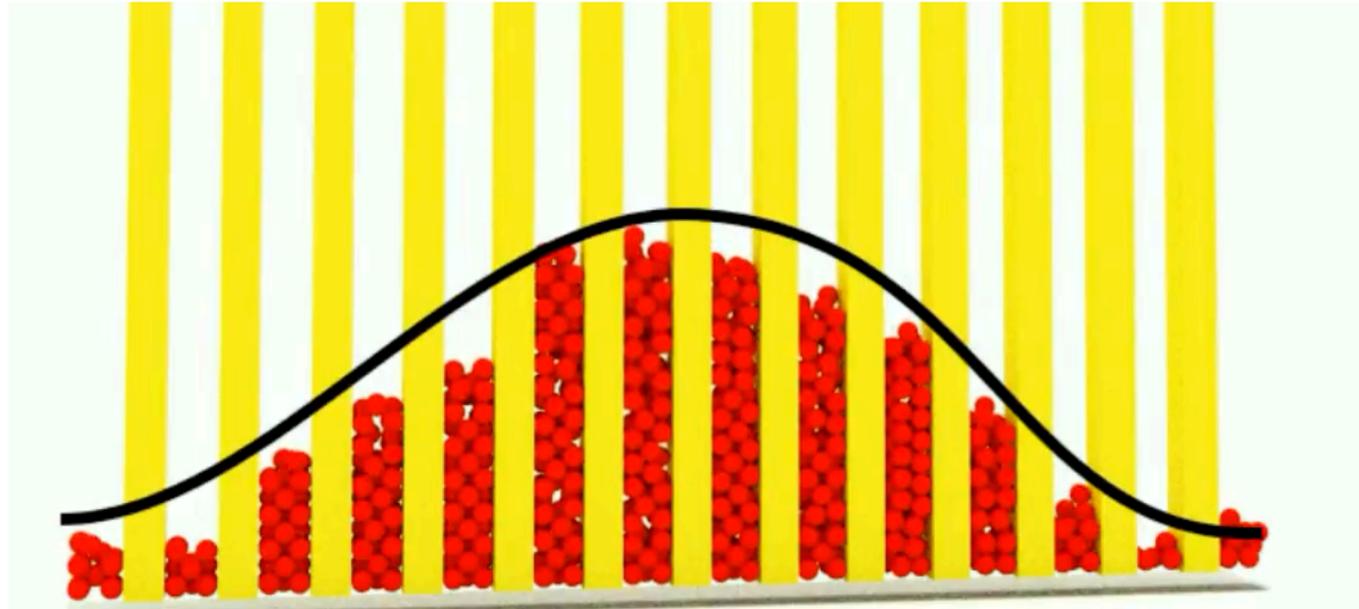


Qual a diferença?



Vizinhos não se conhecem

Qual a diferença?

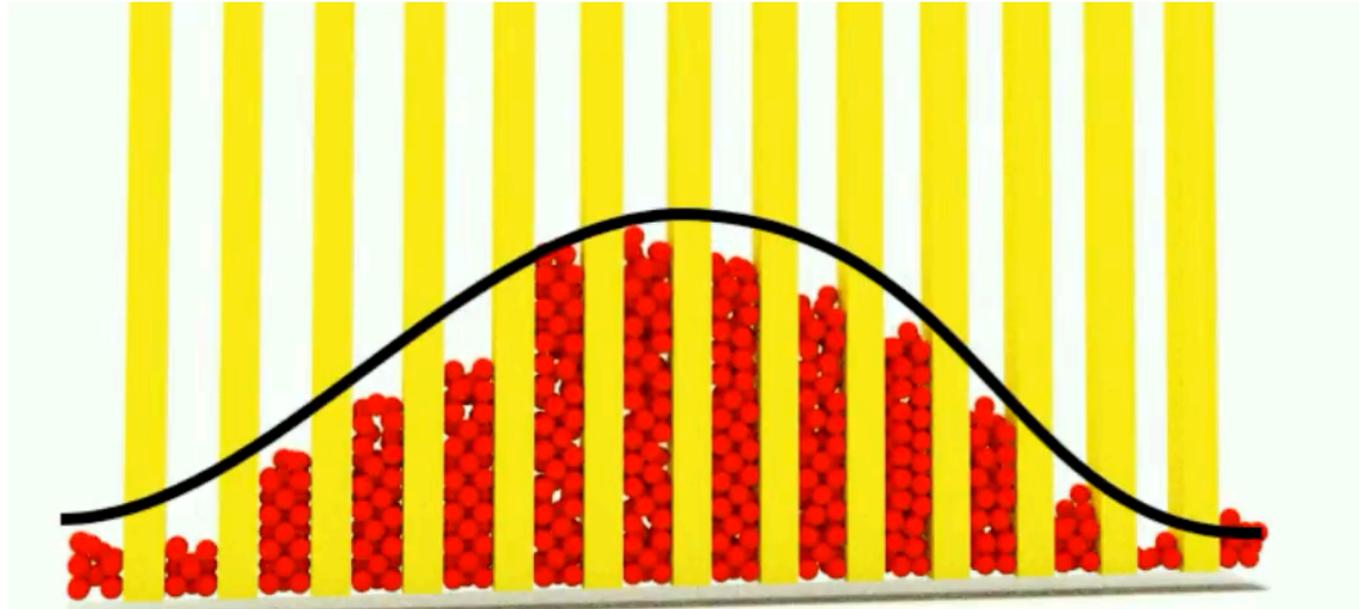


Vizinhos não se conhecem



Vizinhos se gostam

Qual a diferença?



Vizinhos não se conhecem

Independência

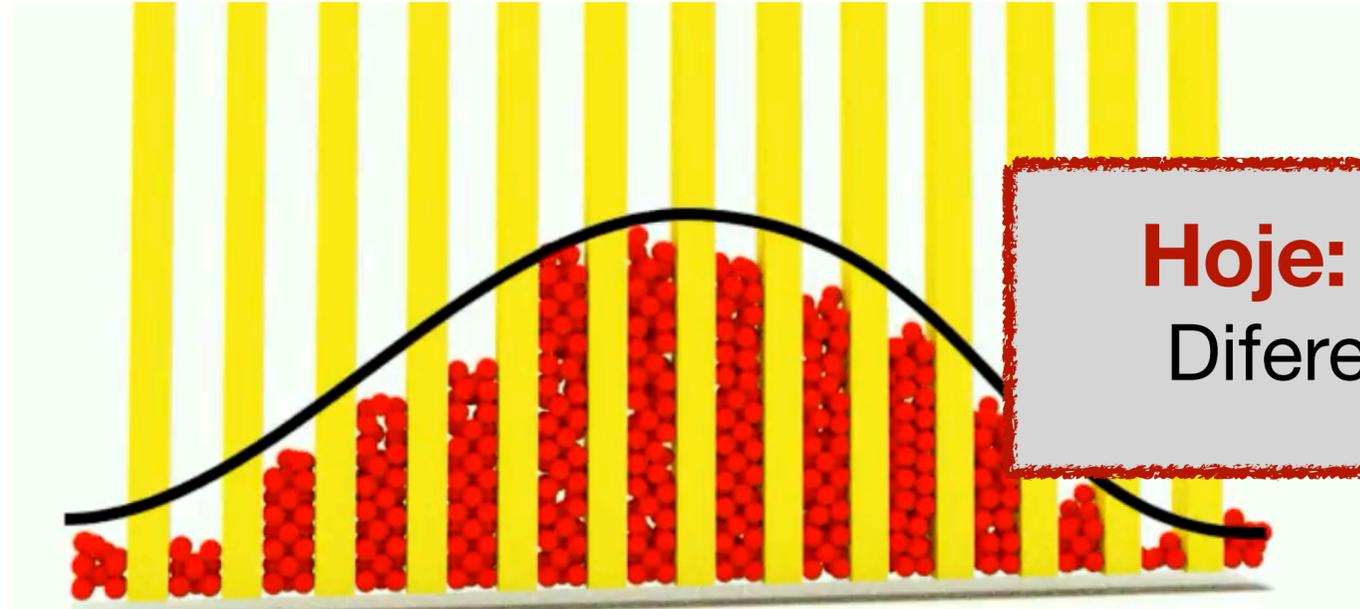
vs



Vizinhos se gostam

Correlação

Qual a diferença?



