ICML
International Conference
On Machine Learning

Position: Interestingness is an Inductive Heuristic for Future Compression Progress


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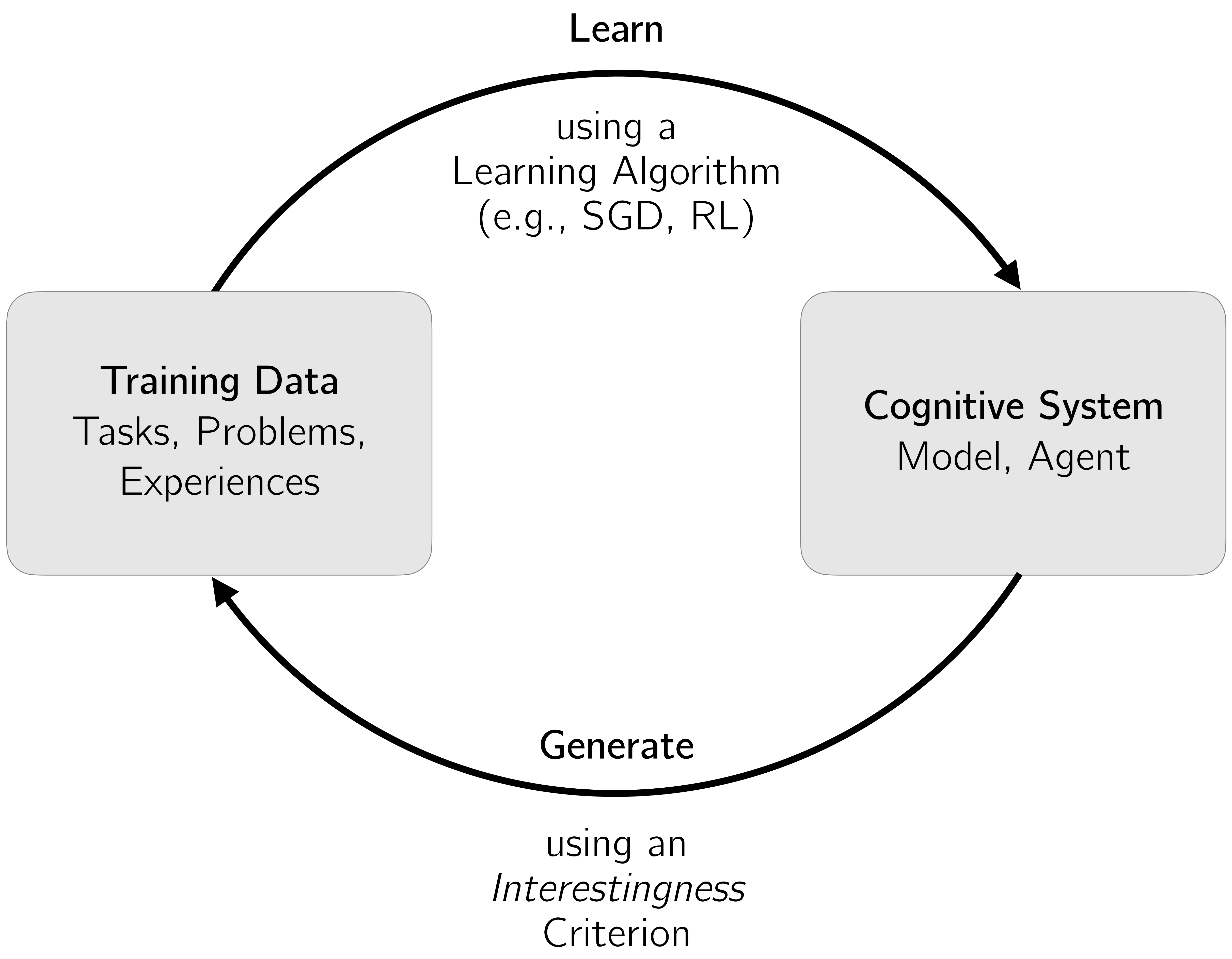
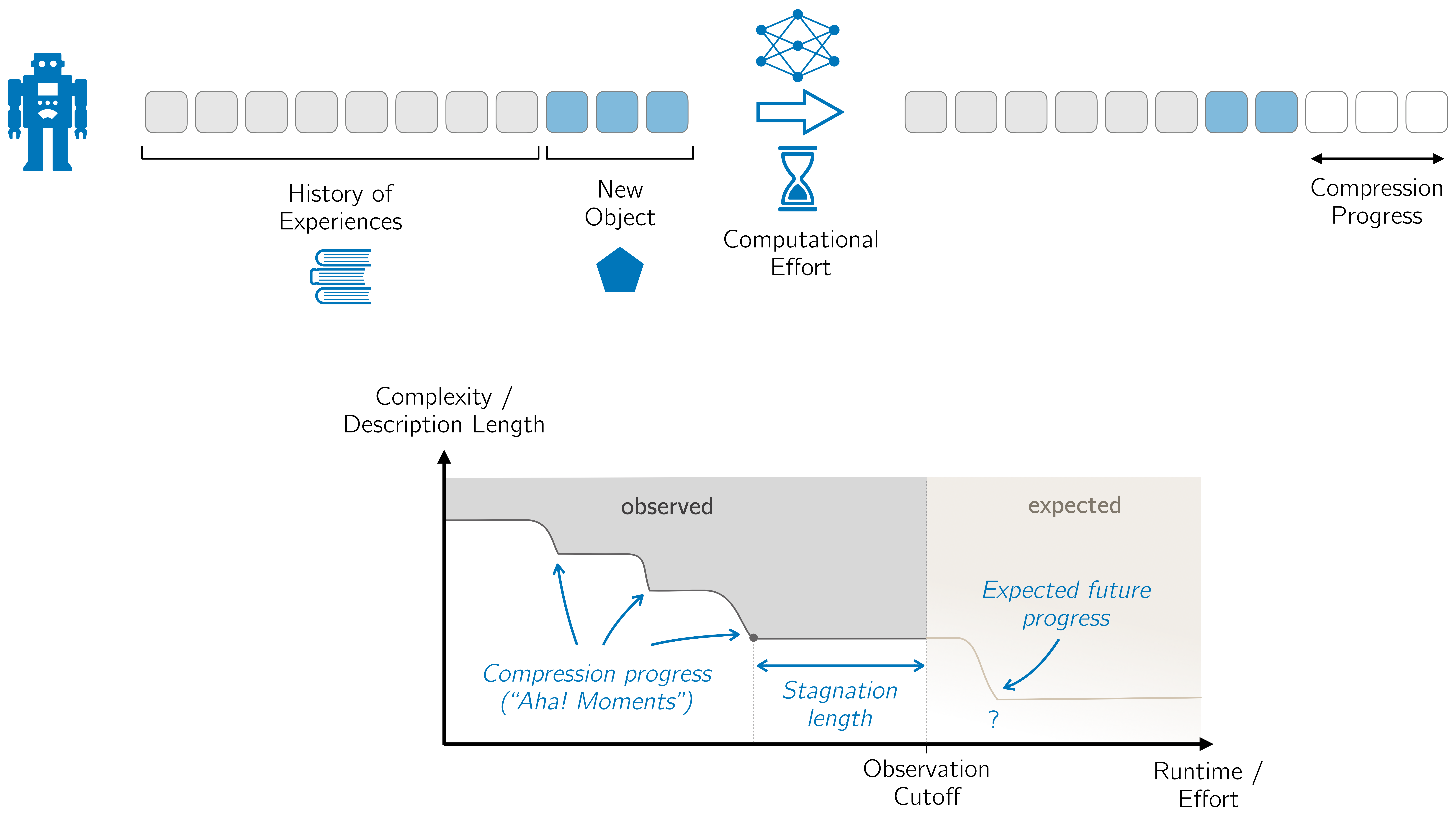
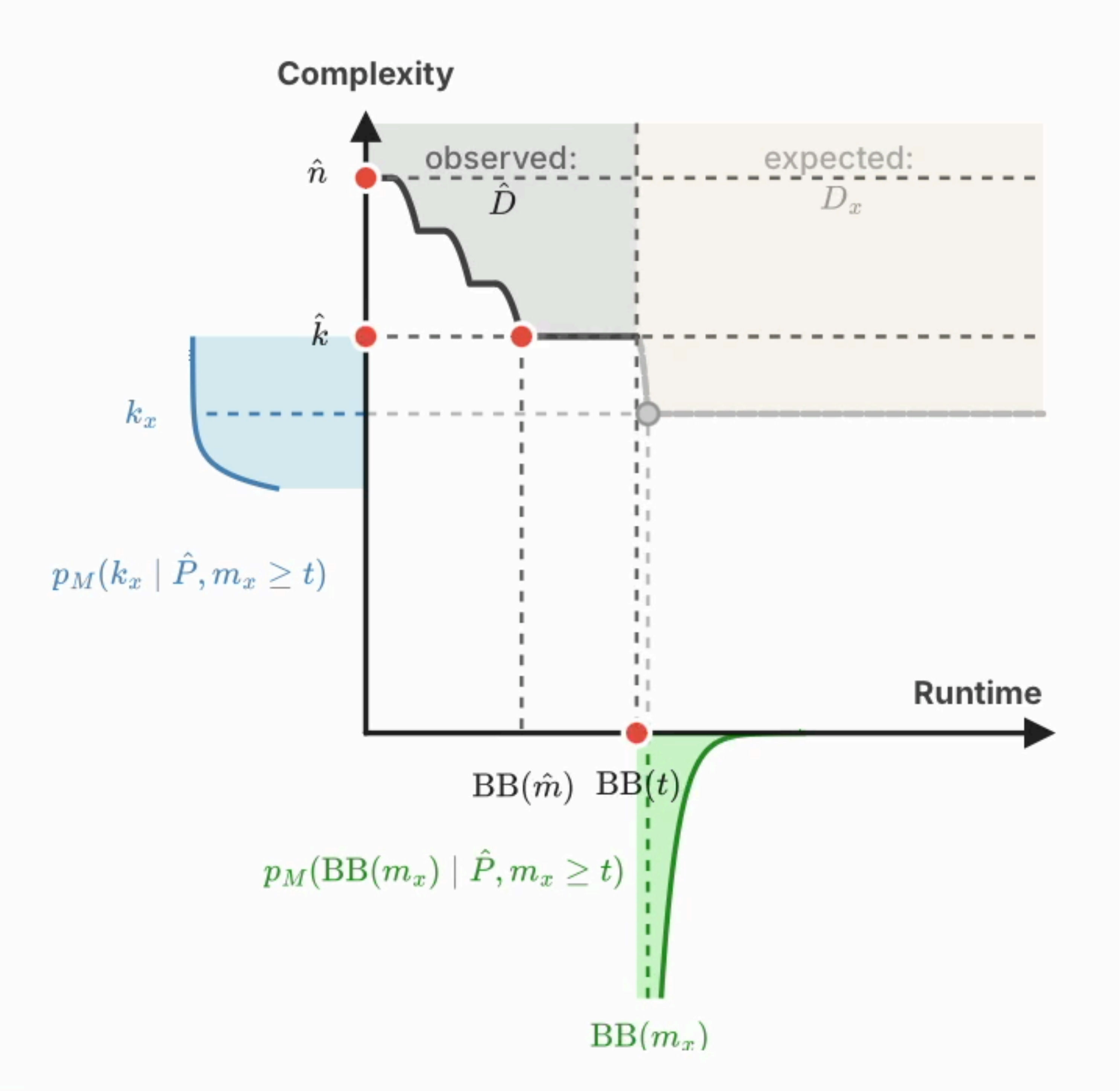


