$$\sum_x Q(x)\log\frac{1}{P(x,y)} = \sum_x Q(x)\log\frac{1}{\frac{P(x,y)}{Q(x)}} + \sum_x Q(x)\log\frac{1}{Q(x)}$$

$$\frac{\textbf{energy}}{\textbf{temperature}} = \frac{\textbf{free energy}}{\textbf{temperature}} + \textbf{entropy}$$

belief in the system

belief in belief in the system

rethinking entropy

$$\frac{1}{4}\log_2 4 + \frac{3}{4}\log_2\frac{4}{3} \quad \approx \frac{1}{4}\times 2 + \frac{3}{4}\times\frac{2}{5}$$

$$\approx \frac{10}{20} + \frac{6}{20}$$

$$-\sum_x Q(x)\log Q(x)$$

knowledge gained

$$\log_2\frac{1}{\frac{1}{8}} = \log_2 8 = \log_2 2^3 = 3$$

$$\log\frac{1}{Q(x)}$$

knowledge lens

$$\frac{1}{4}[\ldots] + \frac{3}{4}[\ldots]$$

$$\sum_x Q(x)\ldots$$

entropy is ambiguity

$$\frac{A}{B} = \frac{x\log_2\frac{1}{x}}{(1-x)\log_2\frac{1}{1-x}}$$

doubling

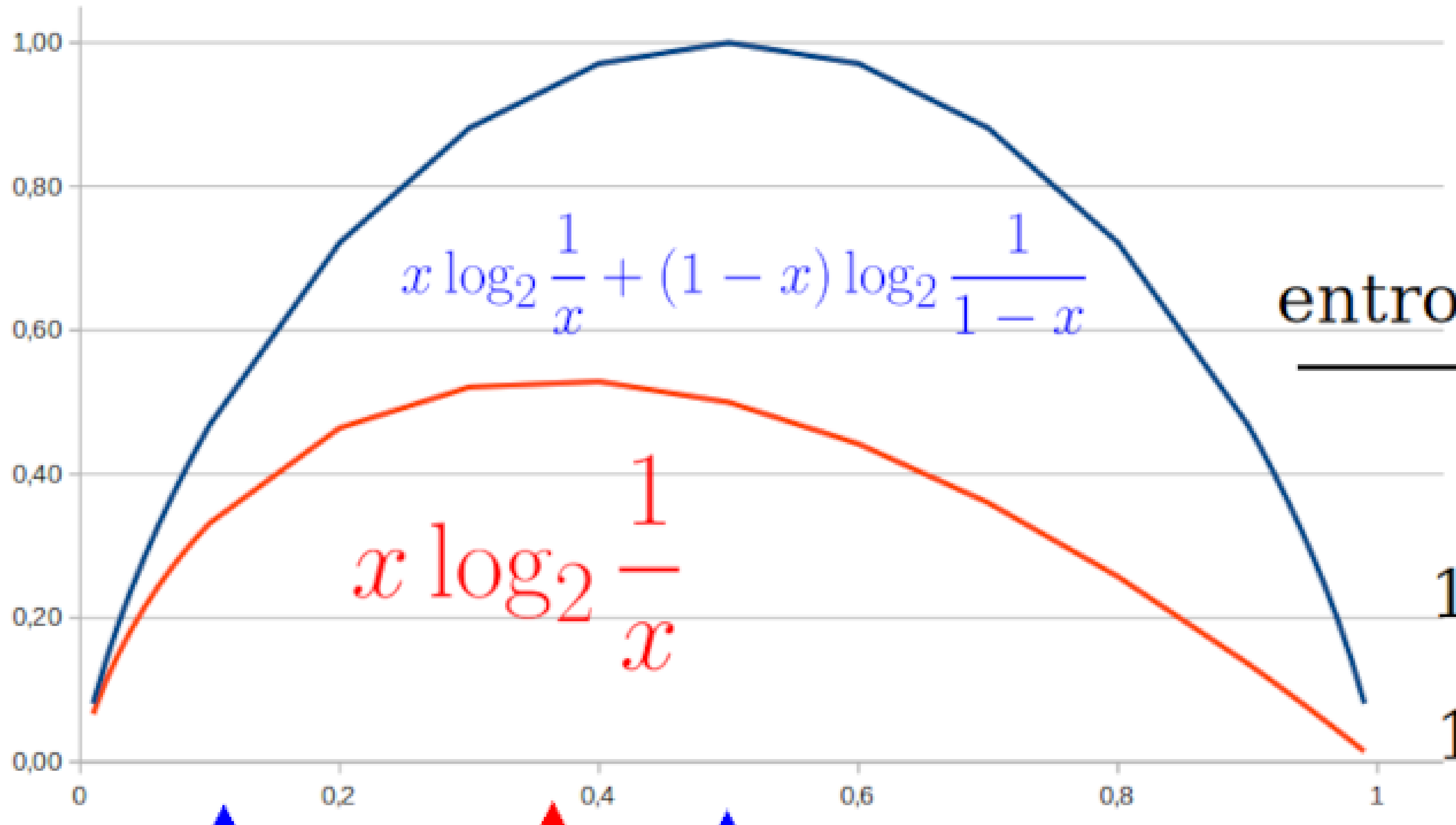
look at

n equal probabilities $\frac{1}{n}$

$$\sum_{k=1}^{n} \frac{1}{n}\log_2\frac{1}{\frac{1}{n}}$$

$$8[\frac{1}{8}\log_2\frac{1}{\frac{1}{8}}] = \log_2 8 = \log_2 2^3 = 3$$

$$64[\frac{1}{64}\log_2\frac{1}{\frac{1}{64}}] = \log_2 64 = \log_2 2^6 = 6$$



$\frac{1}{9}$ $\frac{1}{e} \approx 37\%$ $\frac{1}{2}$

entropy	x	A/B
1	1/2	1
1/2	1/9	2.3
1/4	1/24	3.2
1/8	1/58	4.1