Vizinhos não se conhecem

Independência

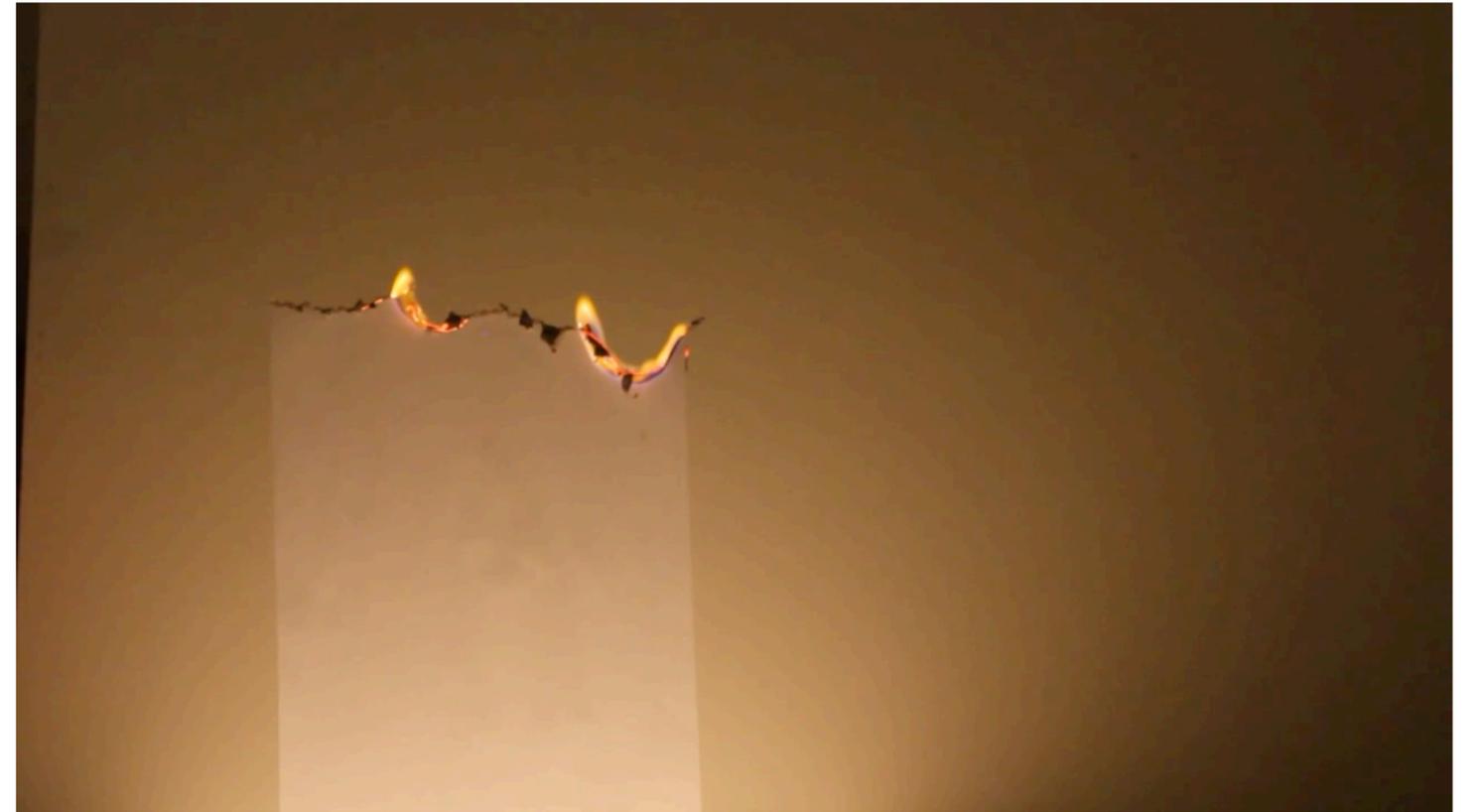
vs



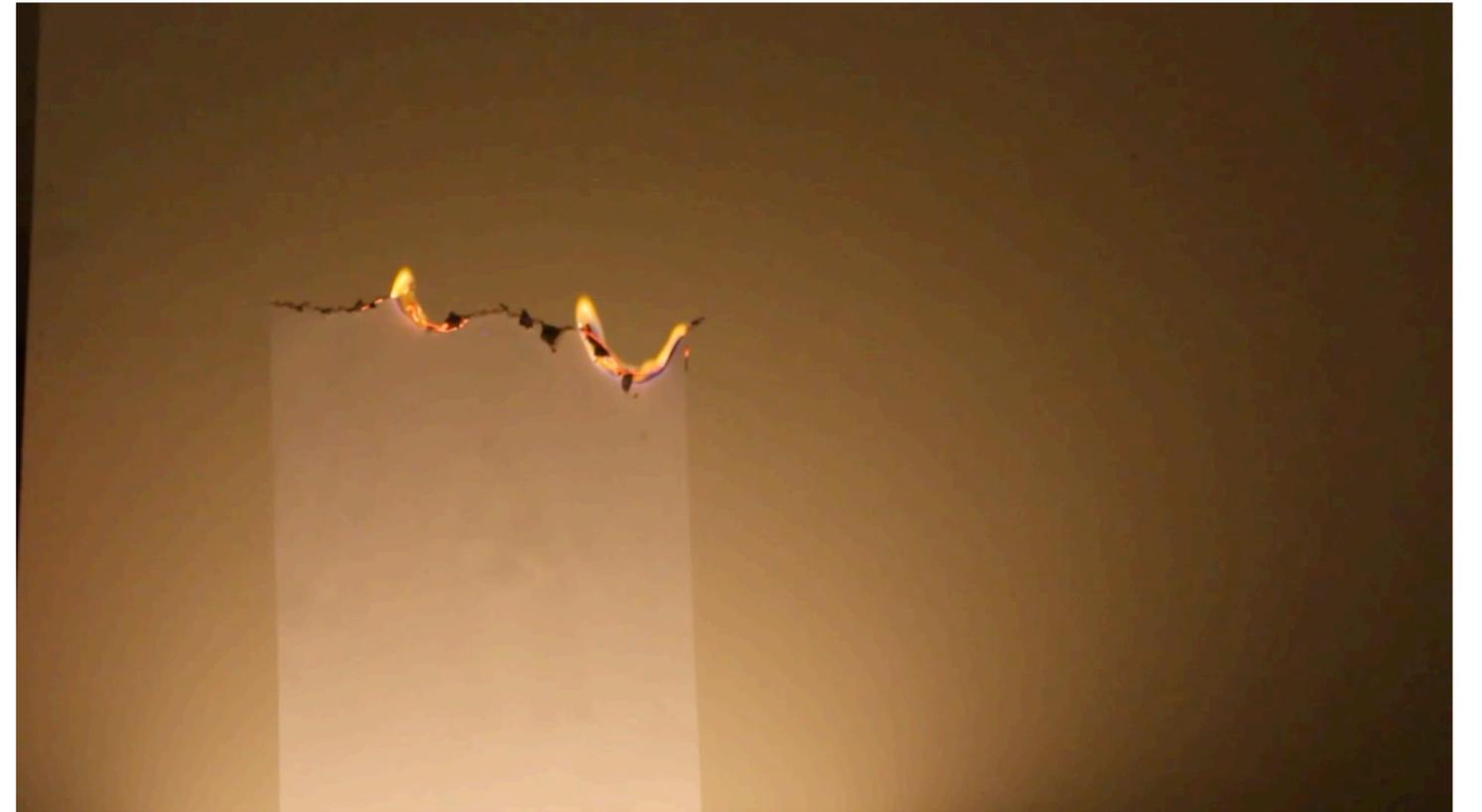
Vizinhos se gostam

Correlação

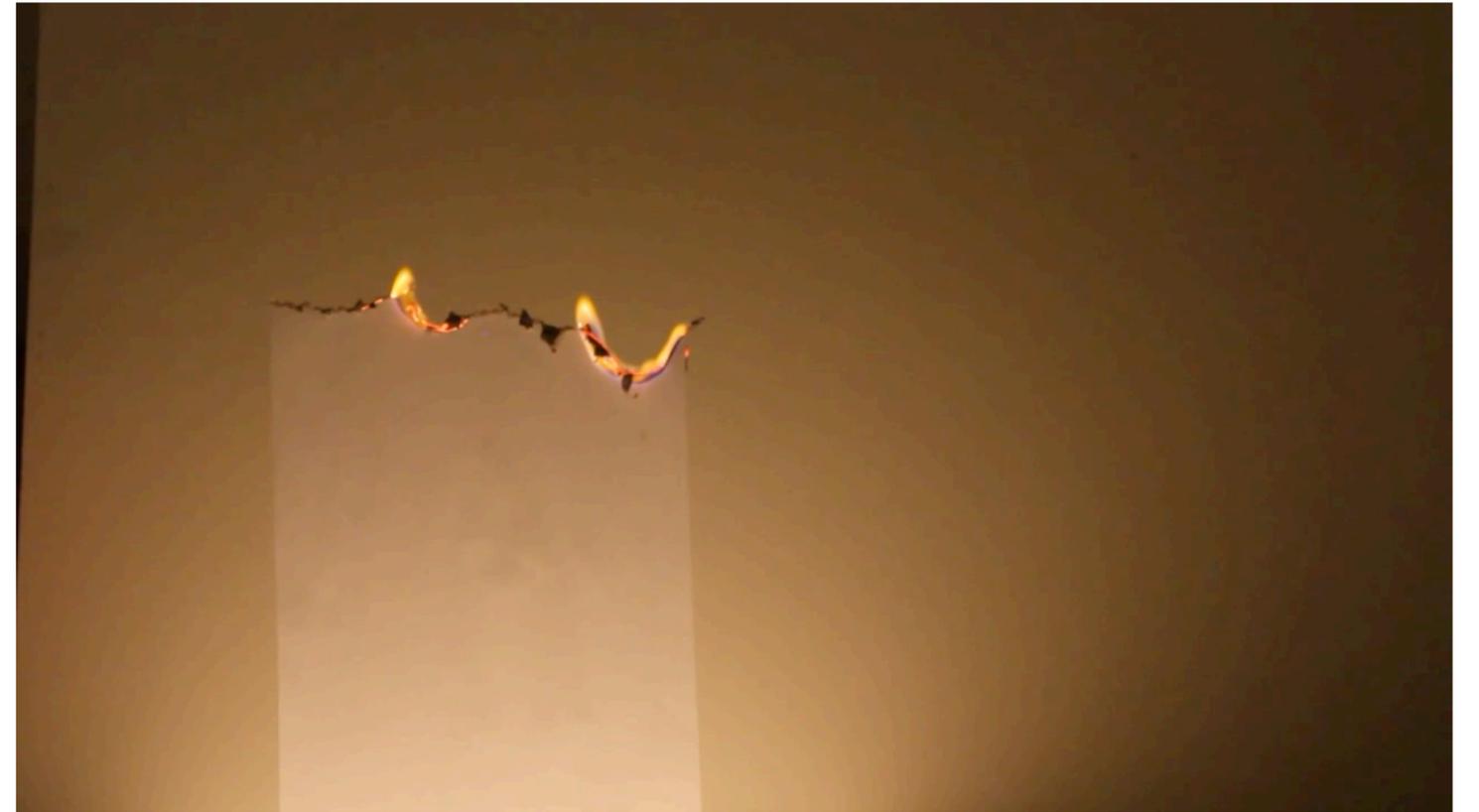
Modelos de crescimento



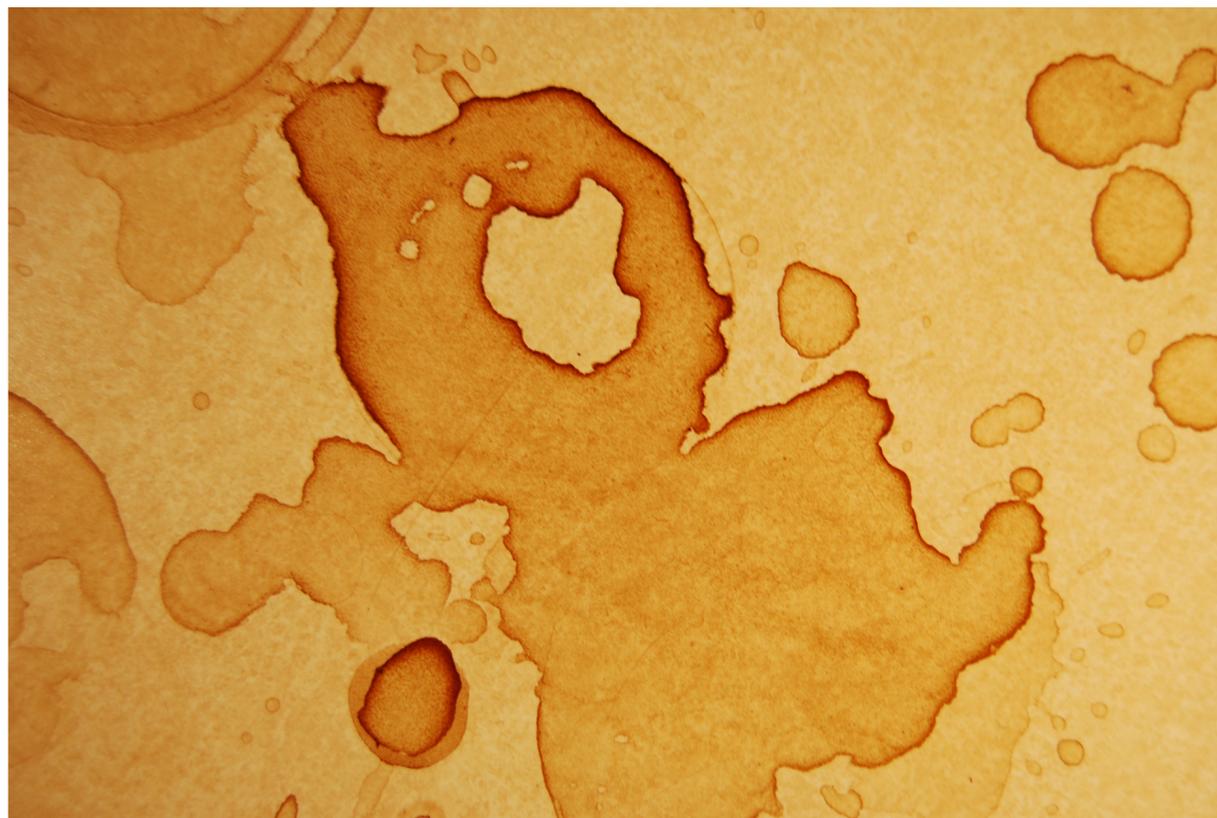
Modelos de crescimento



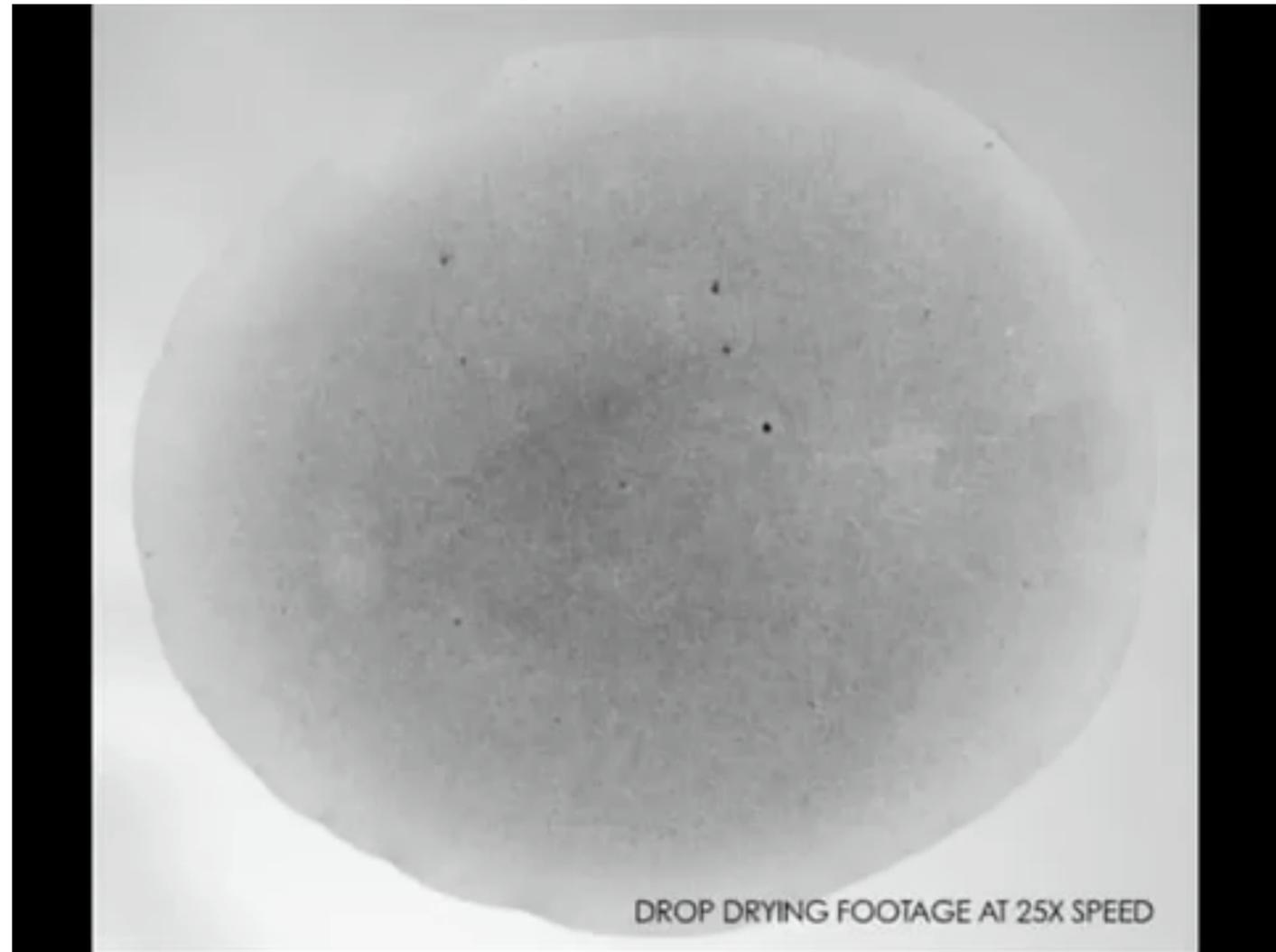
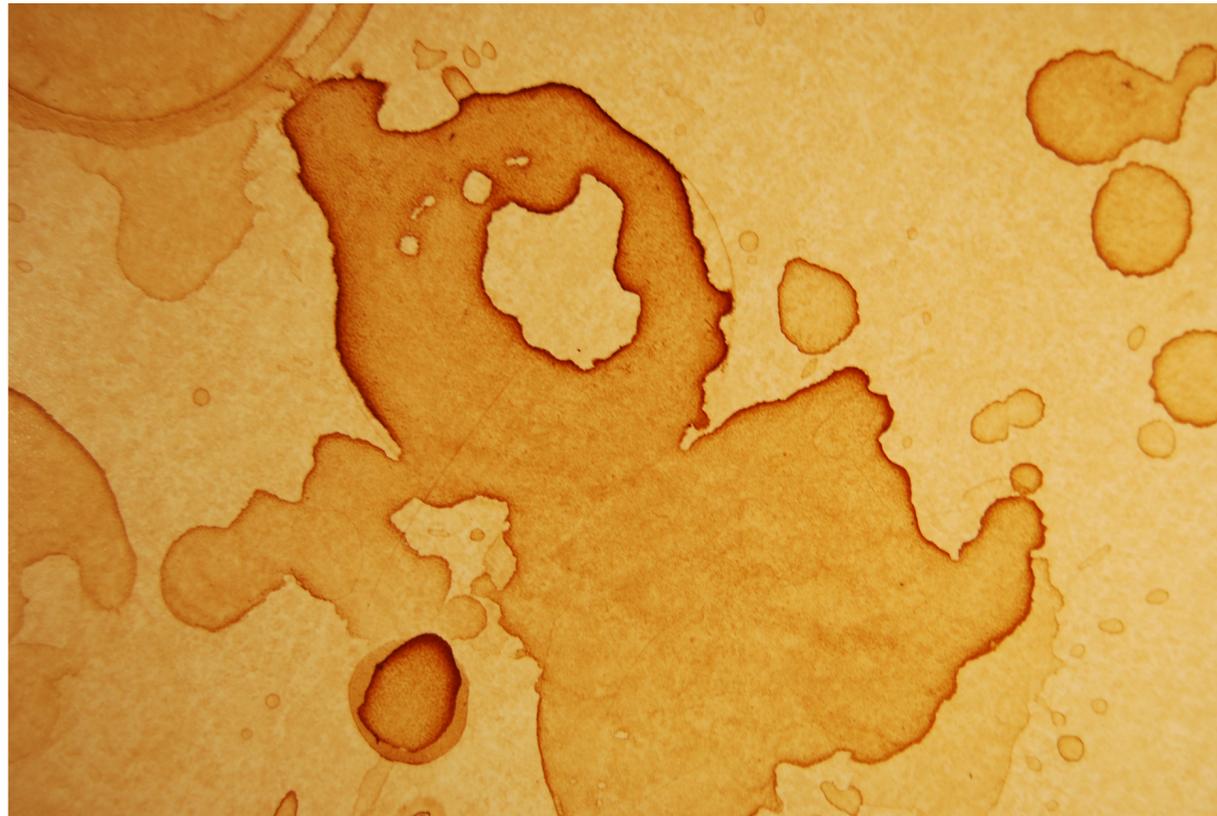
Modelos de crescimento



Vai um cafezinho?



Vai um cafezinho?



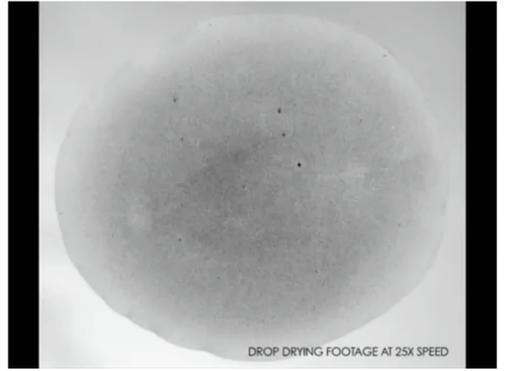
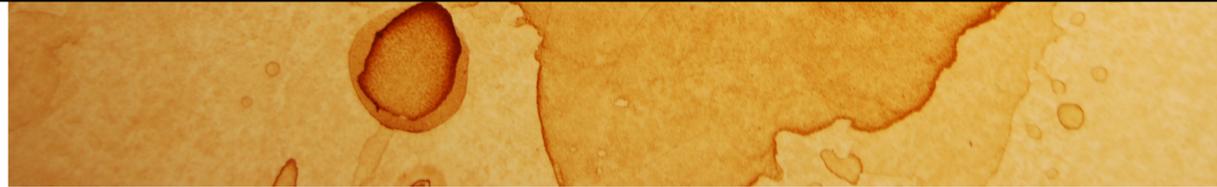
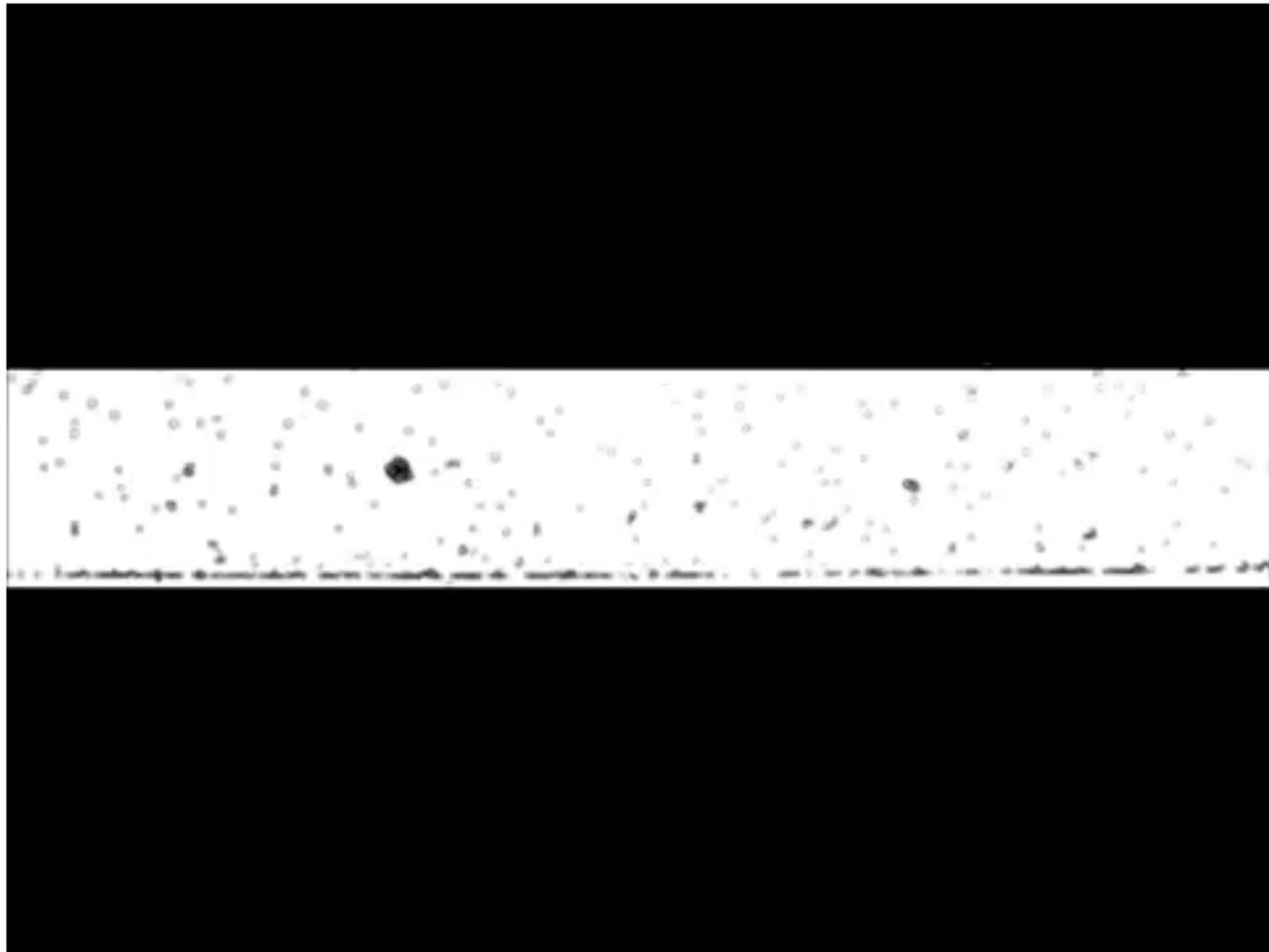
Vídeos extraídos de “The Math Behind Growth of ‘Coffee Rings’”
<https://www.youtube.com/watch?v=8KhEQN-uEZs>

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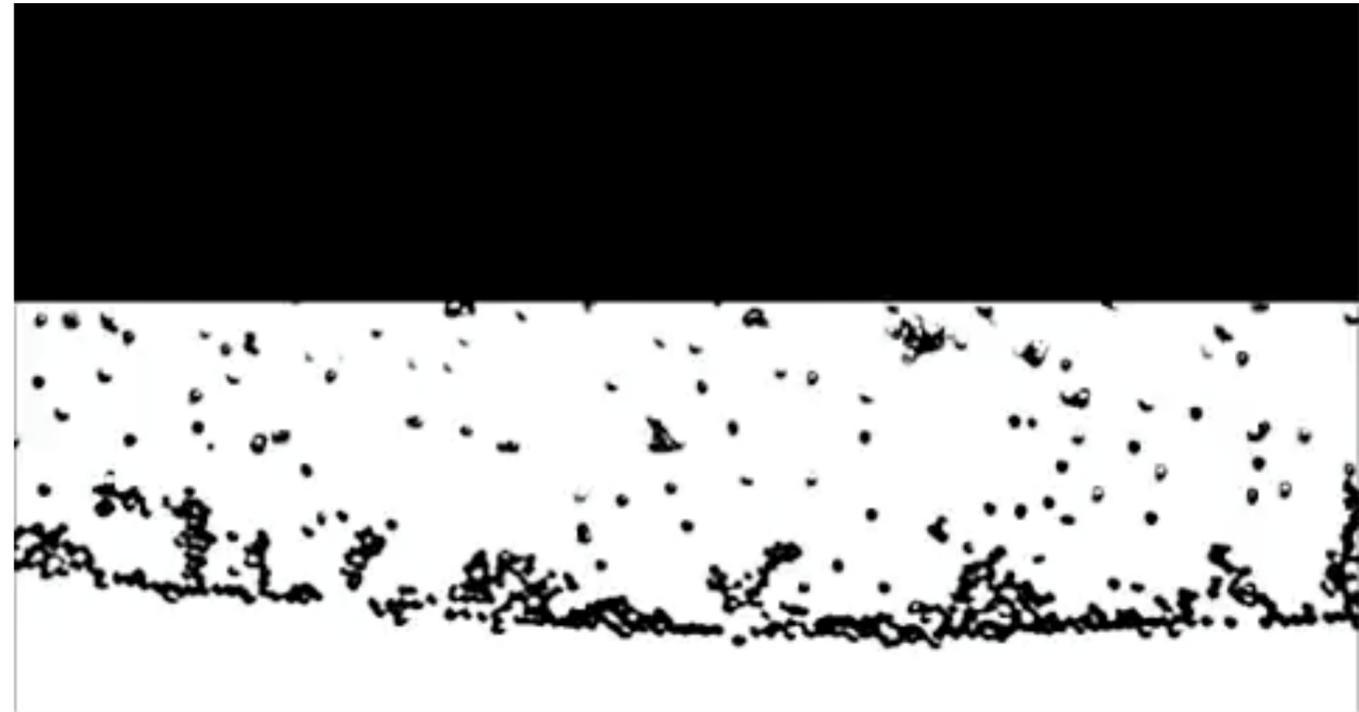
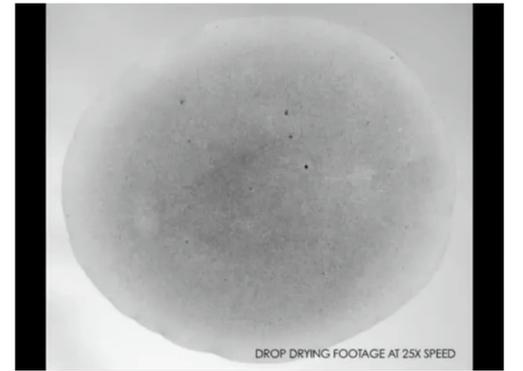
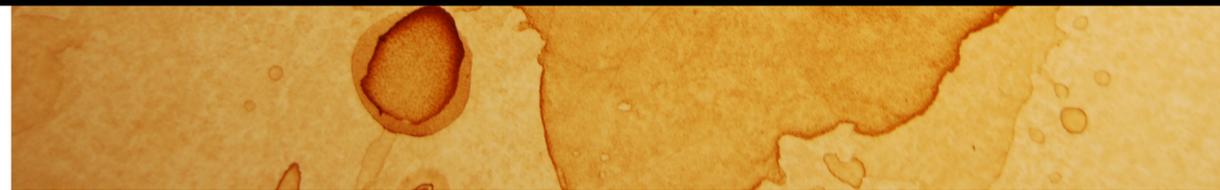
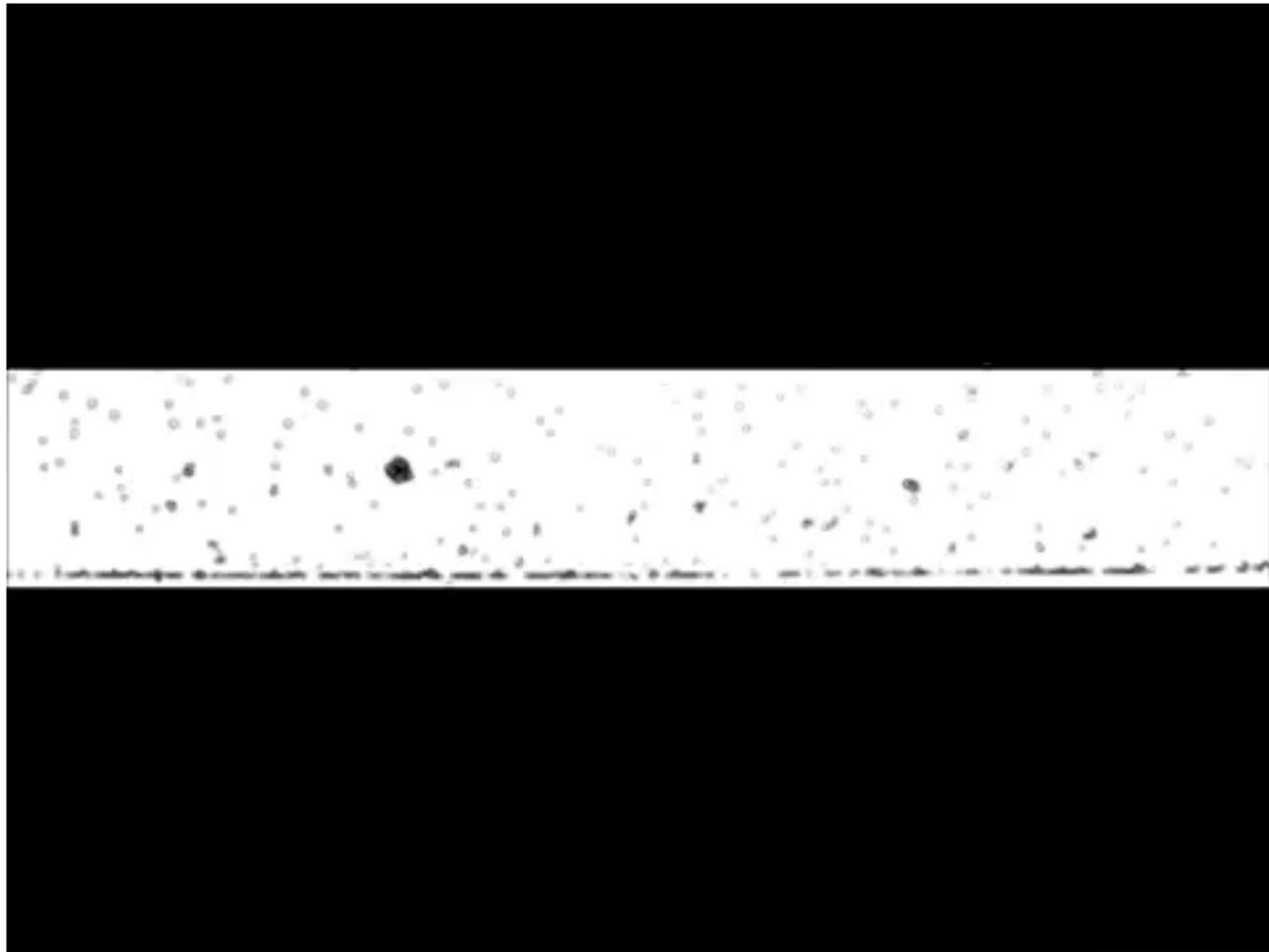
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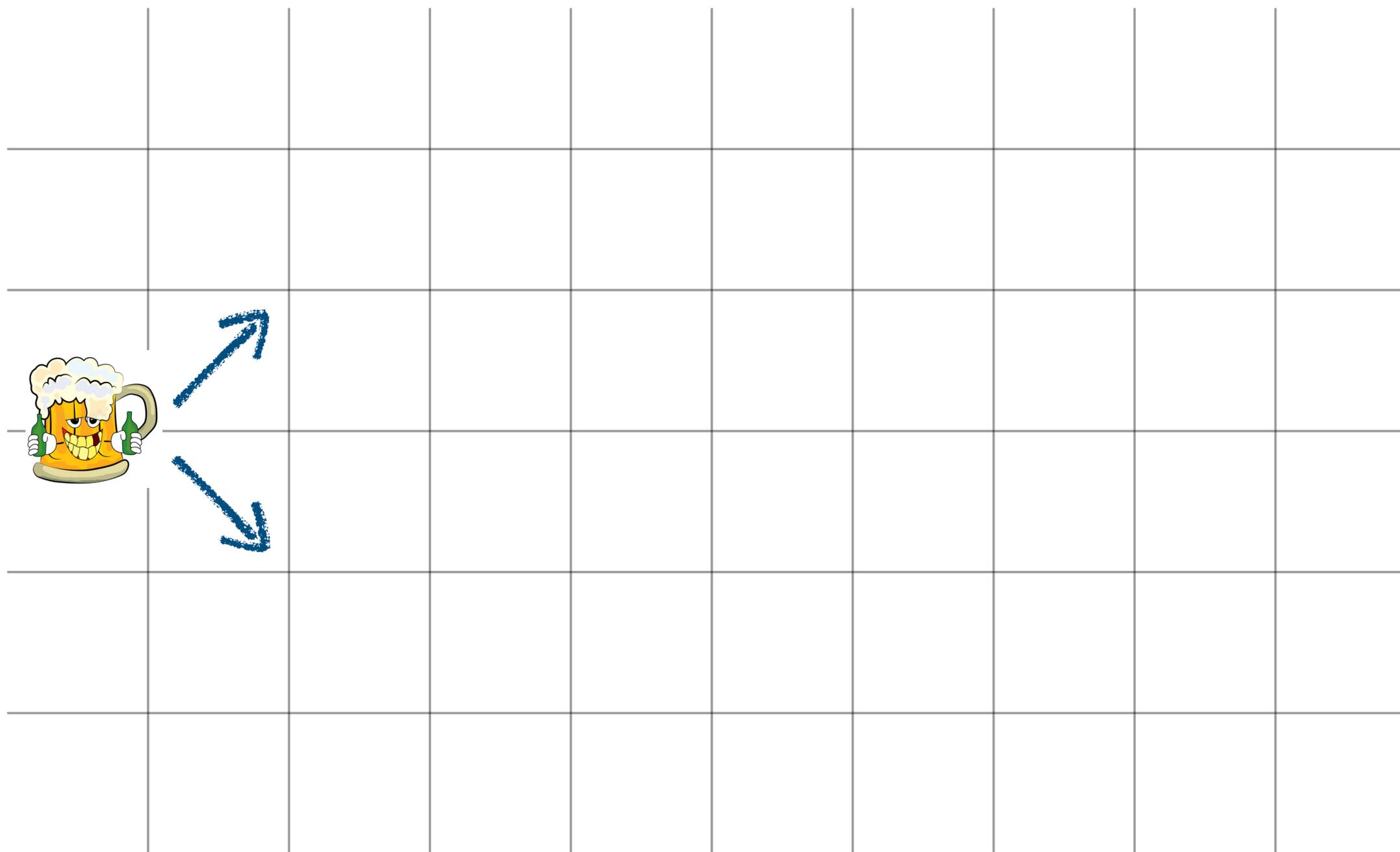
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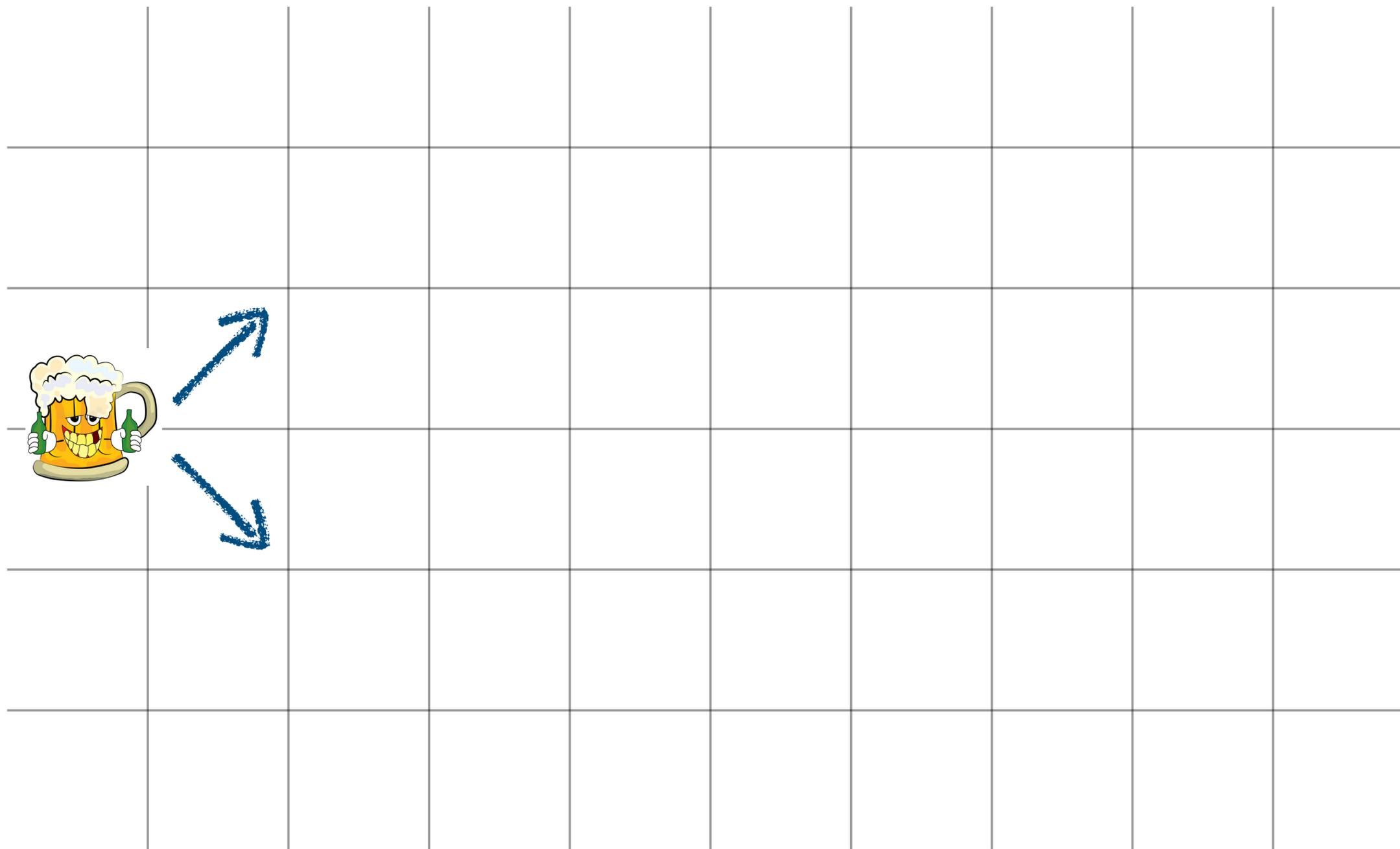
O andar do bêbado