Interestingness is the expected future compression progress under further engagement


History of Experiences
New Object
Computational Effort
Compression Progress
Complexity / Description Length
observed
expected
Expected future progress
Compression progress ("Aha! Moments")
Stagnation length
?
Observation Cutoff
Runtime / Effort

Algorithmic Prior over all computable objects:

$$M(x) = \sum_{p:U(p)=x} 2^{-|p|}$$



Algorithmic Prior over all computable objects:

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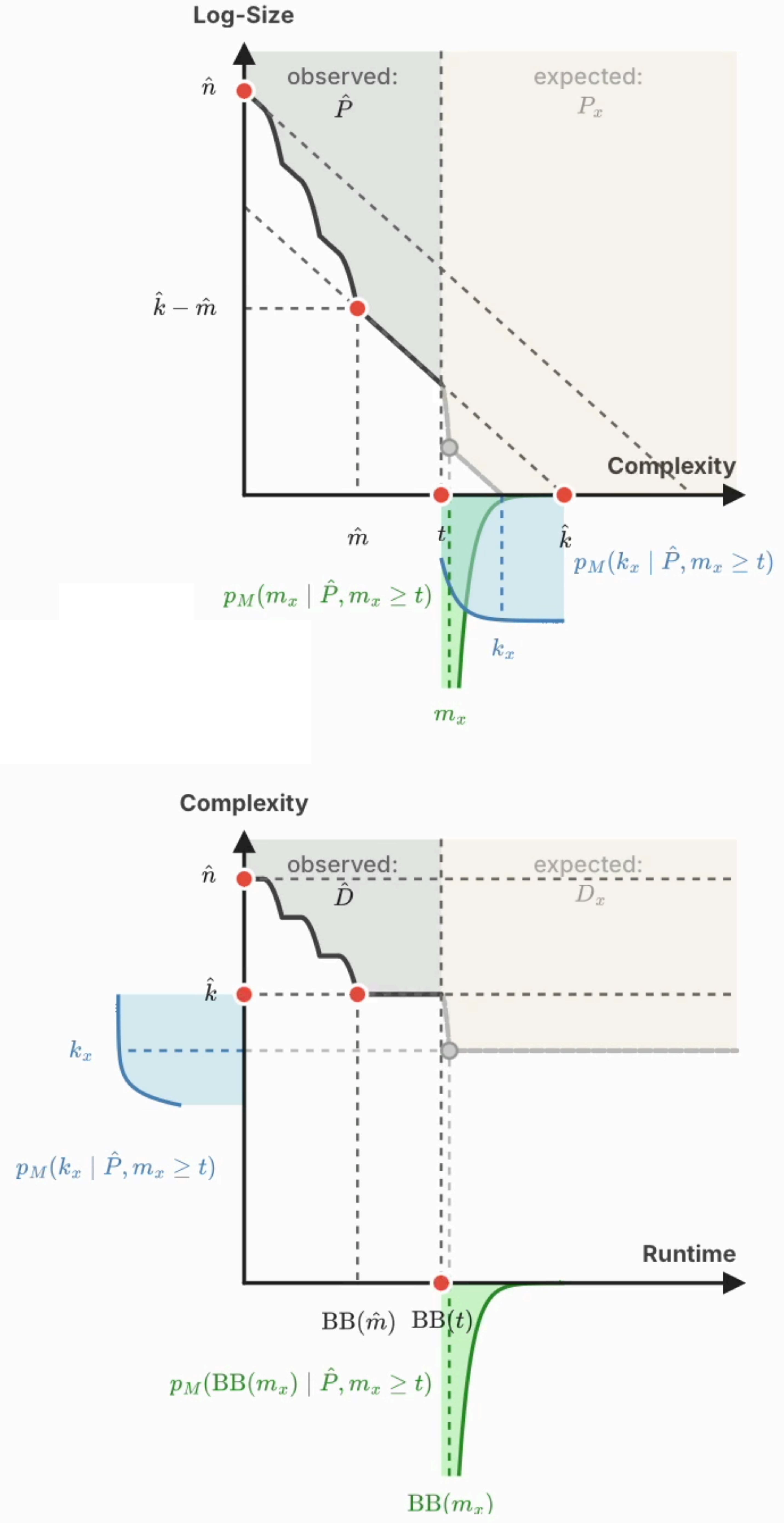
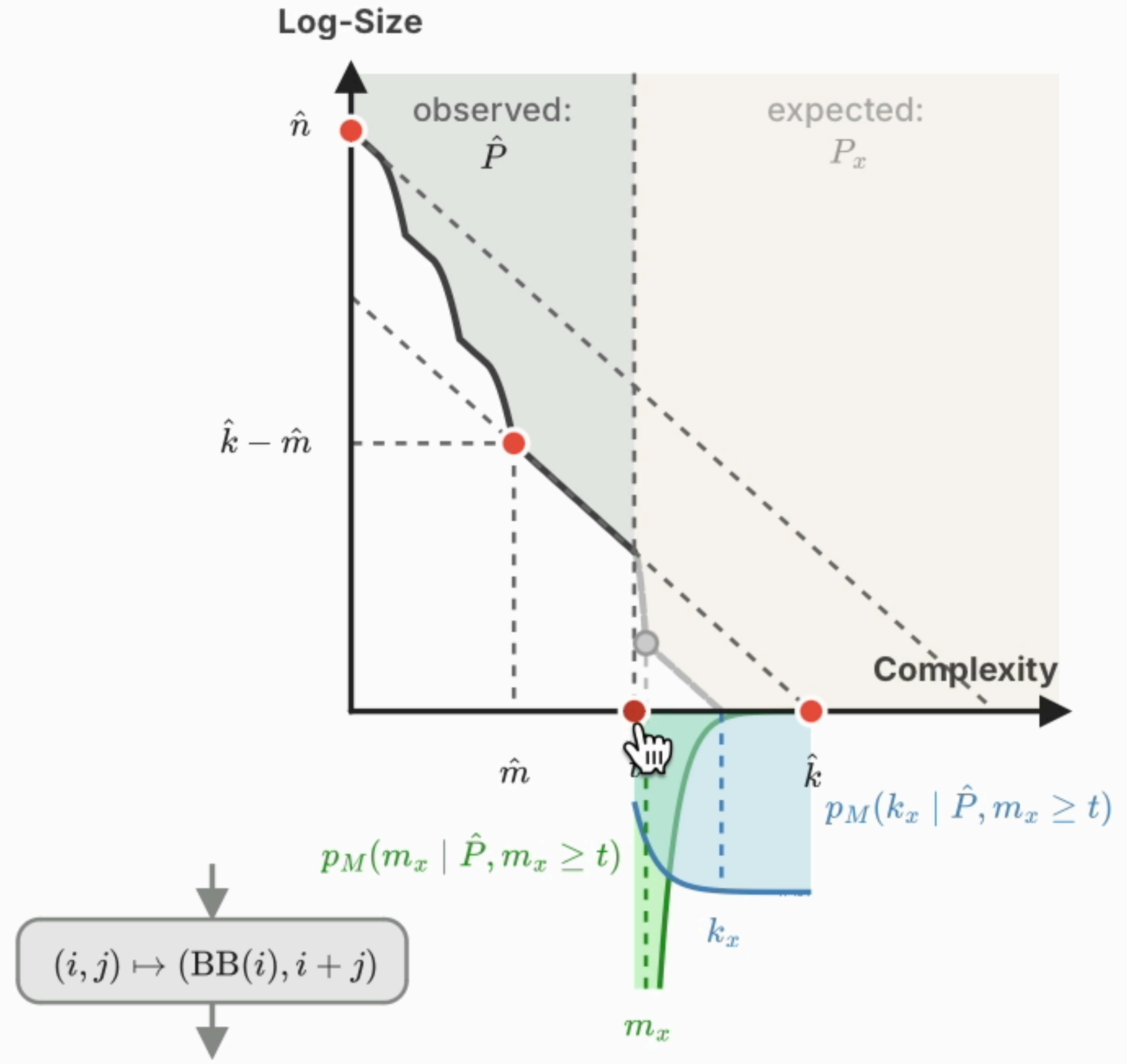
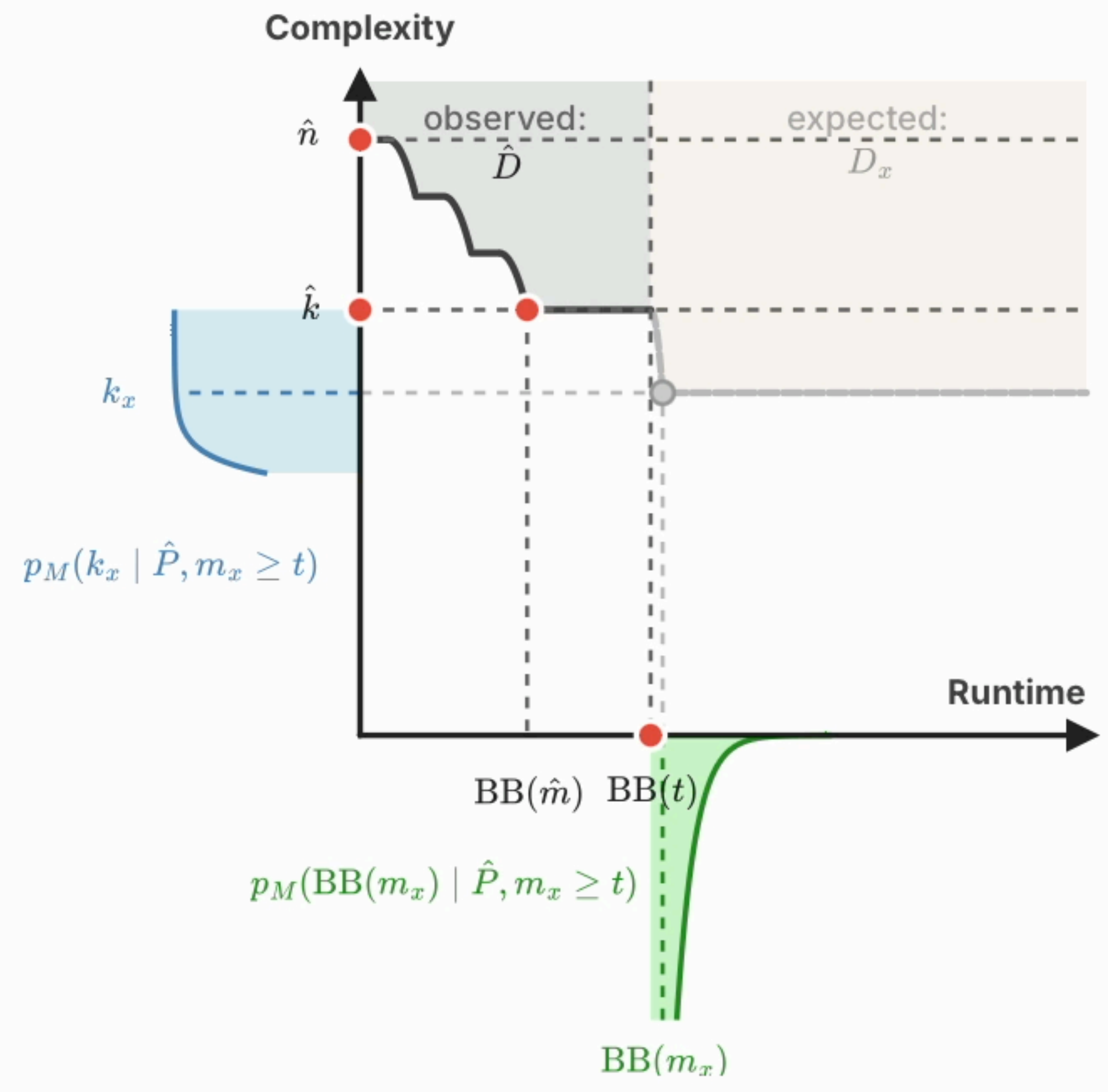