1/16	1/137	4.9
1/32	1/311	5.7
1/64	1/697	6.6
1/128	1/1540	7.3
1/256	1/3369	8.1

halving

look at 2 unequal probabilities x and 1-x

energy

$$p_i = \frac{e^{\frac{-E_i}{k_B T}}}{\sum_i e^{\frac{-E_i}{k_B T}}} = e^{\frac{-(E_i - \mathcal{E})}{k_B T}}$$

Boltzmann distribution

equilibrium

$$\ln p_i = \frac{-(E_i - \mathcal{E})}{k_B T} \qquad \ln \frac{1}{p_i} = \frac{E_i - \mathcal{E}}{k_B T} \qquad b = e^{\frac{1}{k_B T}}$$

interface

$$\sum_i p_i \log_b \frac{1}{p_i} = \sum_i p_i (E_i - \mathcal{E})$$

entropy   expected energy

disequilibrium

$$\sum_i q_i \log_b \frac{1}{p_i} = \sum_i q_i (E_i - \mathcal{E})$$

expected energy

unconscious		conscious		unconscious
$P(x,y)$	compresses	$Q(x)$	decompresses	$P(x,y)$
100,000,000,000 neurons	$\longrightarrow$	100,000 concepts	$\longrightarrow$	100,000,000,000 neurons

$$\frac{1}{P(x,y)} = \frac{Q(x)}{P(x,y)} \frac{1}{Q(x)}$$

$$\log \frac{1}{P(x,y)} = \log \frac{1}{\frac{P(x,y)}{Q(x)}} + \log \frac{1}{Q(x)}$$

$$\sum_x Q(x) \log \frac{1}{P(x,y)} = \sum_x Q(x) \log \frac{1}{\frac{P(x,y)}{Q(x)}} + \sum_x Q(x) \log \frac{1}{Q(x)}$$

$$\frac{\textbf{energy}}{\textbf{temperature}} = \frac{\textbf{free energy}}{\textbf{temperature}} + \textbf{entropy}$$