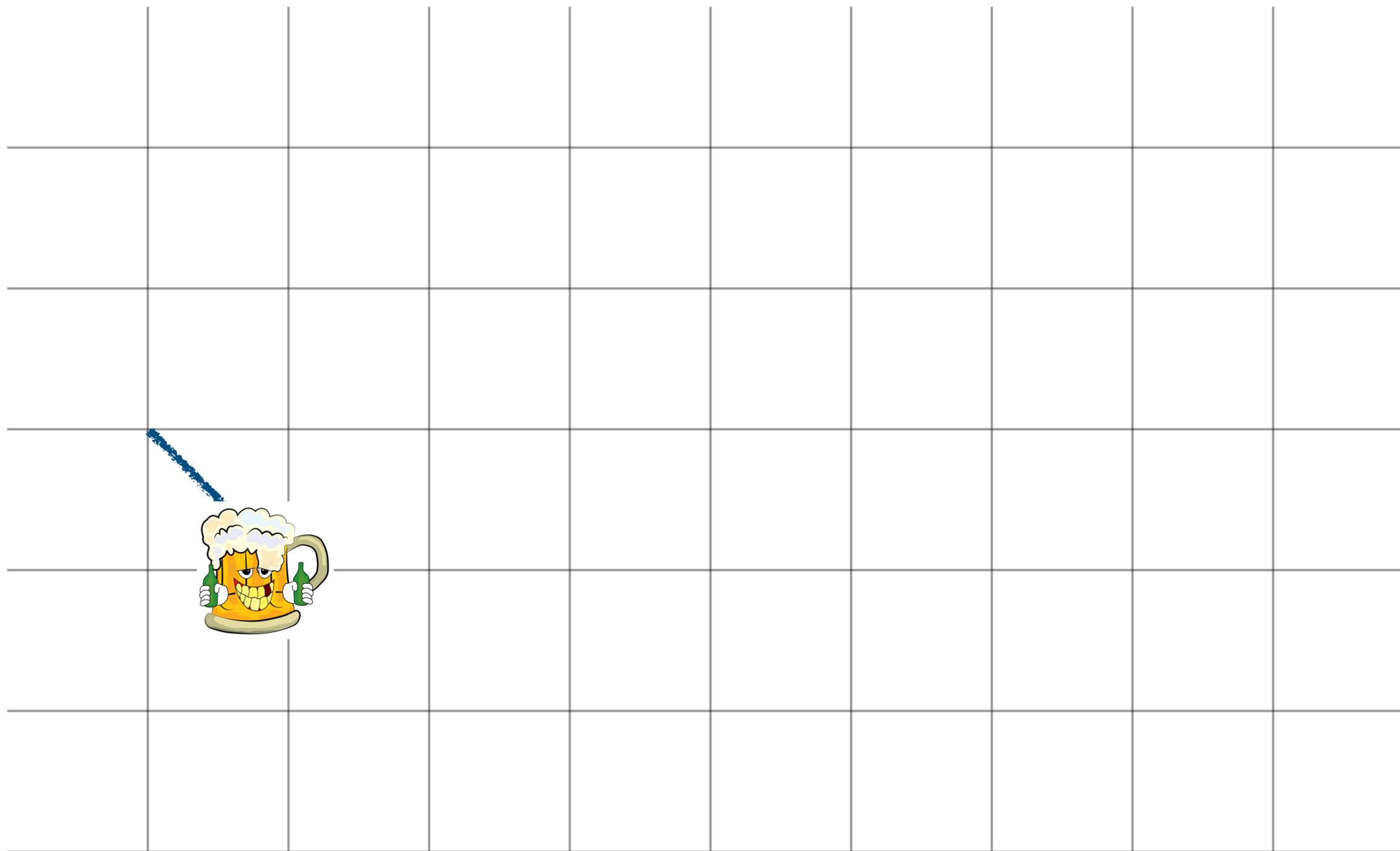
O andar do bêbado



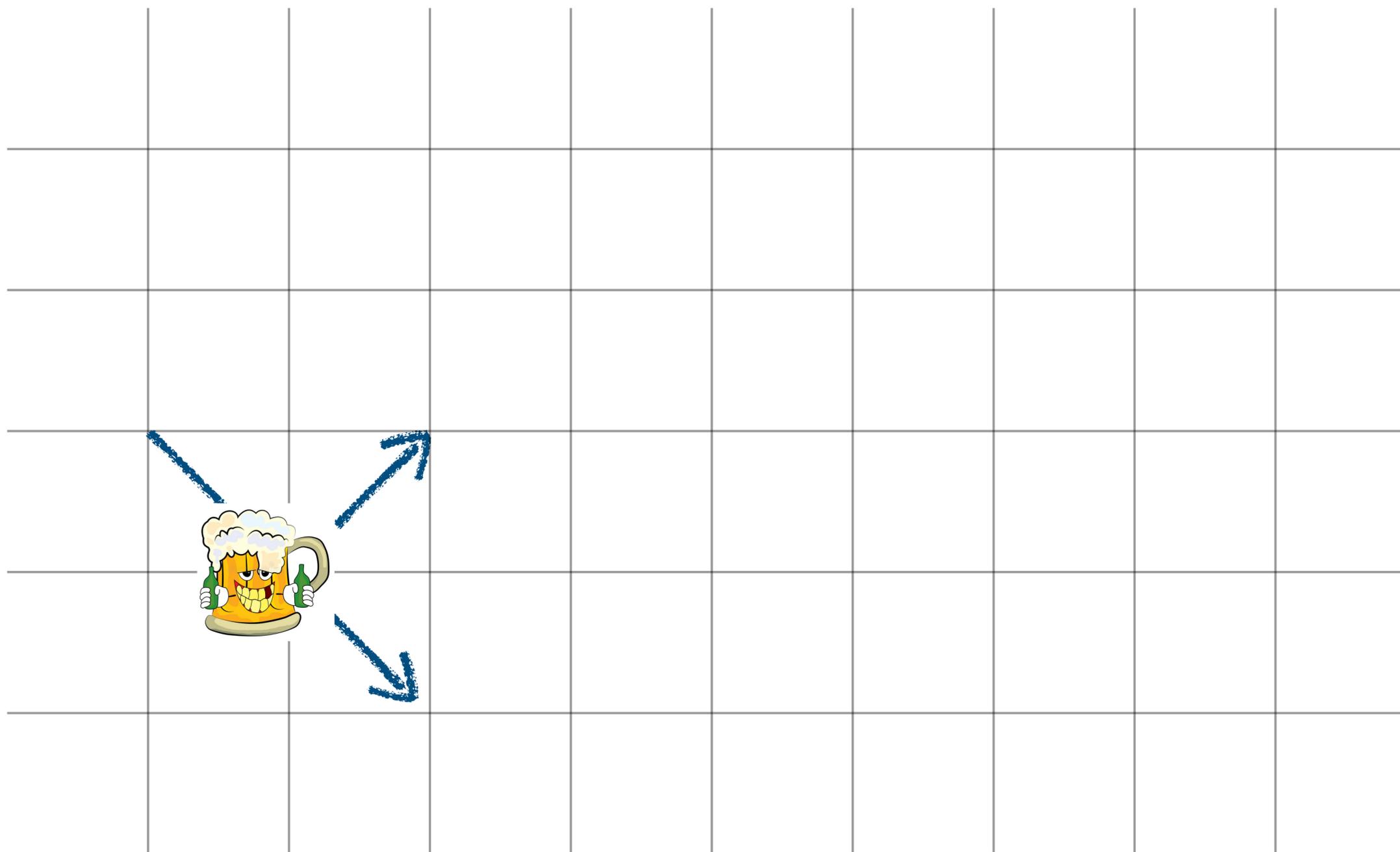
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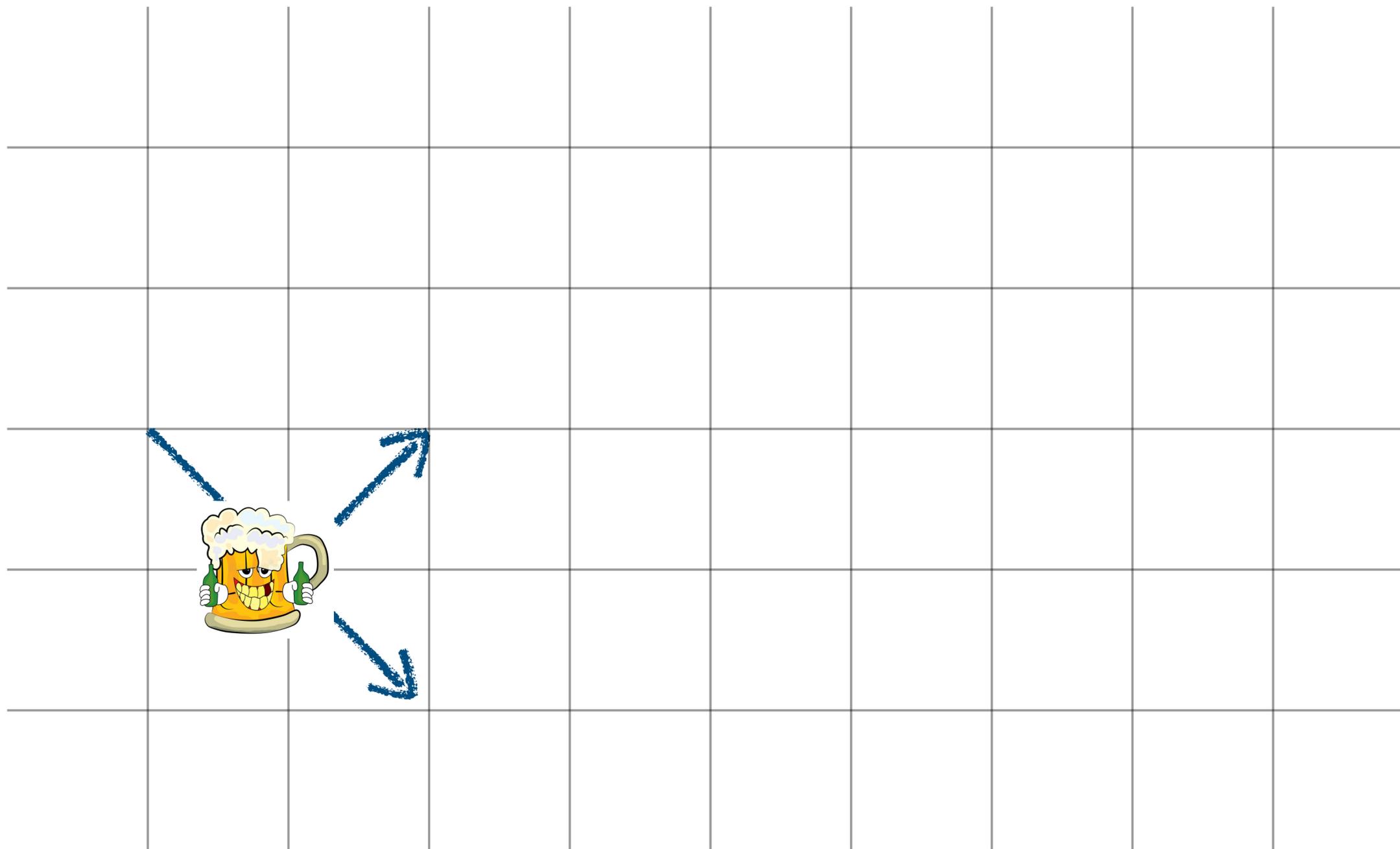
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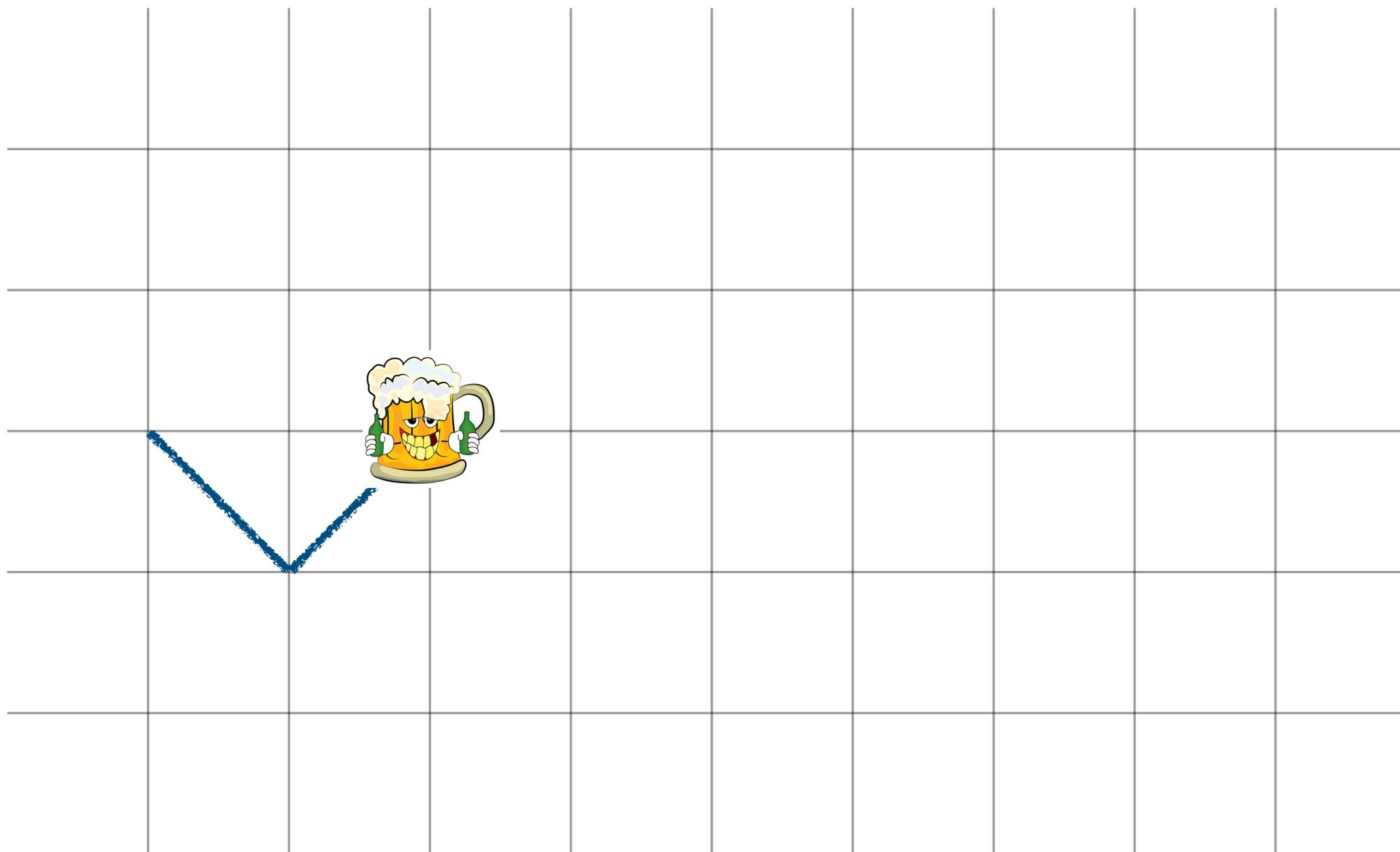
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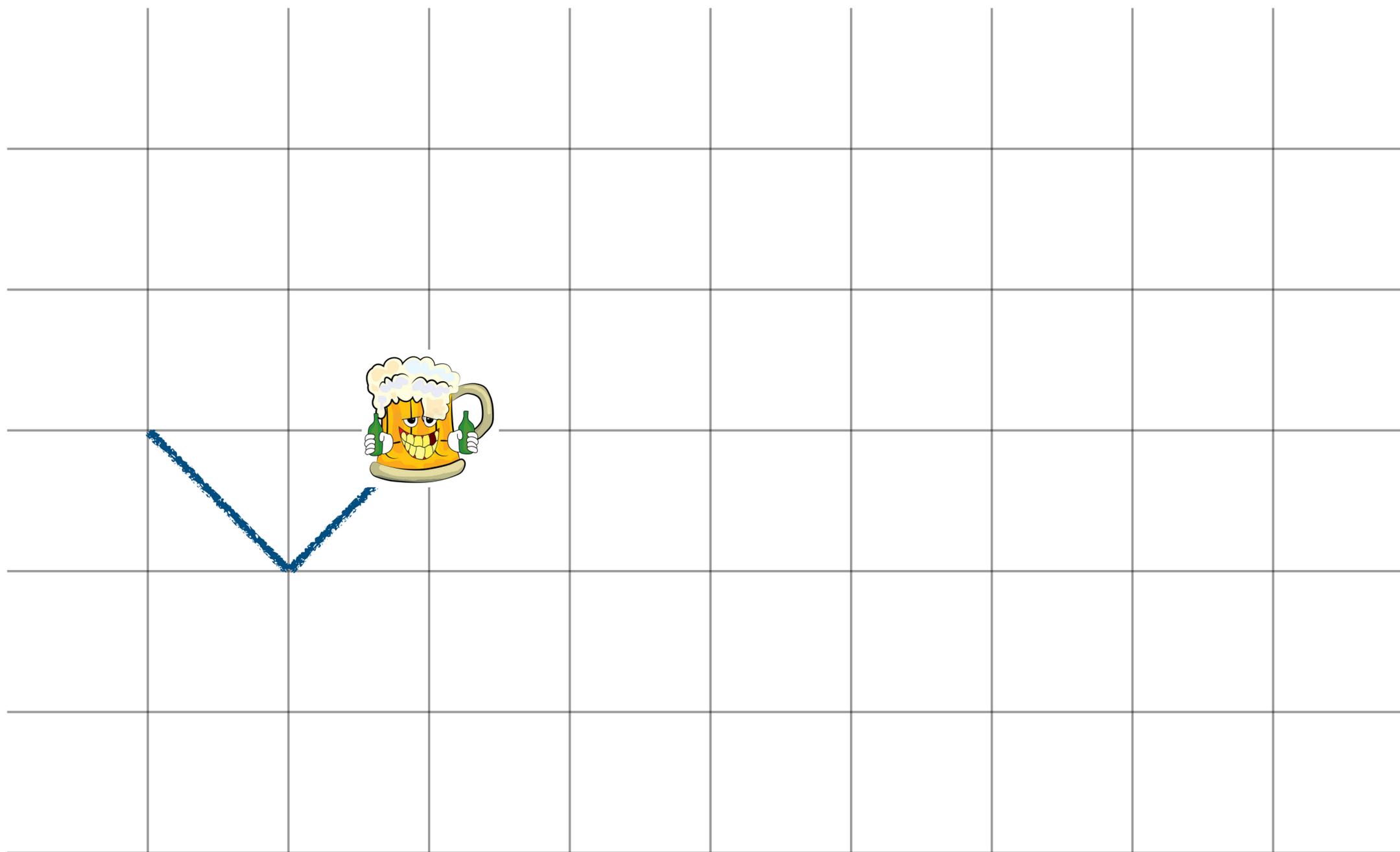
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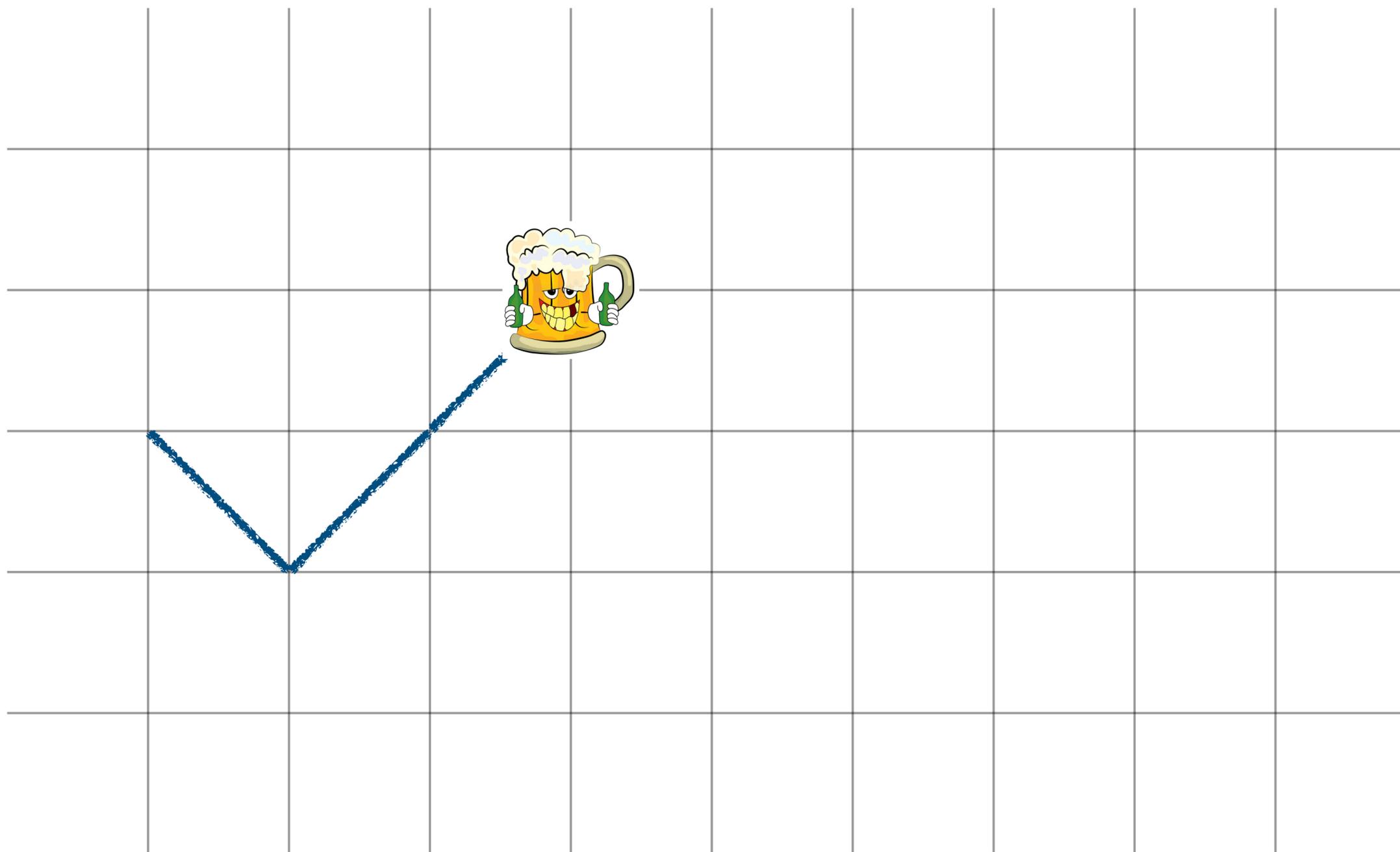
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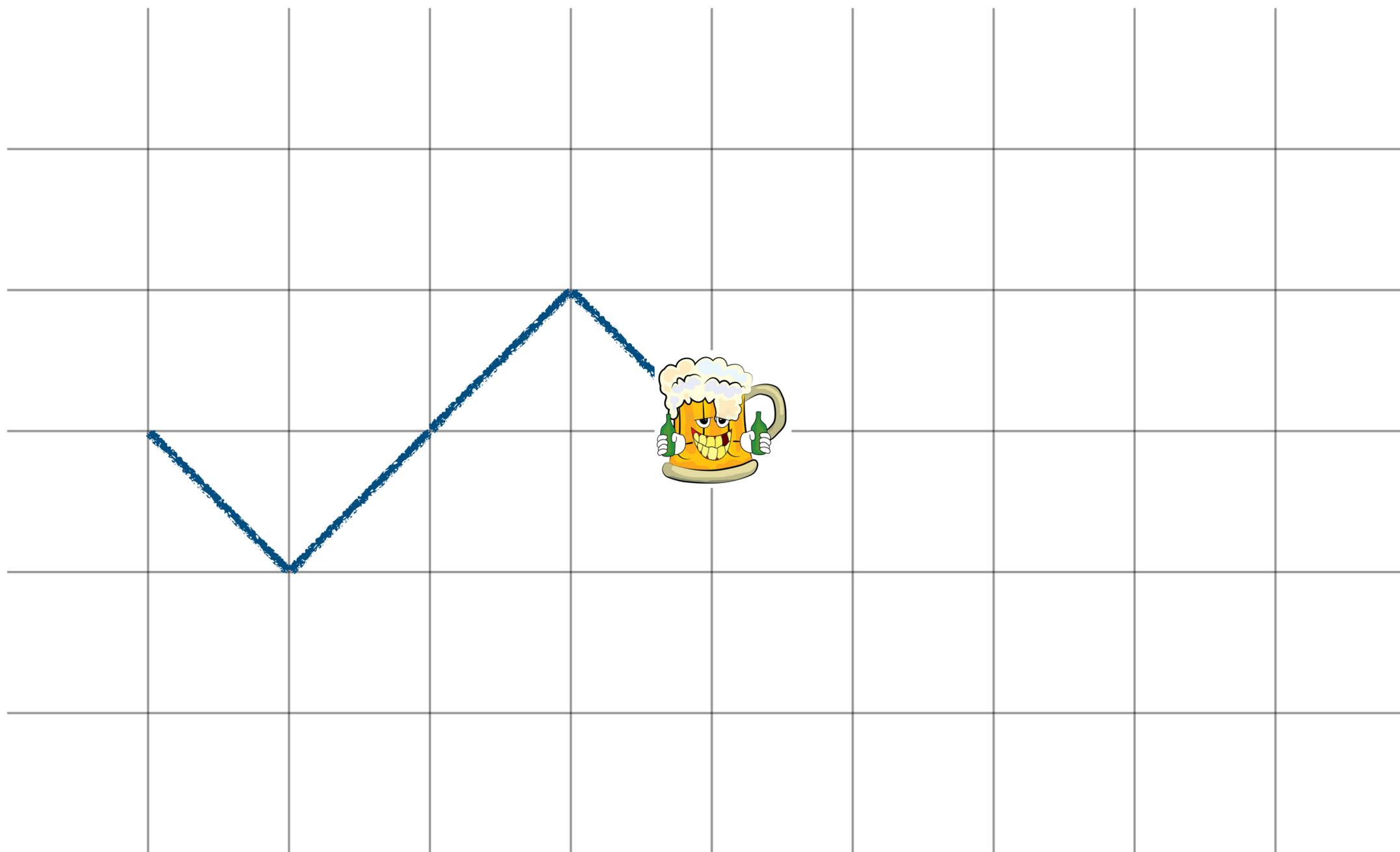
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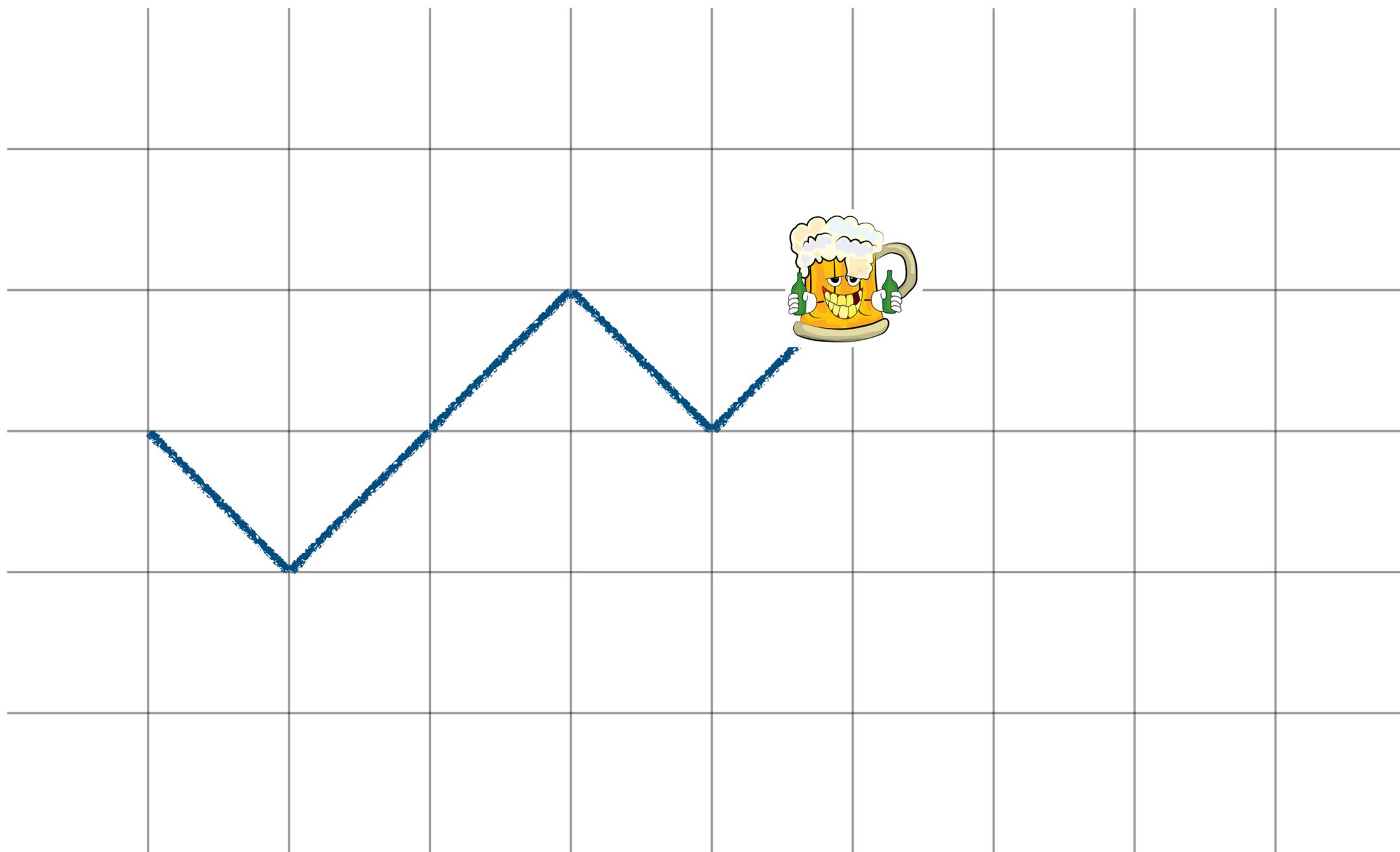
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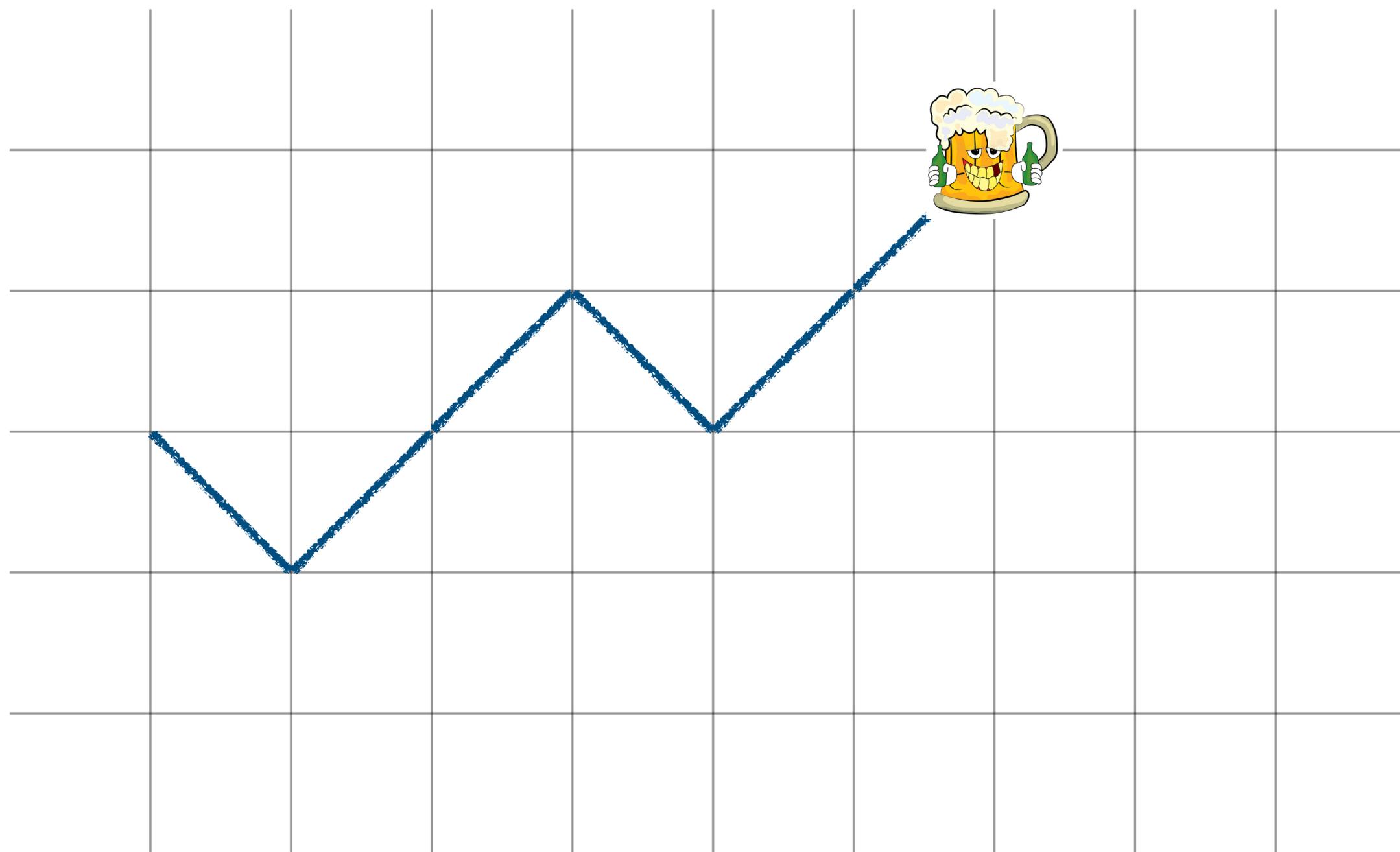
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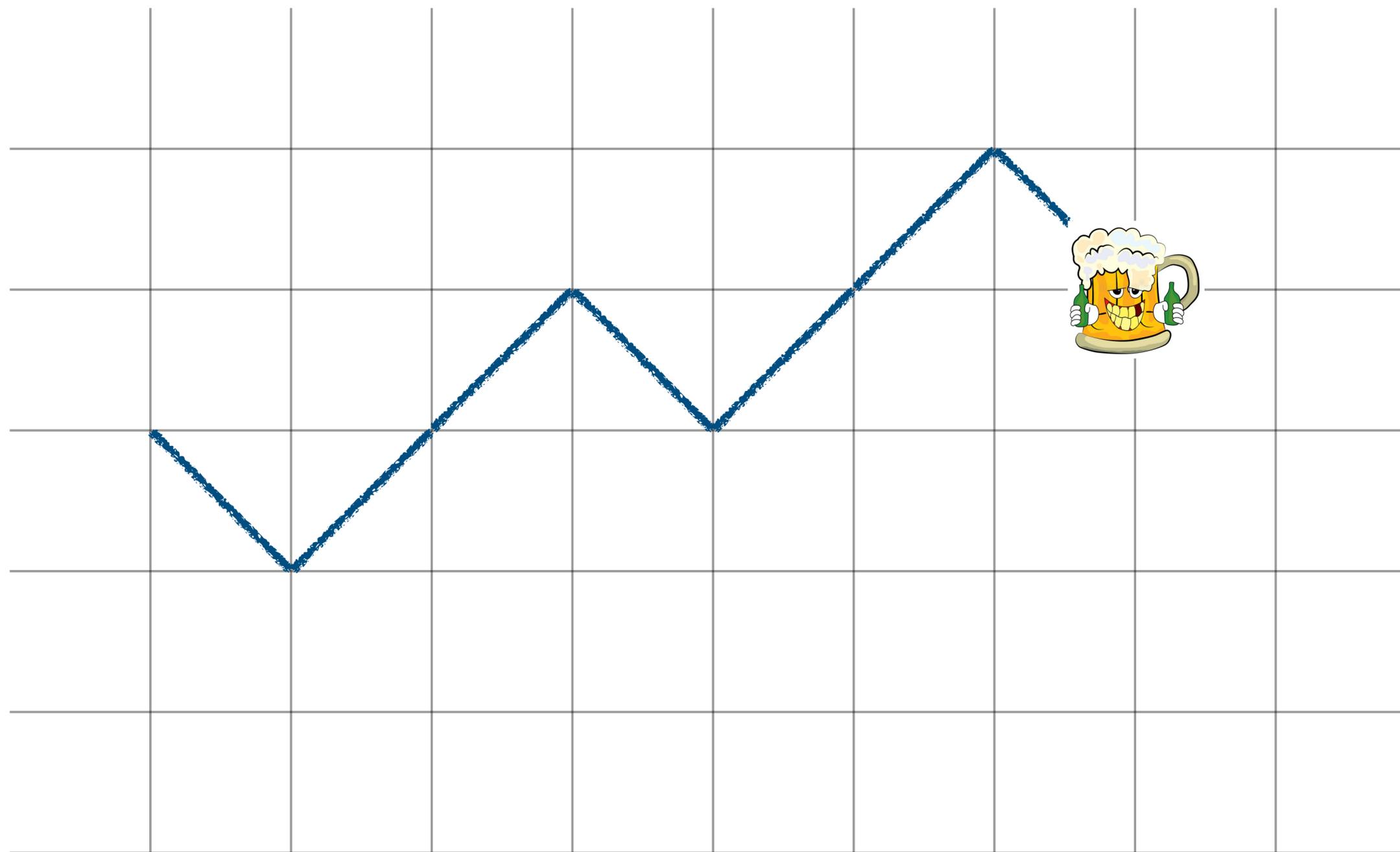
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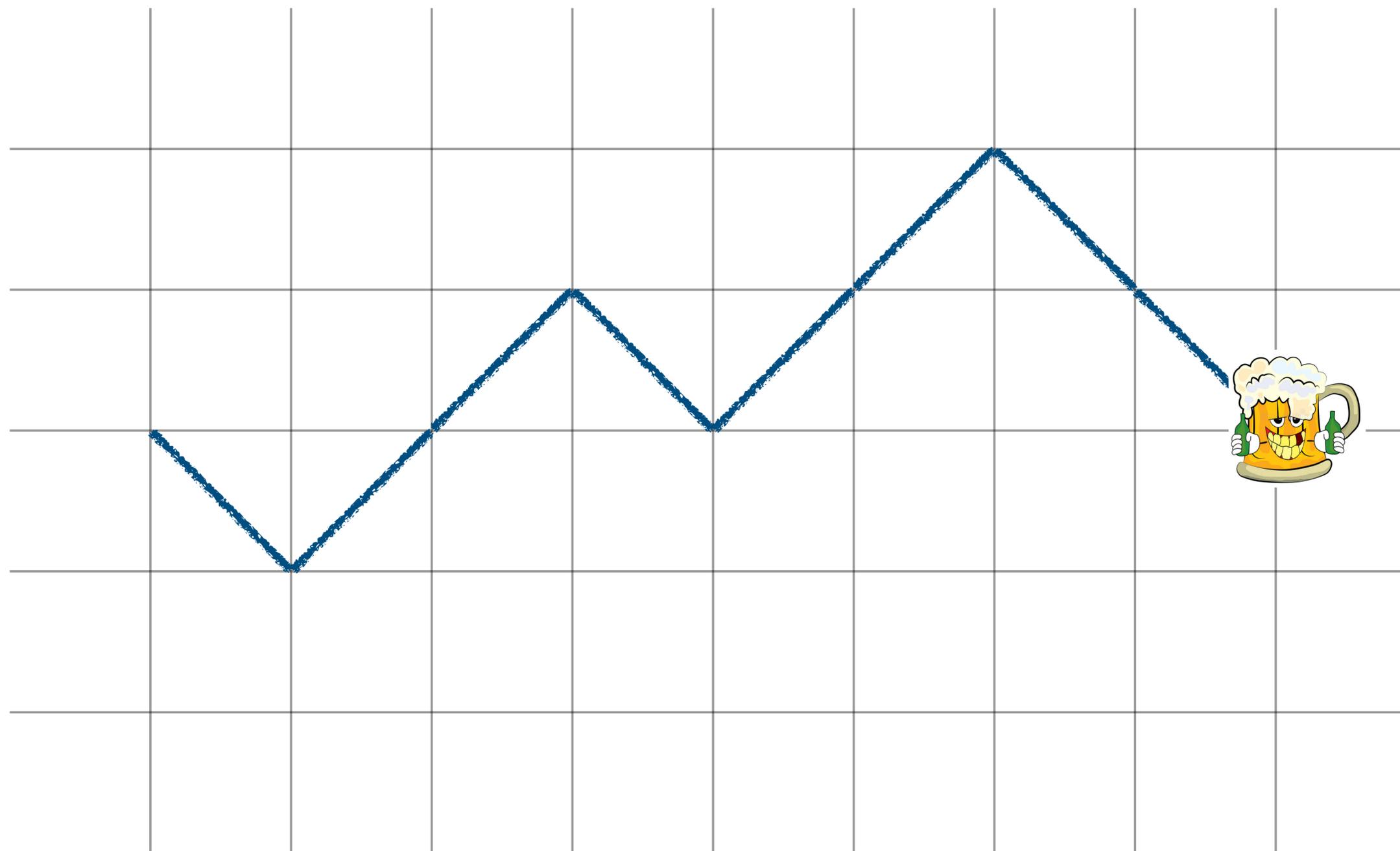
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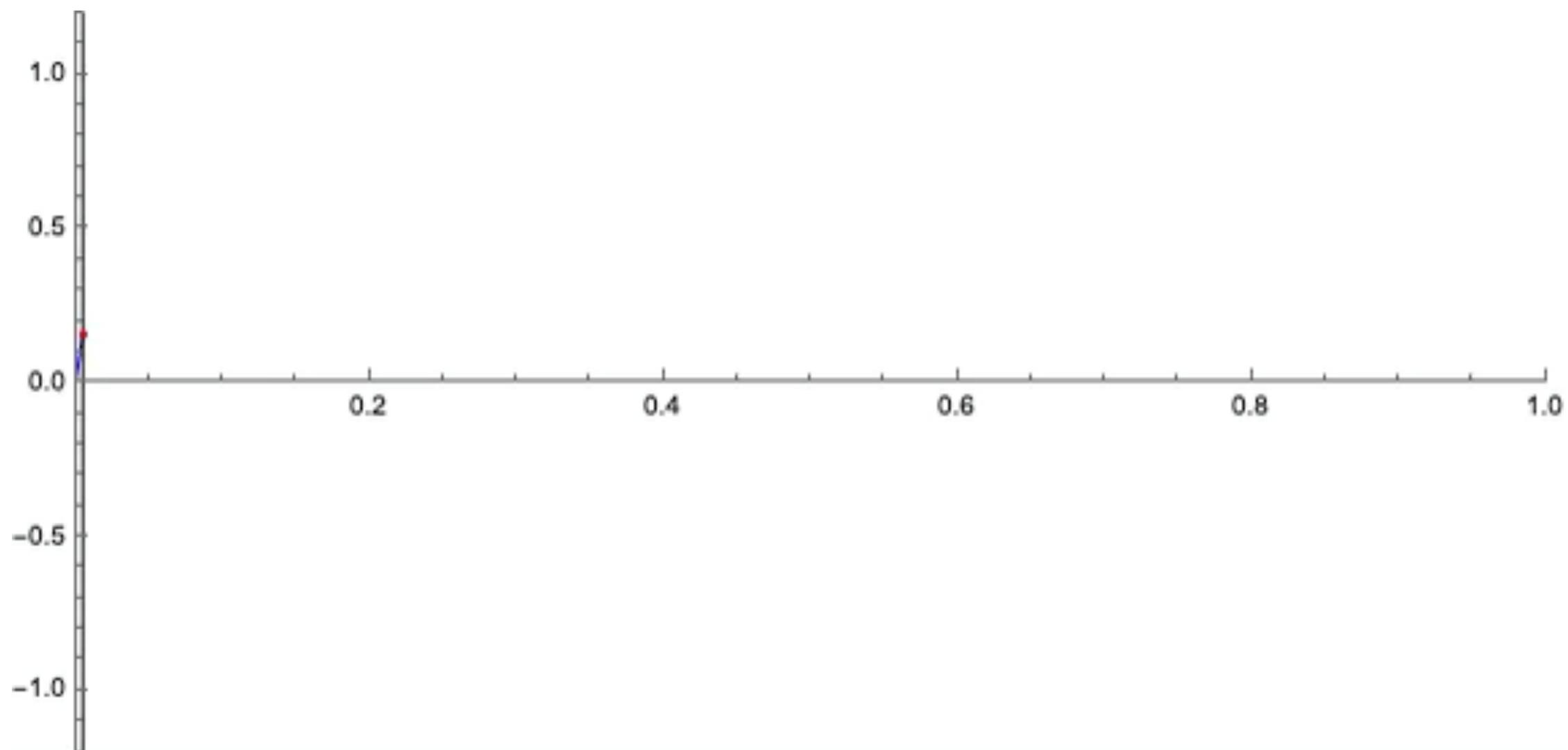
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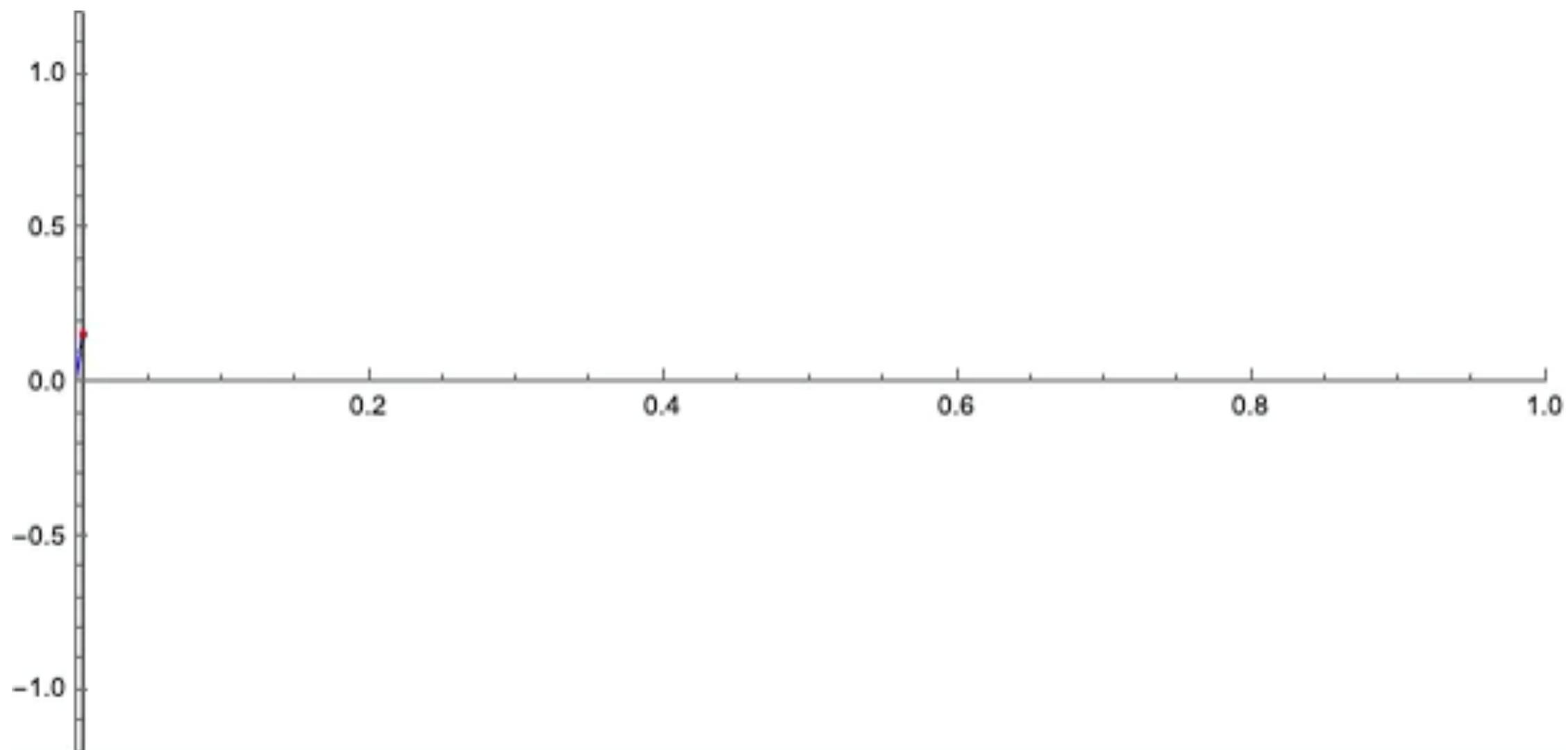
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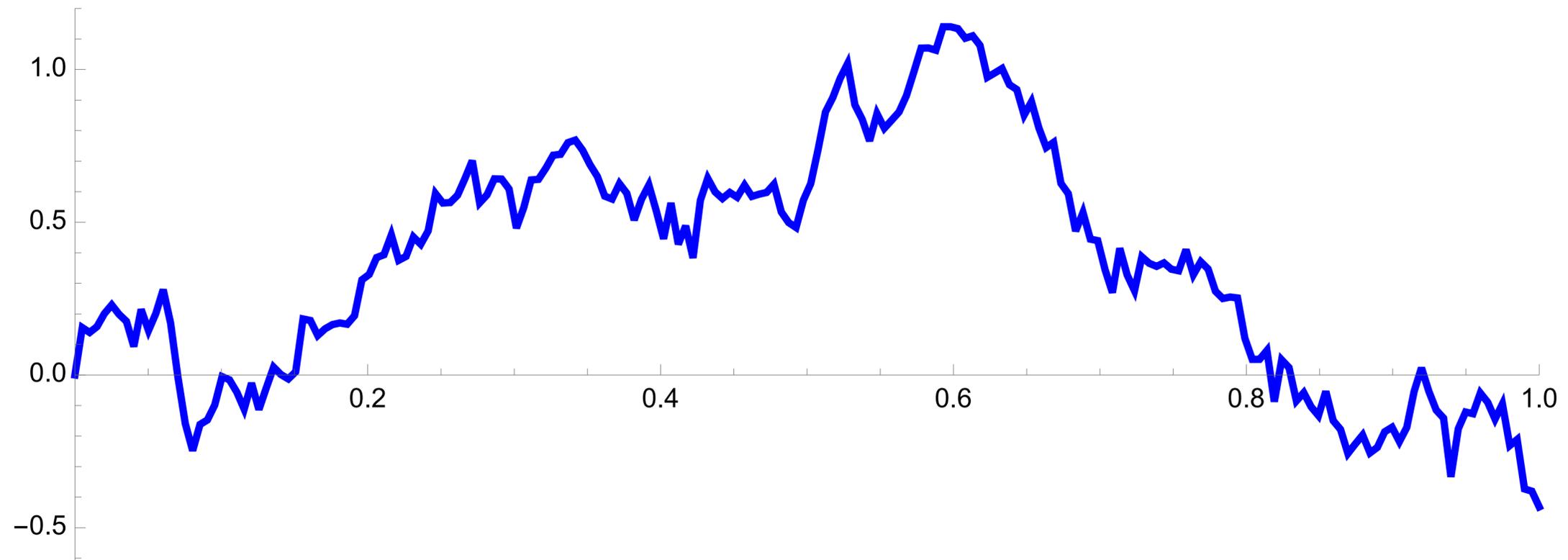
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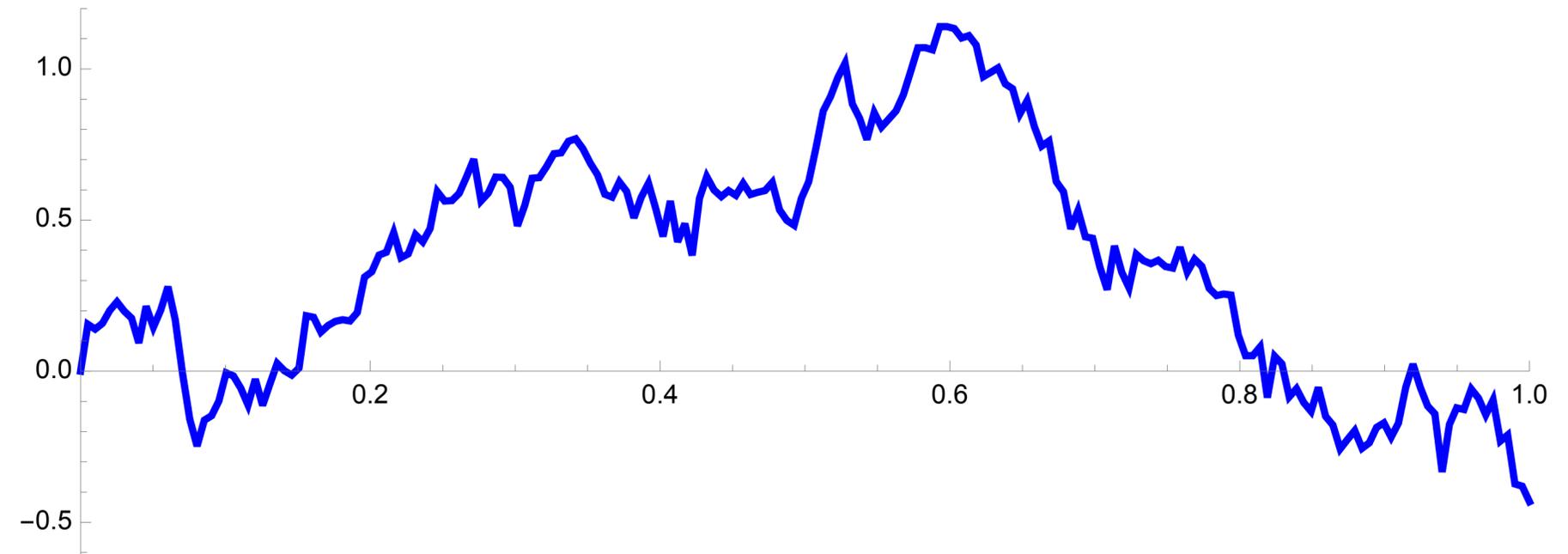
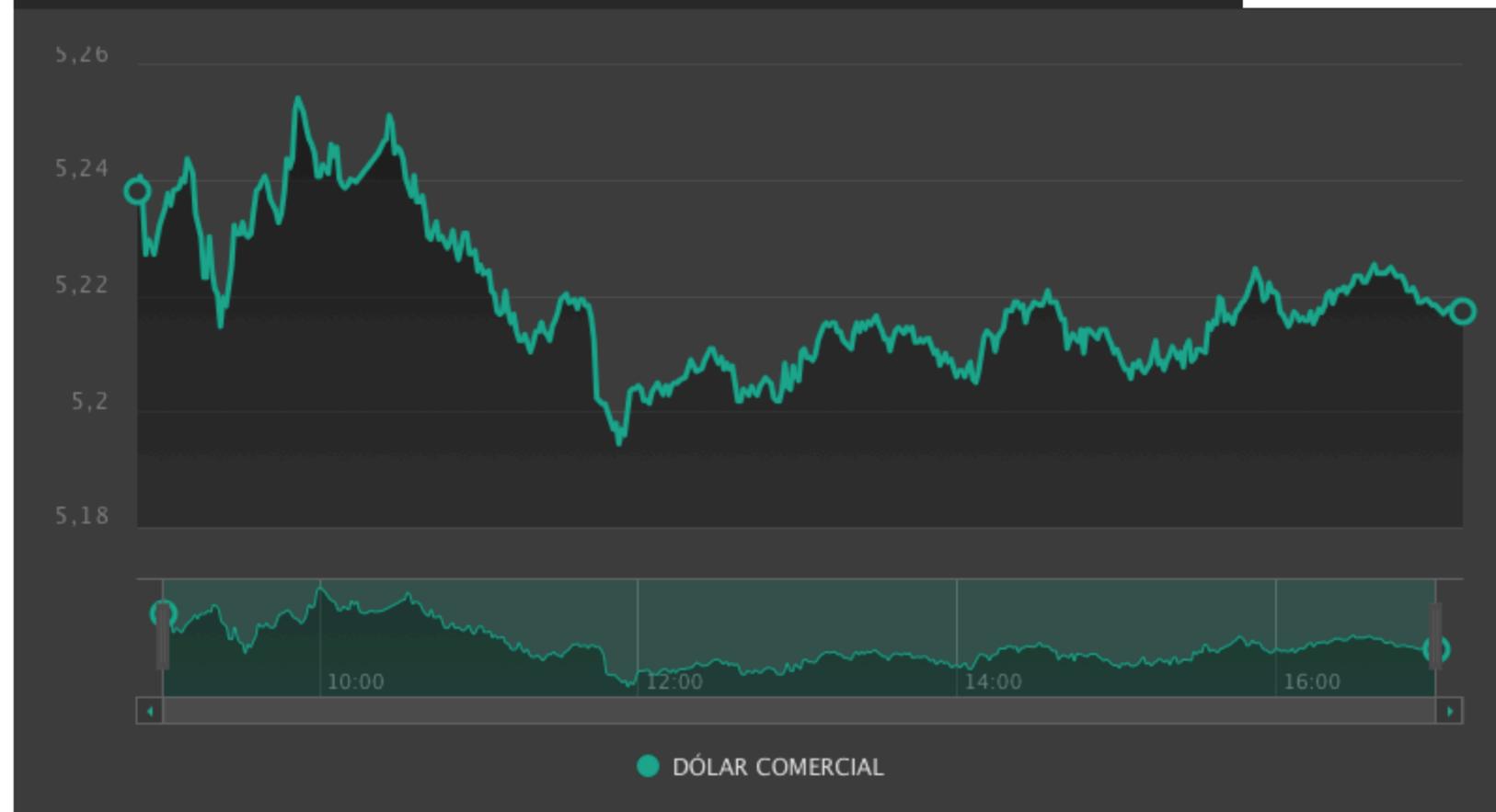
O andar do bêbado