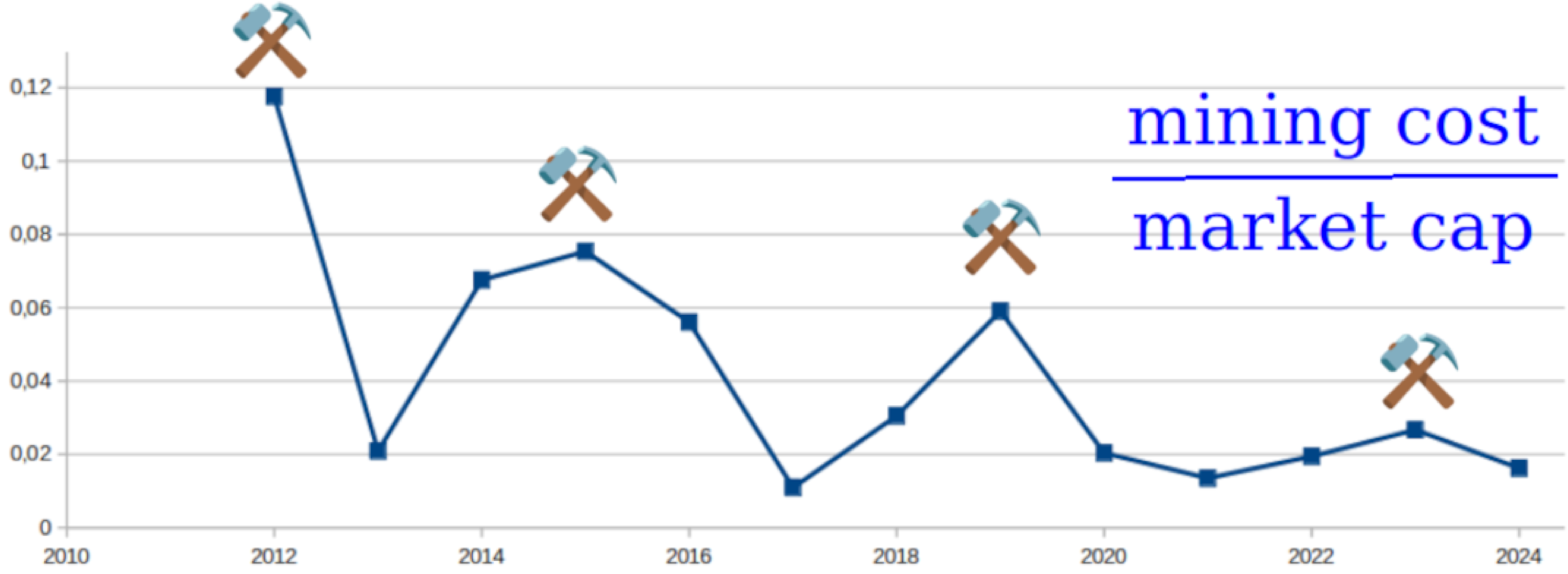
$$\frac{Q(x)}{P(x,y)} = \frac{Q(x)}{P(x|y)}\frac{1}{P(y)}$$

$$\log\frac{1}{\frac{P(x,y)}{Q(x)}} = \log\frac{1}{\frac{P(x|y)}{Q(x)}} + \log\frac{1}{P(y)}$$

$$\sum_x Q(x)\log\frac{1}{\frac{P(x,y)}{Q(x)}} = \sum_x Q(x)\log\frac{1}{\frac{P(x|y)}{Q(x)}} + \sum_x Q(x)\log\frac{1}{P(y)}$$

$$\frac{\textbf{free energy}}{\textbf{temperature}} = \textbf{divergence} + \textbf{knowledge gained}$$


10k
1k
100
10
1
log$_{10}$(price)
2012
2014
2016
2018
2020
2022
2024


0,12
0,1
0,08
0,06
0,04
0,02
0
mining cost / market cap
2010
2012
2014
2016
2018
2020
2022
2024

What is the optimal "cost of doing business"?

$$\frac{\text{electricity cost}}{\text{market cap}} = \frac{\text{20 billion USD / year}}{\text{2 trillion USD}} = 1\% \text{ every year}$$

$$\frac{\textit{belief in belief in the system}}{\textit{belief in the system}}$$

$$\frac{\textbf{miners} \\ \text{entropy Quai}}{\textbf{users} \\ \text{energy Qi}}$$

	ALTERNATIVE	CUSTOMARY
y	evidence	evidence
x	inferred cause	inferred cause
$P(x,y)$	unconscious backward-looking	generative model predictive
$Q(x)$	conscious forward-looking	approximation optimized
	gap between unconscious and conscious	boundary between agent and environment