O andar do bêbado



O andar do bêbado



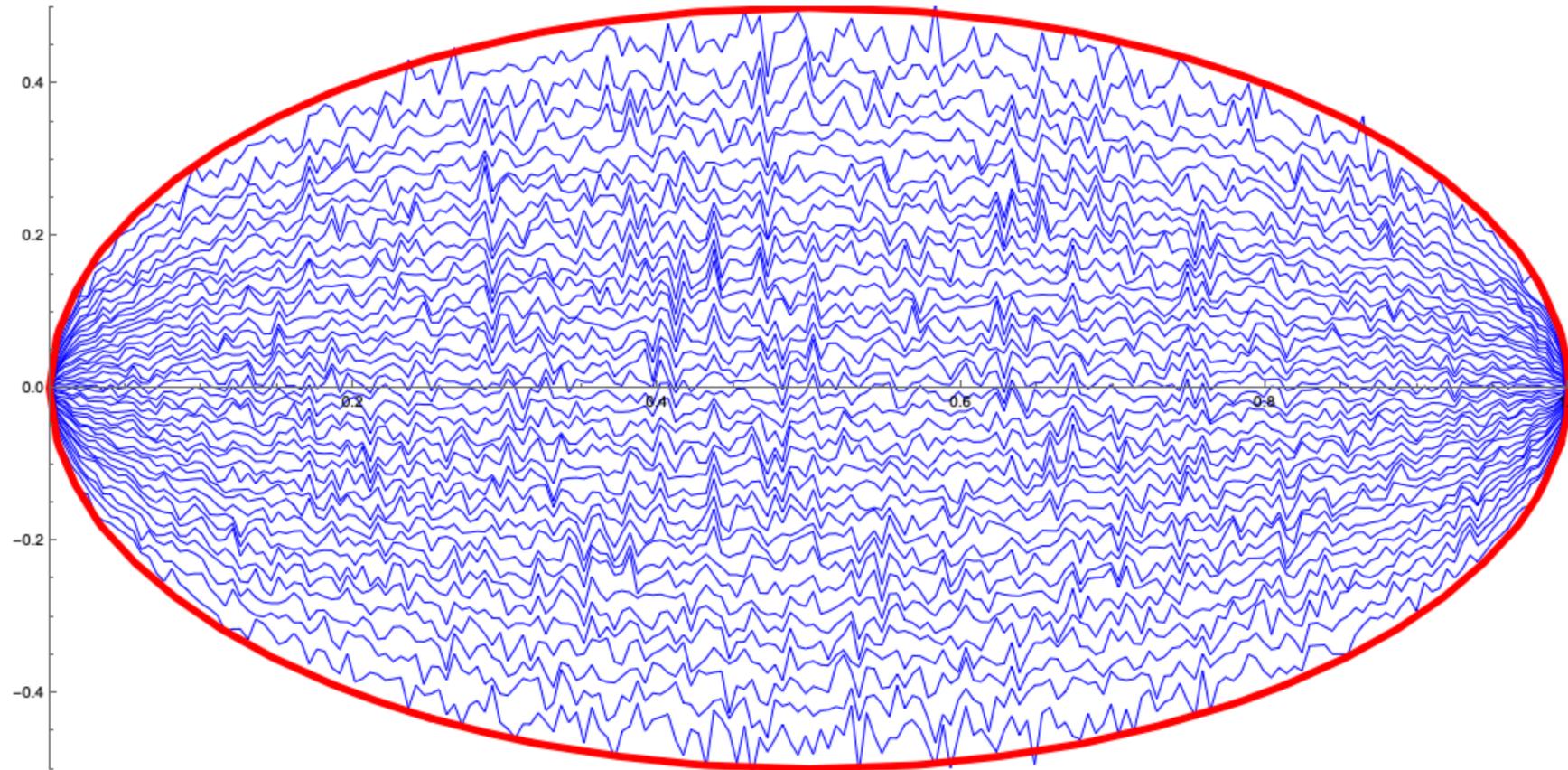
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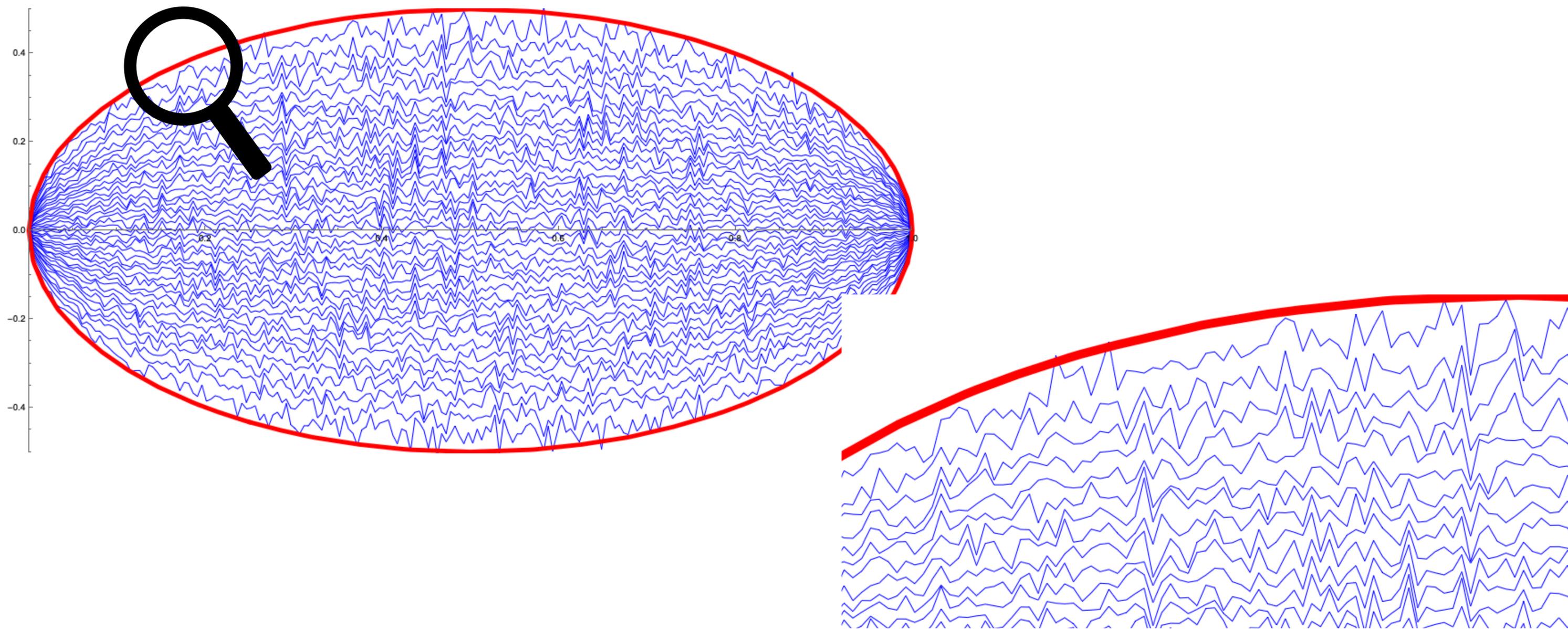
O andar de vários bêbados



O andar de vários bêbados



O andar de vários bêbados



Tá, mas pra que serve?

Tá, mas pra que serve?

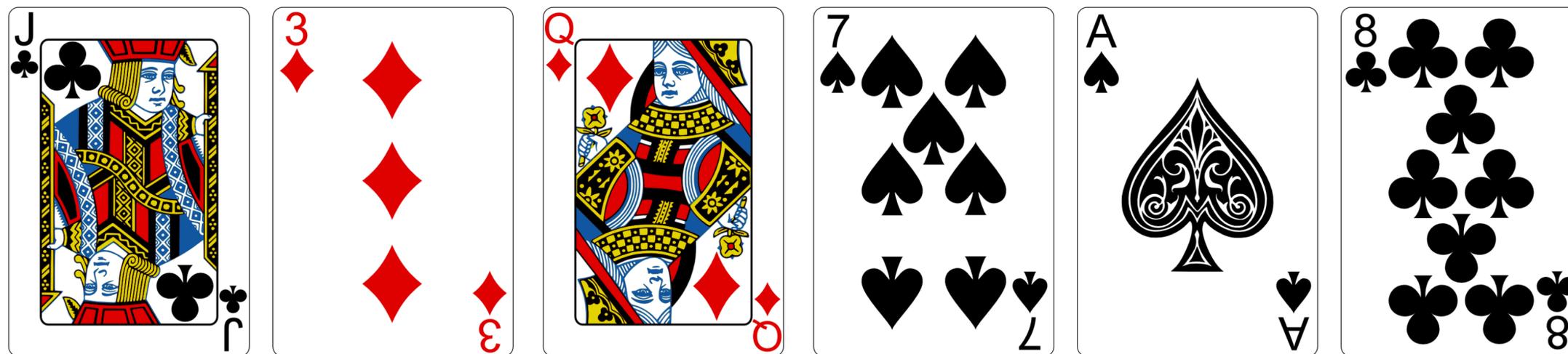
Escolha seu laboratório!

Escolha seu laboratório!

Vamos embaralhar?

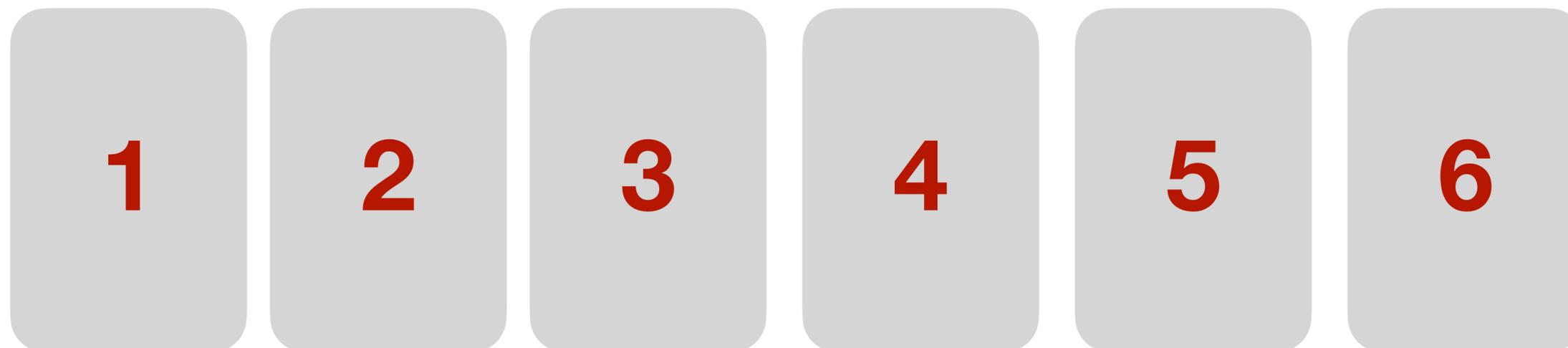
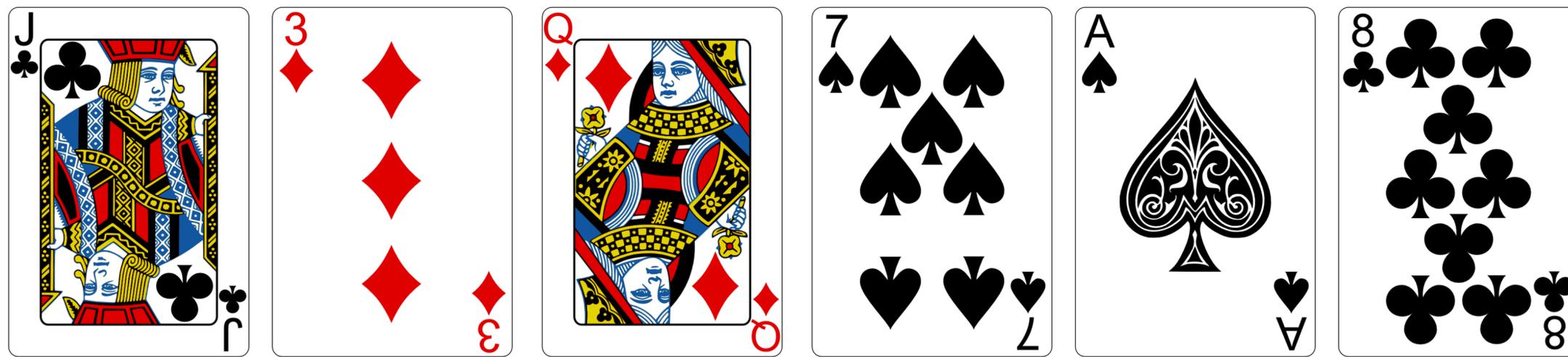
Escolha seu laboratório!

Vamos embaralhar?



Escolha seu laboratório!

Vamos embaralhar?



Escolha seu laboratório!

Vamos embaralhar?

1

2

3

4

5

6

Vamos embaralhar?

3

1

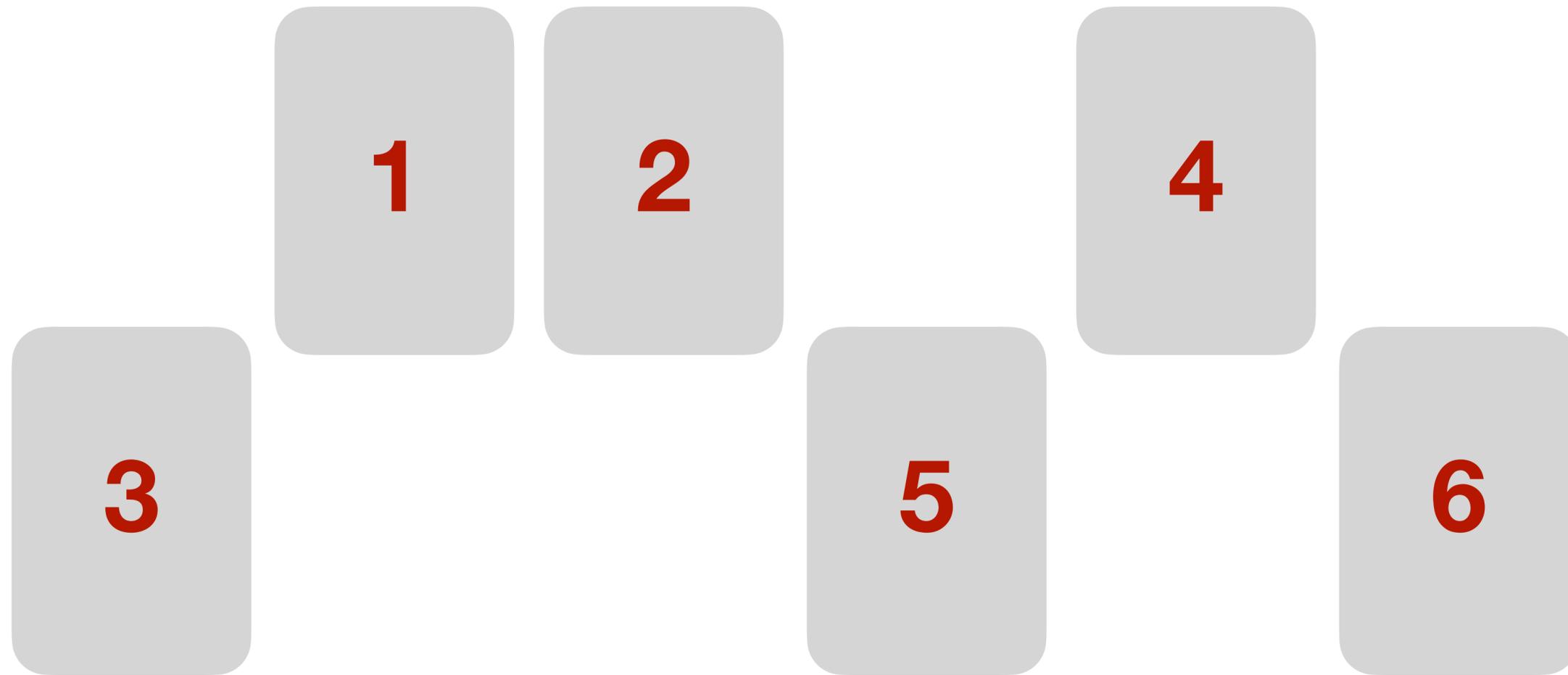
2

5

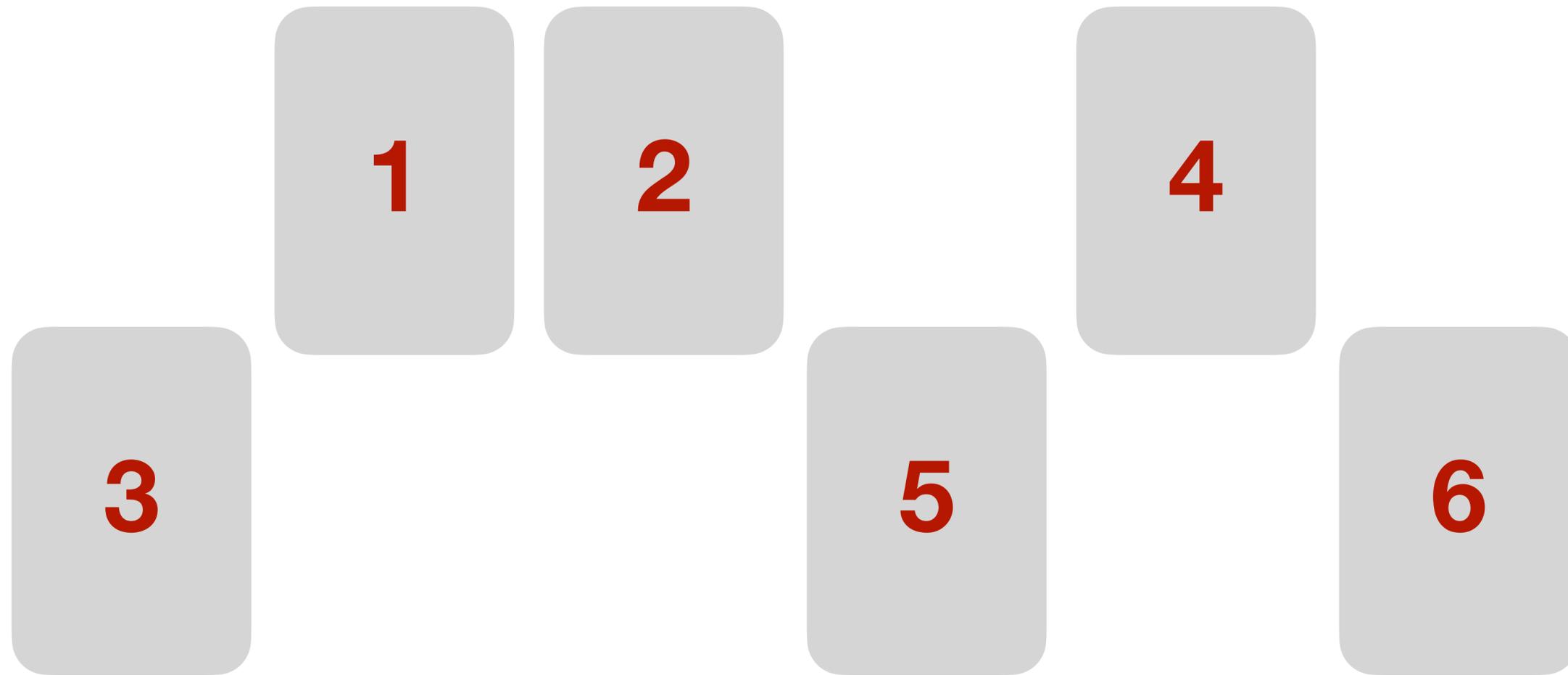
4

6

Vamos embaralhar?

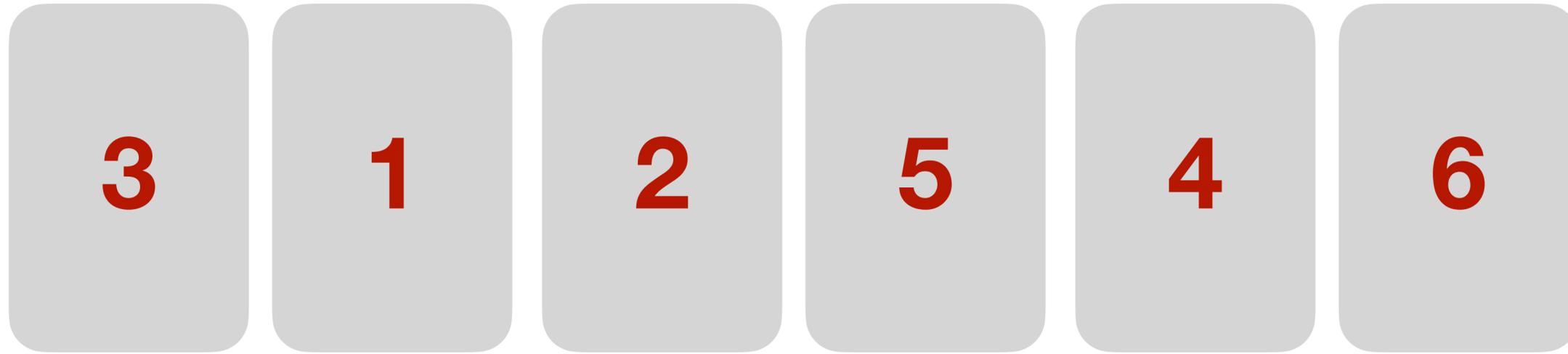


Vamos embaralhar?



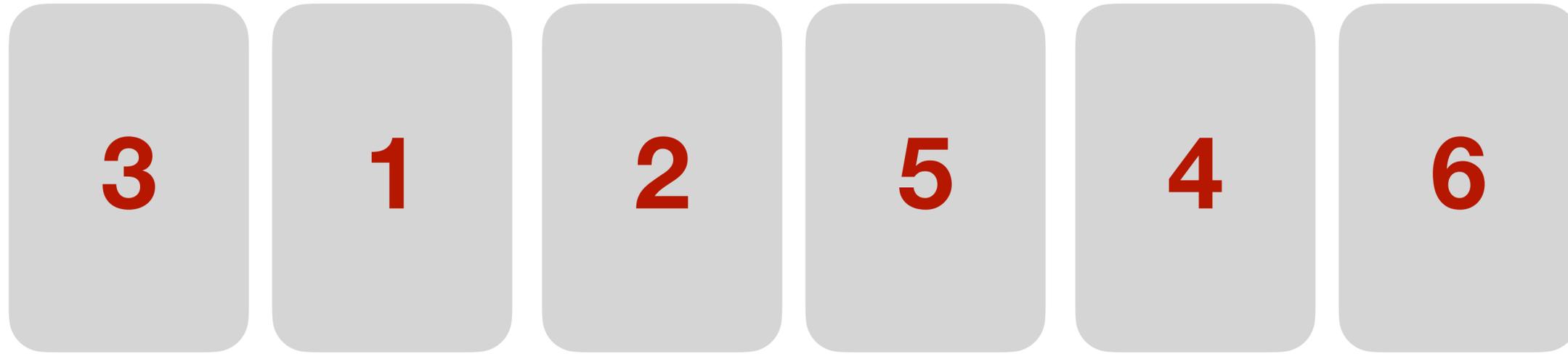
3, 5, 6

Vamos embaralhar?



3, 5, 6

Vamos embaralhar?



3, 5, 6

Vamos embaralhar?



3, 5, 6

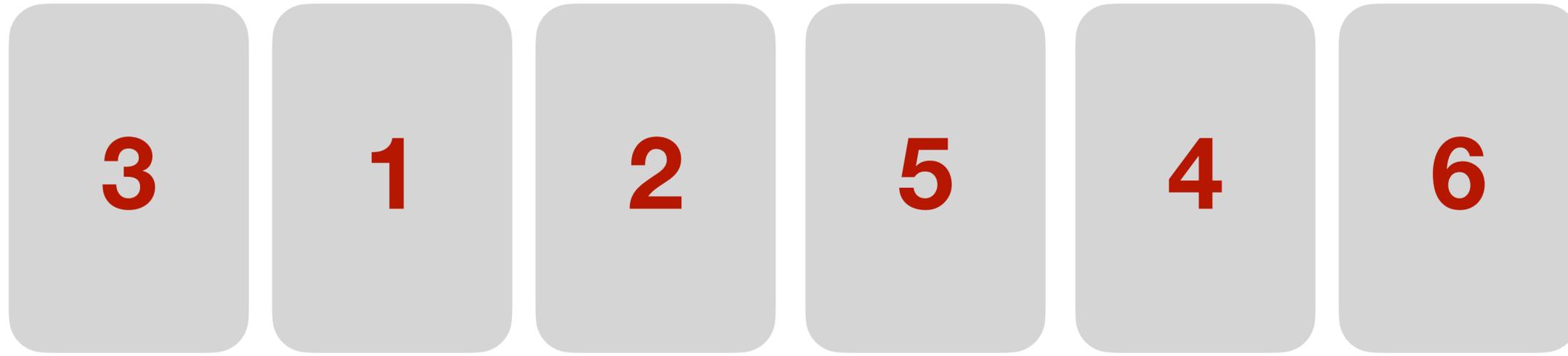
Vamos embaralhar?



3, 5, 6

1, 2, 5, 6

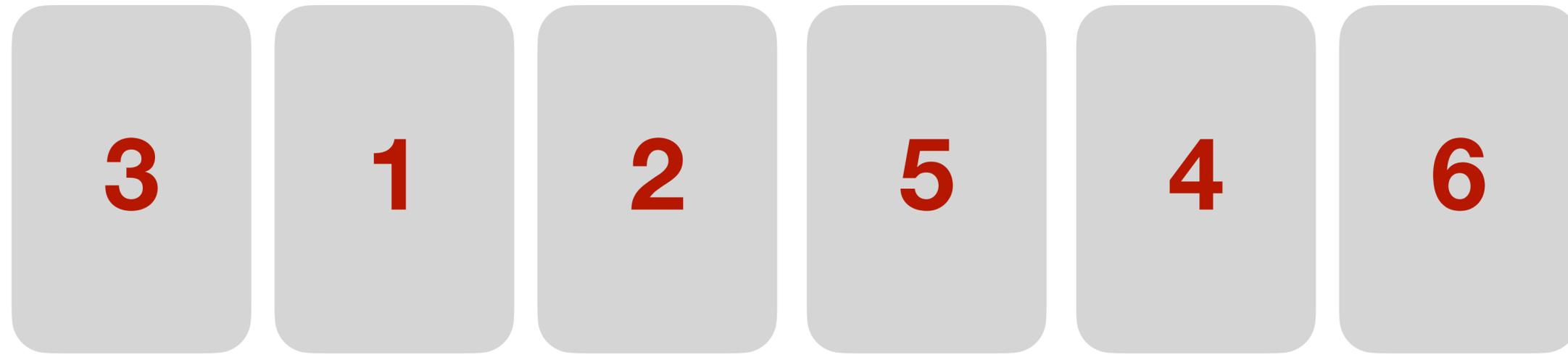
Vamos embaralhar?



3, 5, 6

1, 2, 5, 6

Vamos embaralhar?



3, 5, 6

1, 2, 4, 6

3, 4, 6

3, 4

1, 2, 5, 6

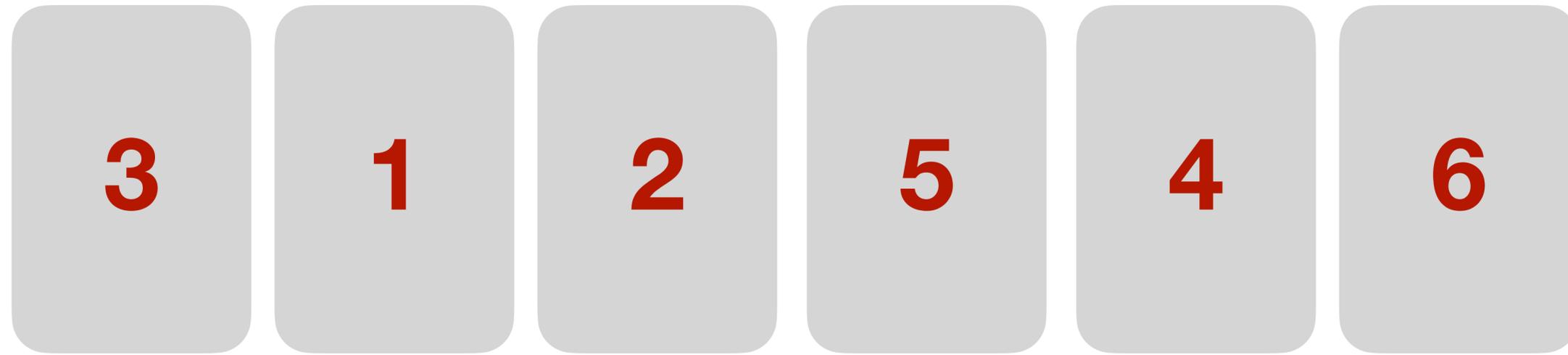
1, 2, 6

1, 2, 5

3, 5

...

Vamos embaralhar?



Qual a maior?

3, 5, 6

1, 2, 4, 6

3, 4, 6

3, 4

1, 2, 5, 6

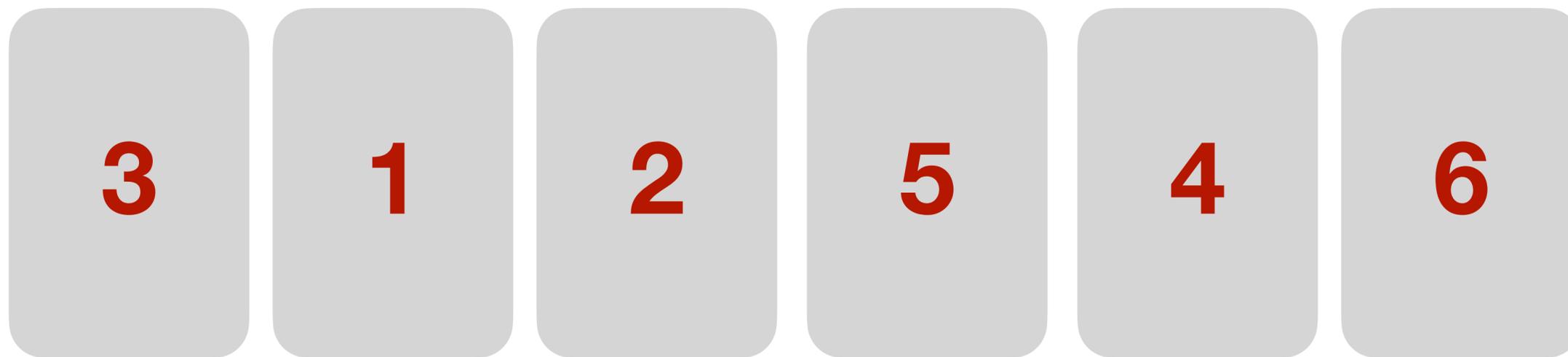
1, 2, 6

1, 2, 5

3, 5

...

Vamos embaralhar?

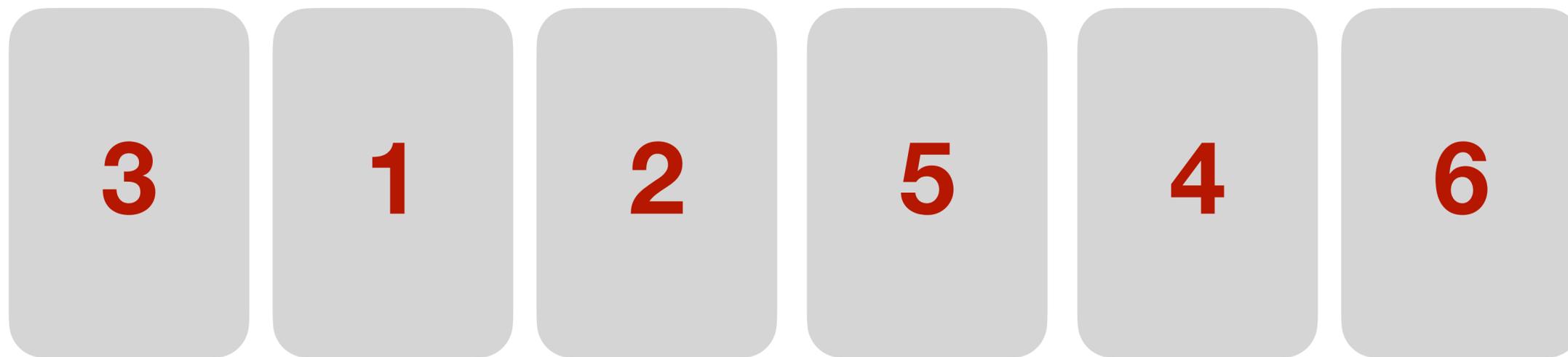


Qual a maior?

3, 5, 6 3, 4, 6 3, 4 1, 2, 4, 6 1, 2, 5, 6

1, 2, 6 1, 2, 5 3, 5 ...

Vamos embaralhar?



Qual a maior?

3, 5, 6 1, 2, 6 3, 4, 6 3, 4 1, 2, 4, 6 1, 2, 5, 6

1, 2, 6 1, 2, 5 3, 5 ... Comprimento = 4

Vamos embaralhar?

Agora faça com um baralho maior...

Vamos embaralhar?

Agora faça com um baralho maior...

1

2

3

4

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22

23

Vamos embaralhar?

Agora faça com um baralho maior...



Vamos embaralhar?

Agora faça com um baralho maior...

Vamos embaralhar?

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O erro é aproximadamente $\sqrt[6]{5000} \times \chi_2$

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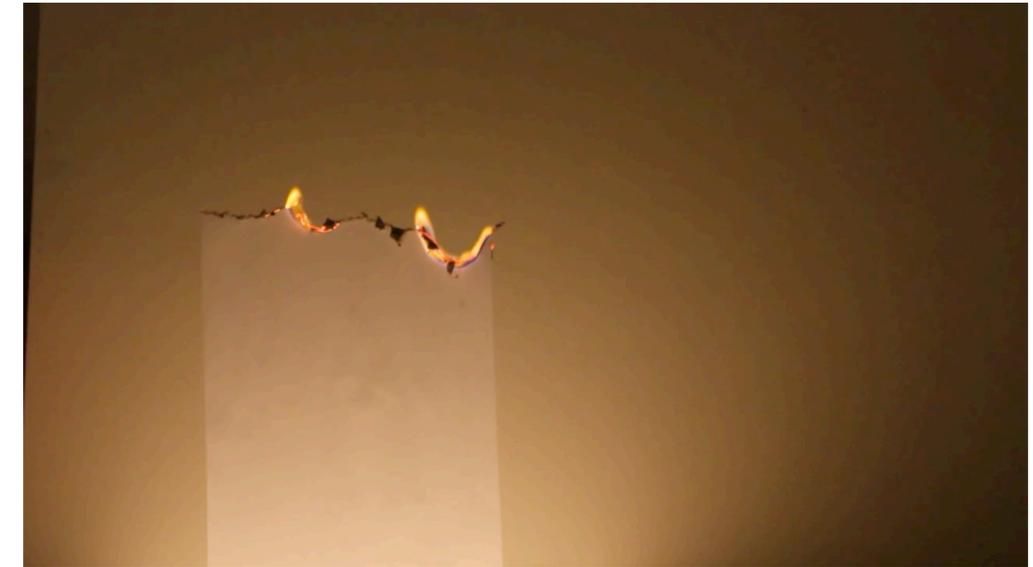
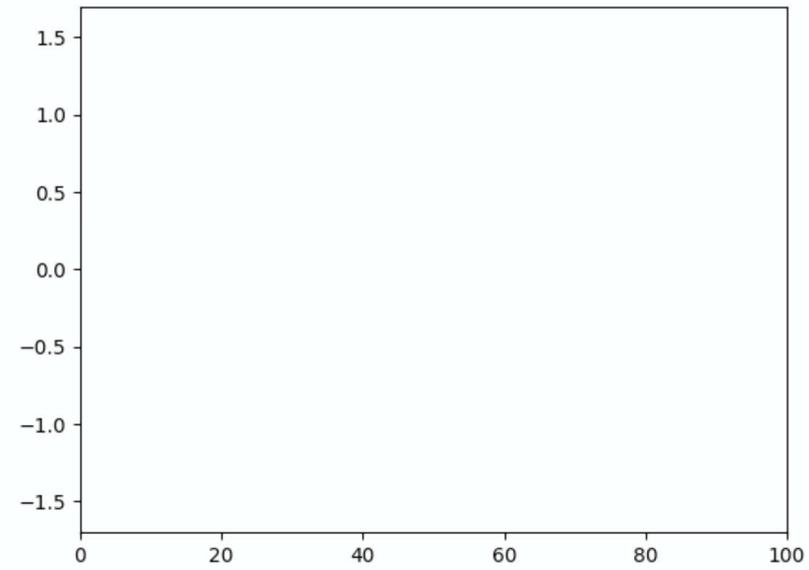
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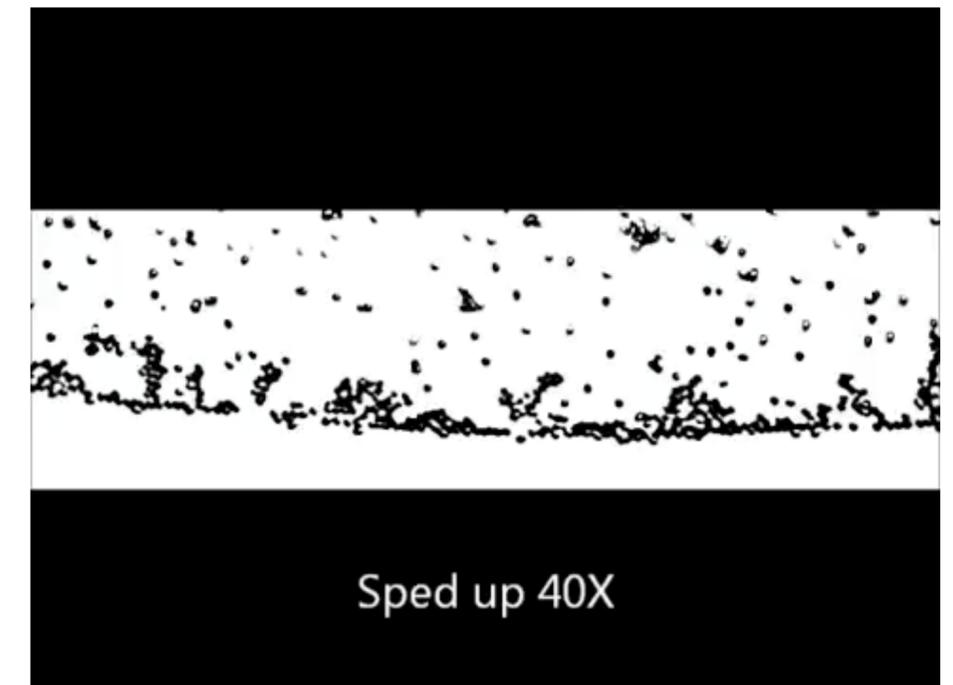
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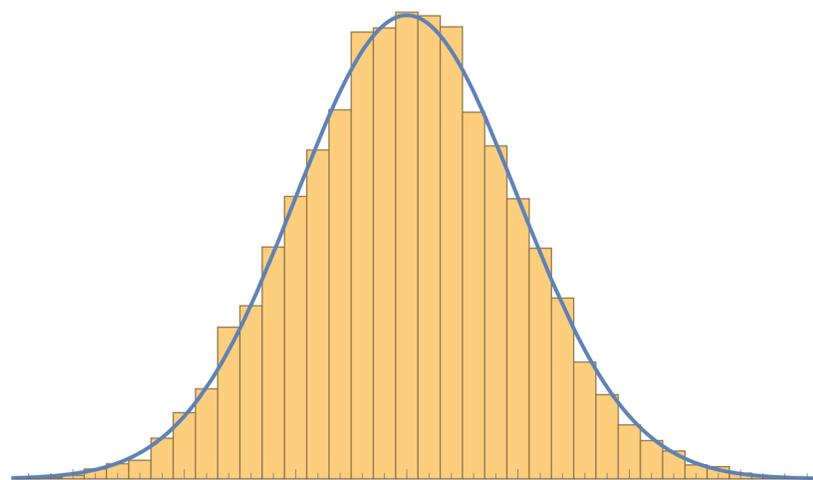
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Distribuição de Tracy - Widom

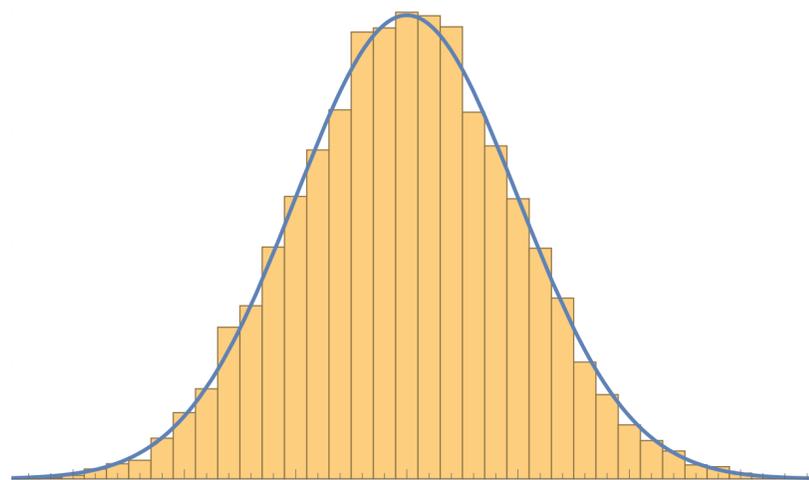
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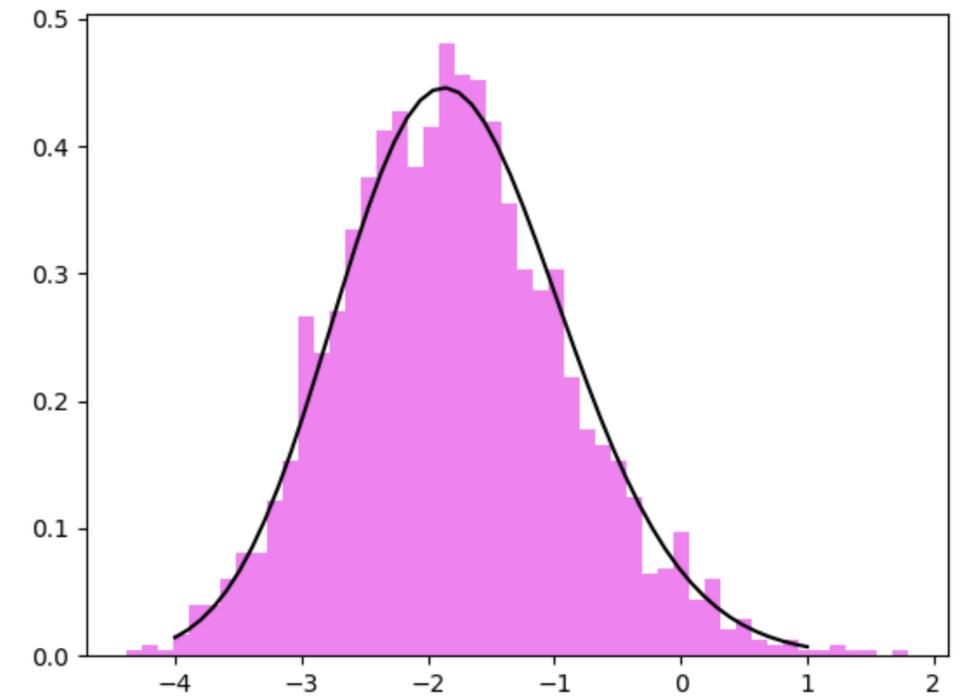
$$f(x) = \frac{1}{\sqrt{2\pi}} e^{-\frac{x^2}{2}}$$

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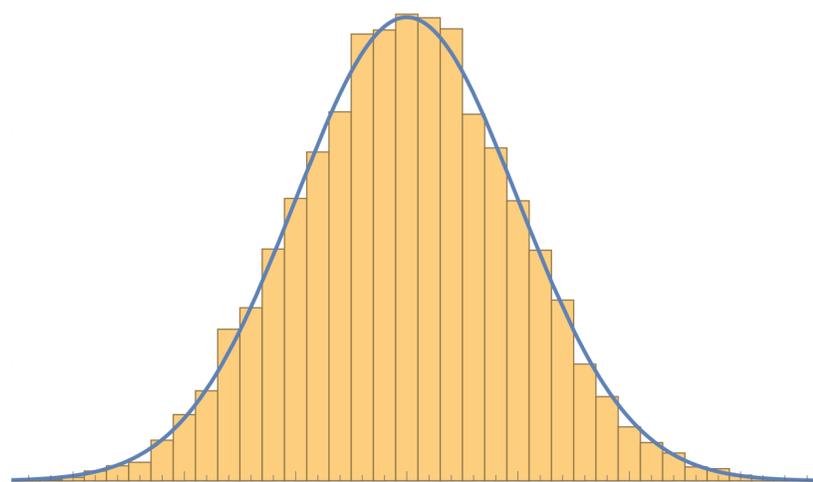
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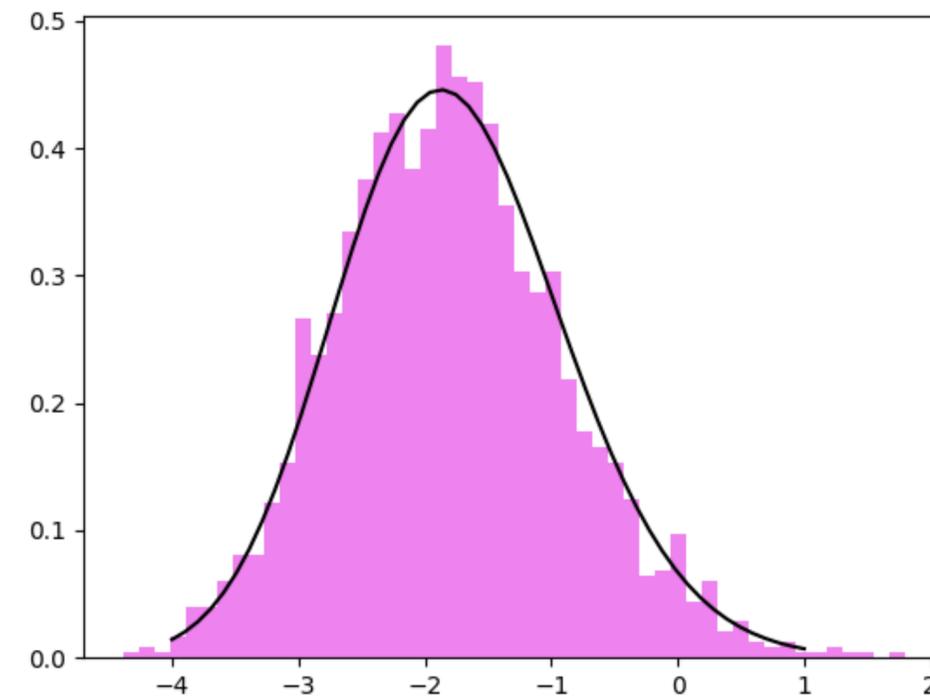
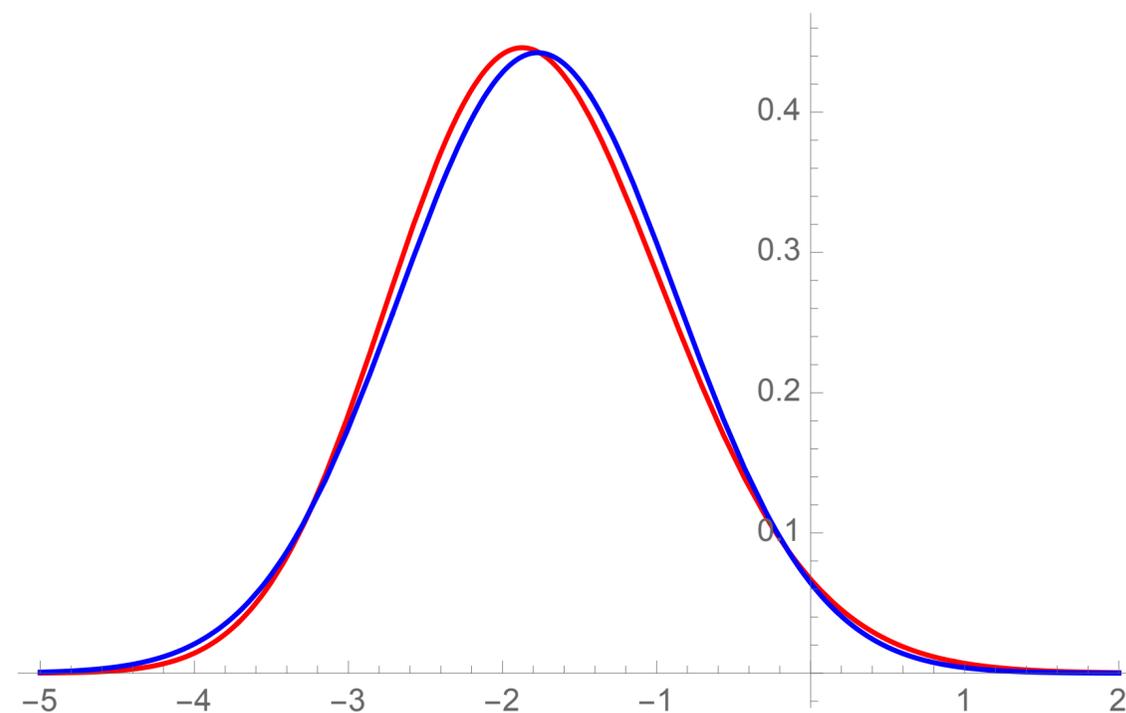
Cortesia de Carla Pinheiro (ICMC-USP)

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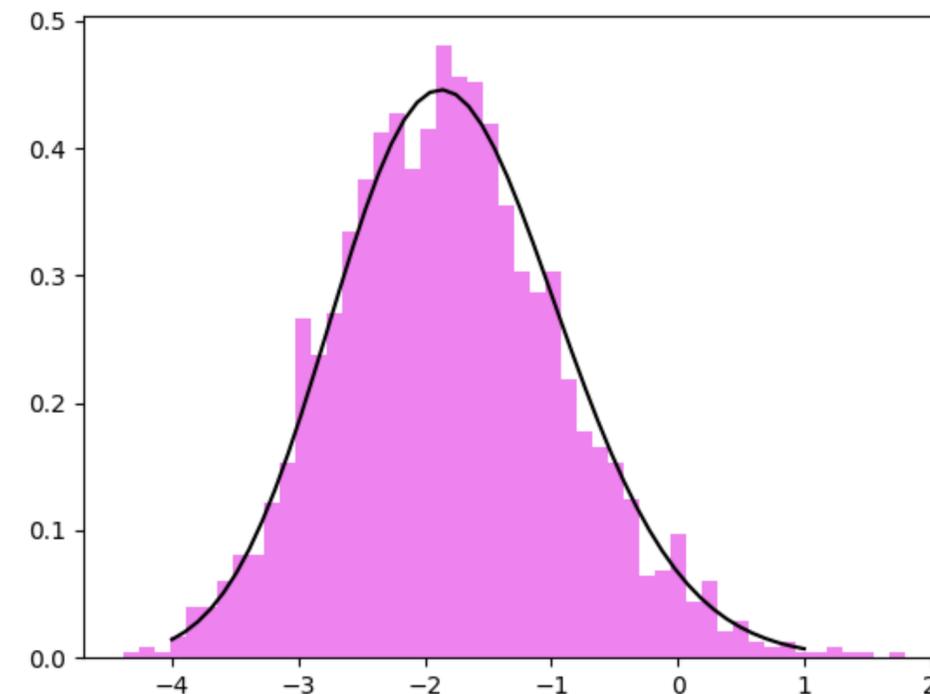
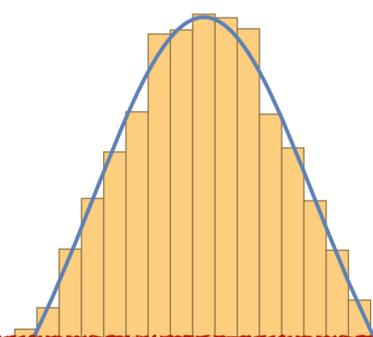


Cortesia de Carla Pinheiro (ICMC-USP)

— TW
— Gaussian

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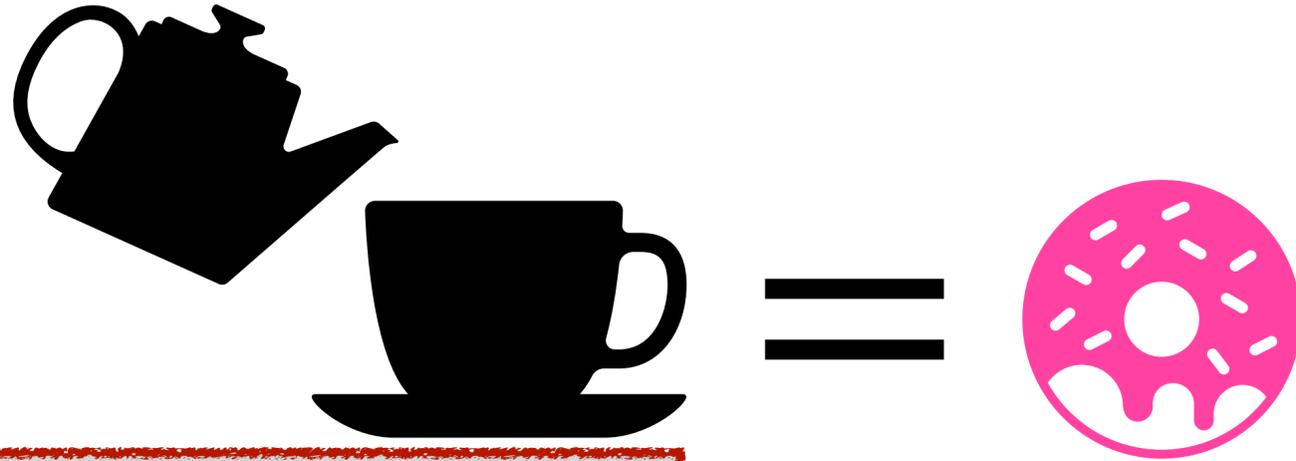
Cortesia de Carla Pinheiro (ICMC-USP)

Receita: $\text{Prob}(\chi_2 \leq x) = F_2(x)$

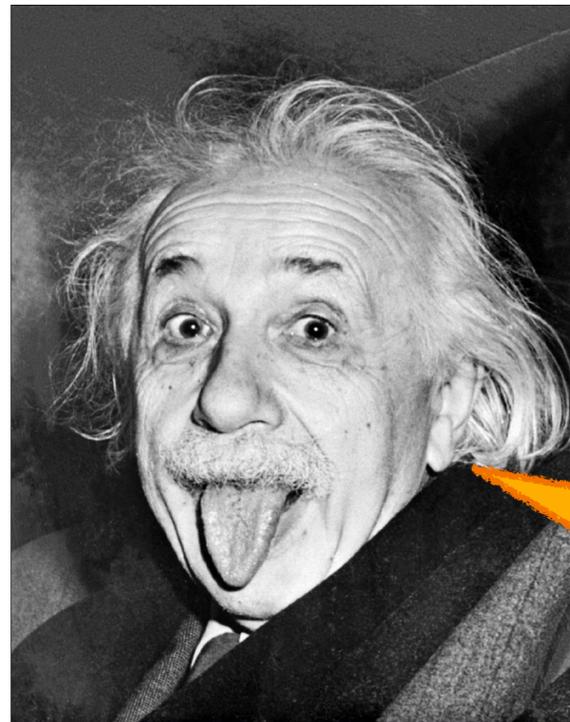
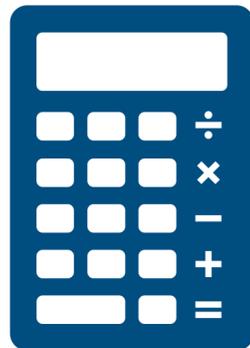
$$u(x) := \frac{d^2}{dx^2} \log F_2(x) \quad \text{satisfaz} \quad u'' = xu + 2u^3$$

— TW
— Gaussian





O que é matemática?



Matemática é,
a seu próprio modo,
a poesia das idéias lógicas

Esportes

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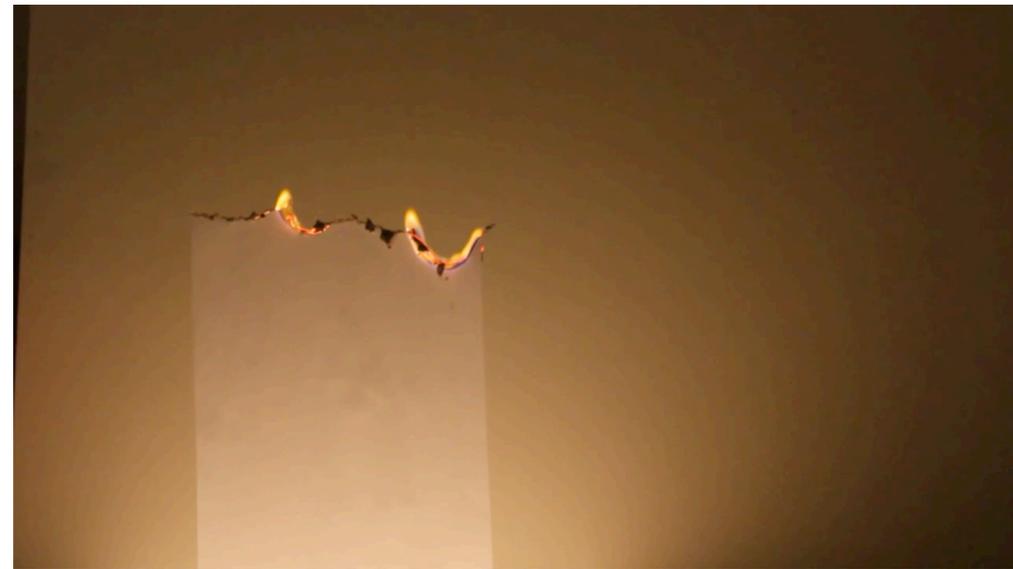
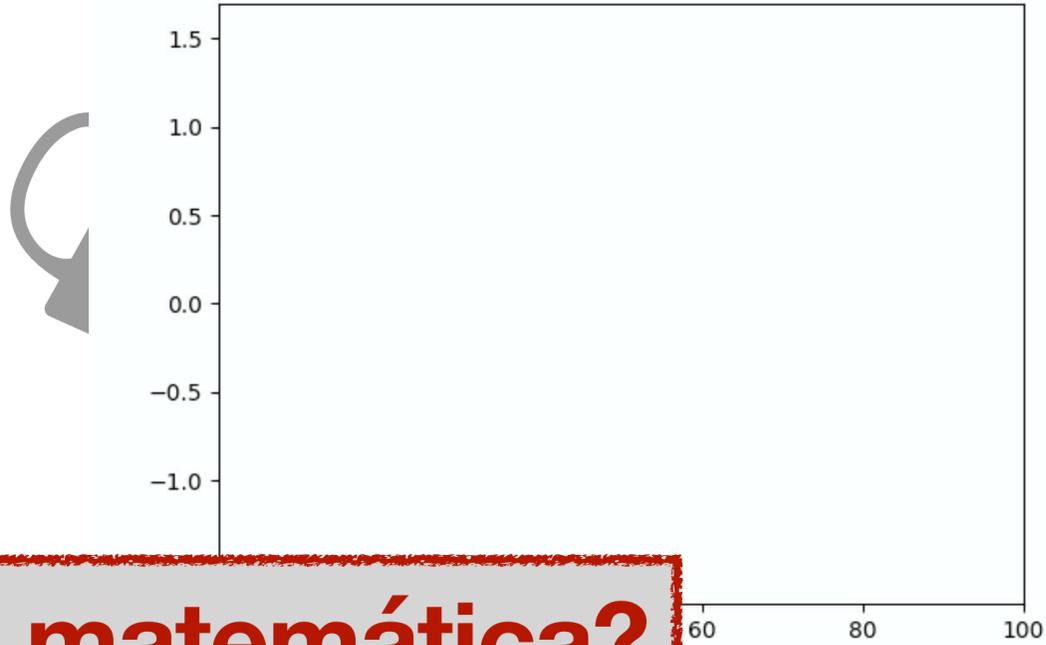
Da partícula de Deus à bola, quando a 'big data' encontra o futebol

Físicos teóricos, matemáticos e programadores lideram os departamentos de análise de dados de alguns dos principais clubes da Europa, que atribuem a eles a melhora nos jogos e nas contratações

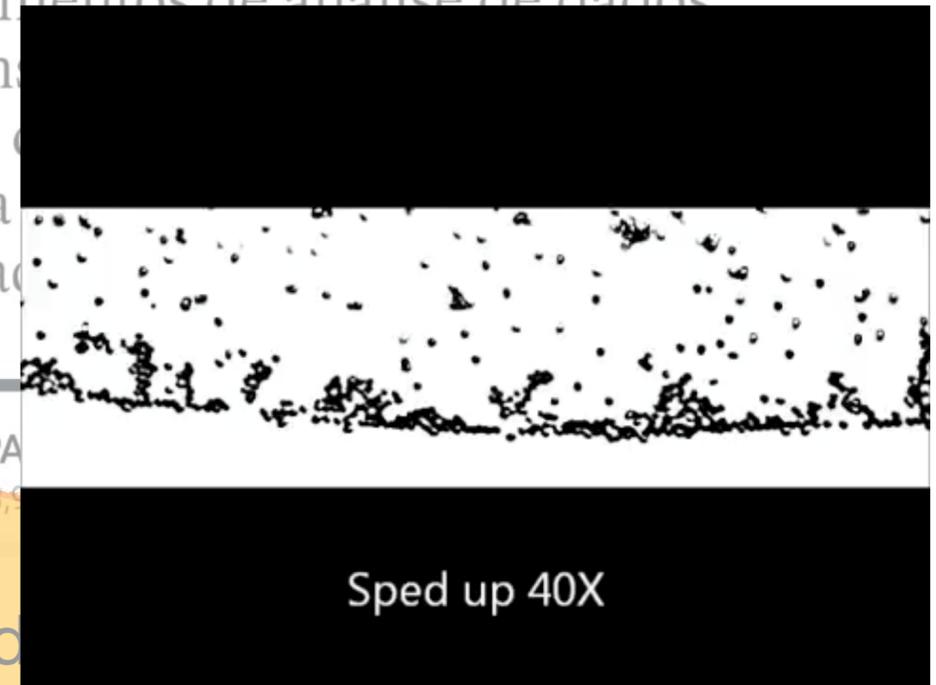
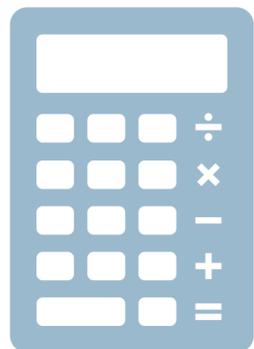
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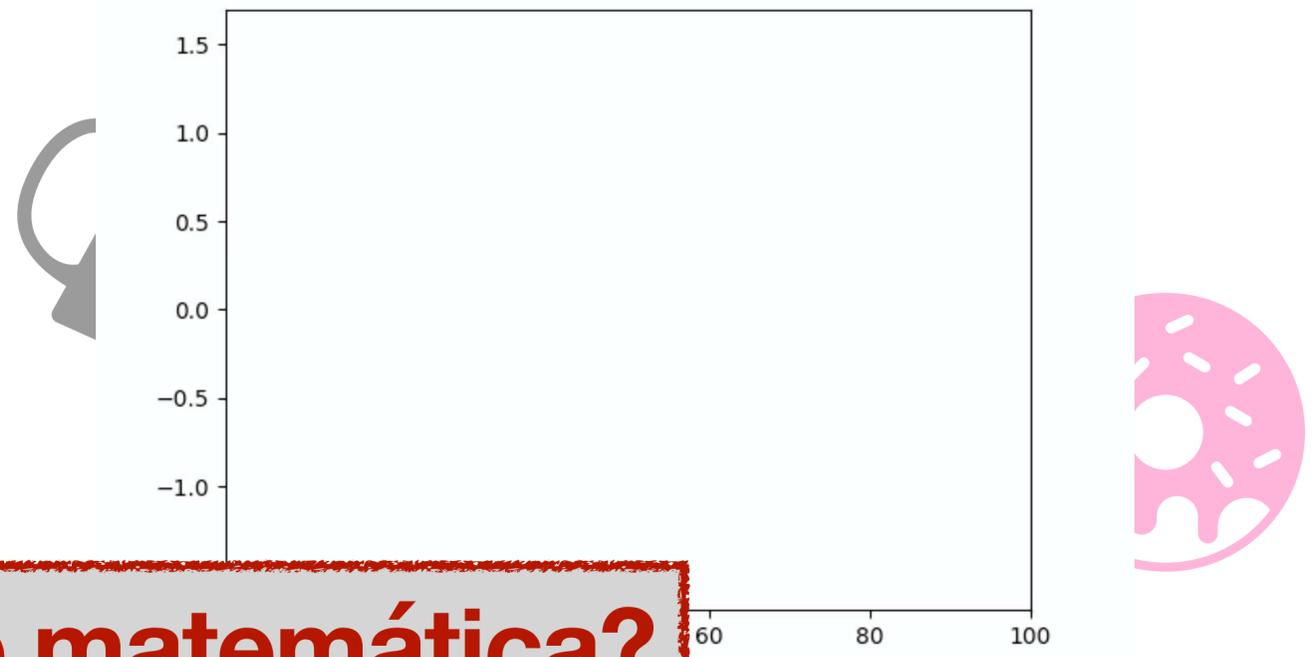
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Físicos teóricos, matemáticos e programadores lideram os departamentos de análise de dados de alguns departamentos de física em Europa, para a análise de dados de ataques

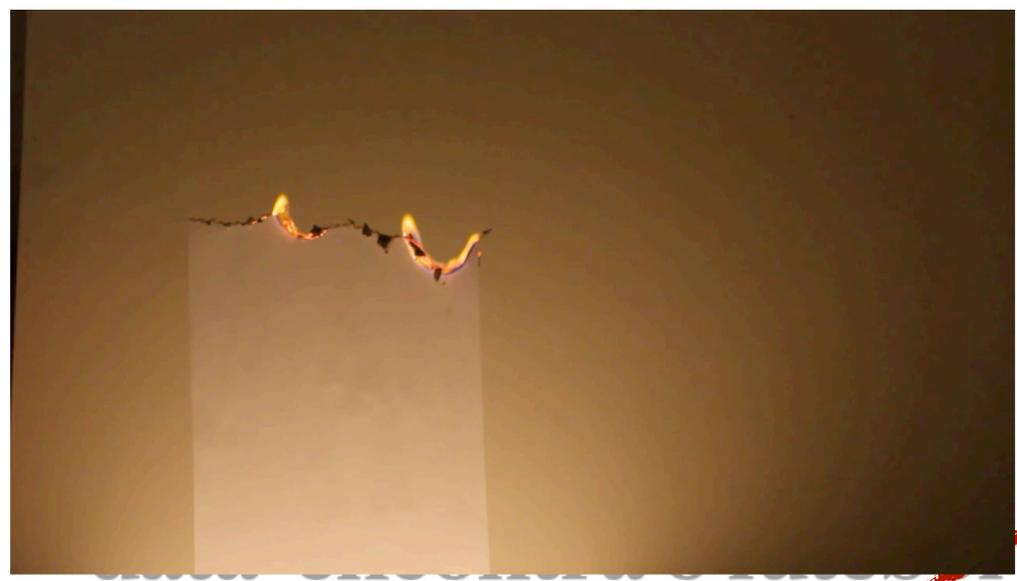


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lógicas

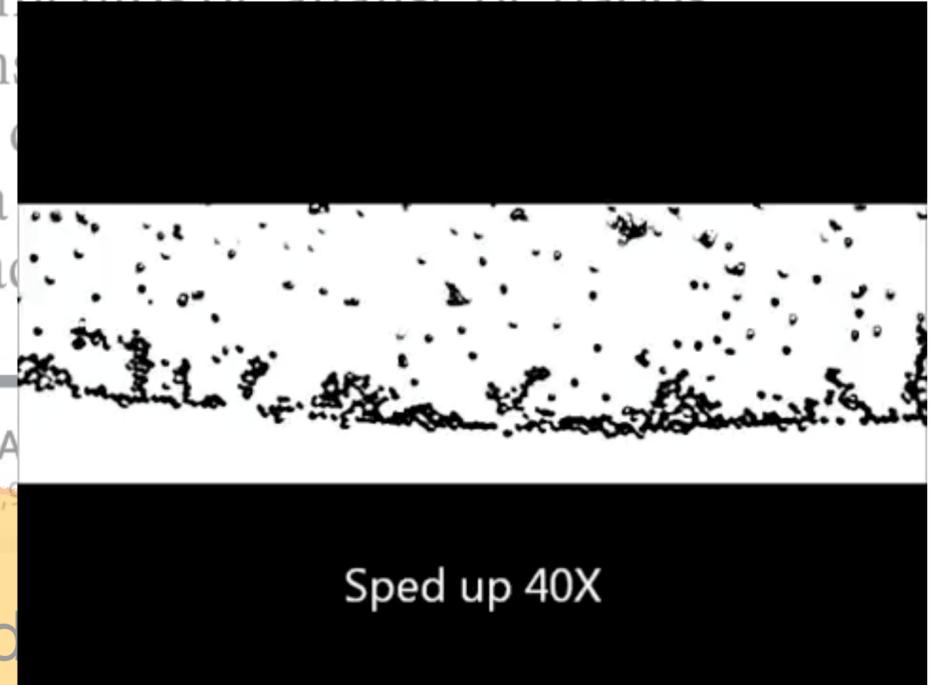
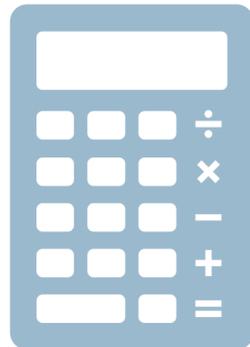


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É olhar para padrões além do que os olhos vêem

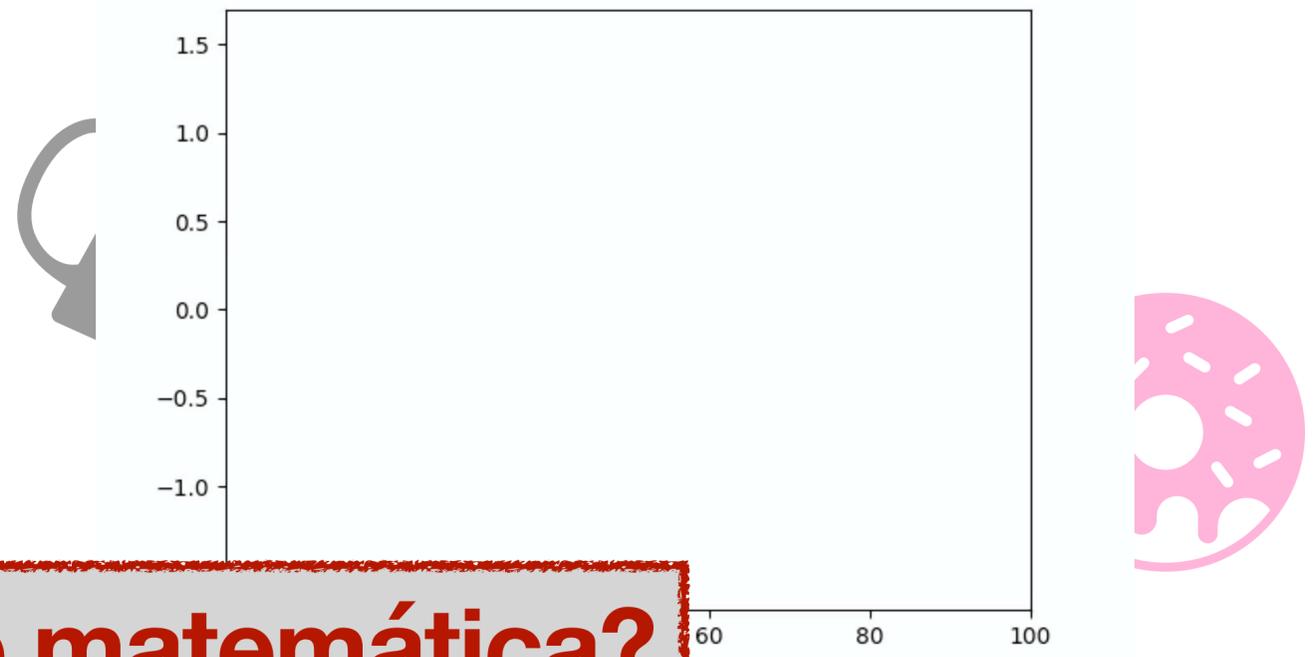


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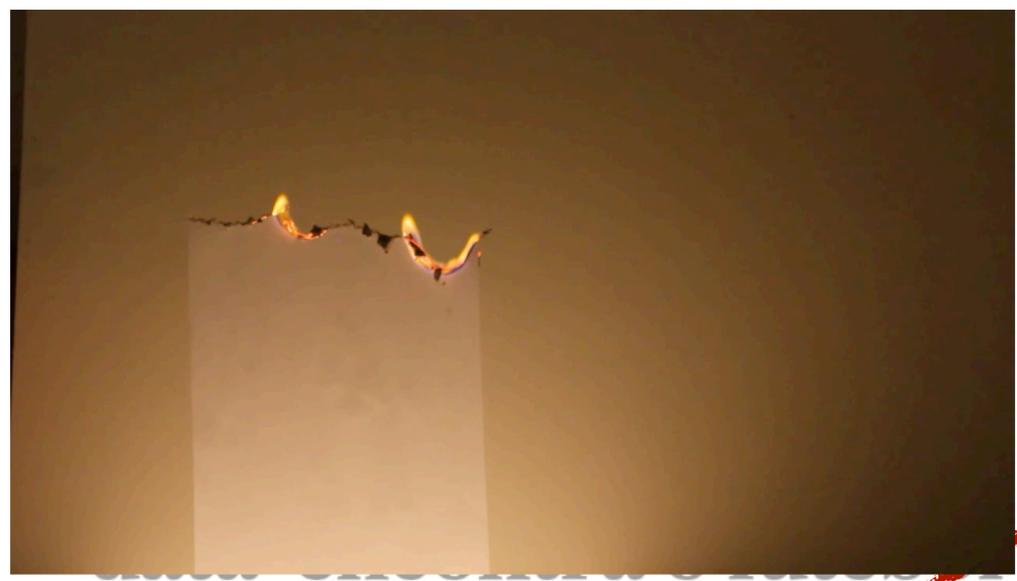
Sped up 40X

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silvag@usp.br

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