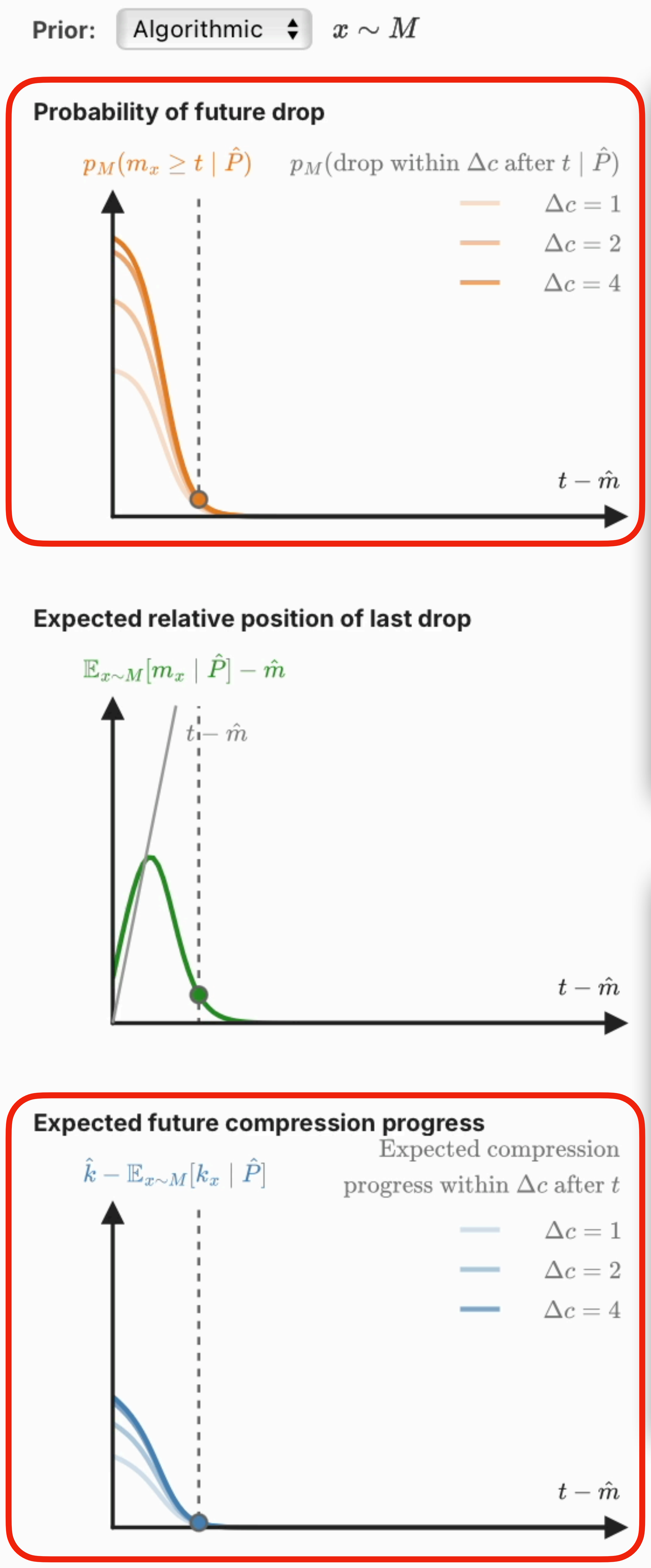
Algorithmic Prior over all computable objects:

$$M(x) = \sum_{p:U(p)=x} 2^{-|p|}$$



Affine Transform $(i, j) \mapsto (\mathrm{BB}(i), i + j)$





Proposition 4.2. *Assuming the object x producing $\hat{P}$ is sampled from the Algorithmic Prior M rather than the Length Prior, the following properties hold:*

(i) *The probability of a further drop at or after complexity t is:*

$$p_M(m_x \geq t \mid \hat{P}) = \frac{1}{1 + \frac{2^{-\hat{m}+O(\log \hat{n})}}{2^{-t+O(\log \hat{n})}+2^{-\hat{k}+O(\log \hat{n})}}},$$

which, for $\hat{k} - t \gg 0$, simplifies to:

$$p_M(m_x \geq t \mid \hat{P}) \approx 2^{-(t-\hat{m})+O(\log \hat{n})}.$$

(ii) *Given the existence of such a drop, the expected complexity of x is:*

$$\mathbb{E}_{x\sim M}[k_x \mid \hat{P}, m \geq t] \approx \frac{\hat{k}+t}{2}.$$

(iii) *Without conditioning on the existence of a further drop, the expected further compression progress is:*

$$\hat{k} - \mathbb{E}_{x\sim M}[k_x \mid \hat{P}] \approx 2^{-(t-\hat{m})+O(\log \hat{n})}.$$

Proposition 4.3. *Assuming $\hat{k} - t \gg 0$ and $t - \hat{m} \gg \log \hat{n}$, the Algorithmic Prior M yields significantly higher expectations for future insight than the Length Prior L. Specifically, the following ratios hold:*

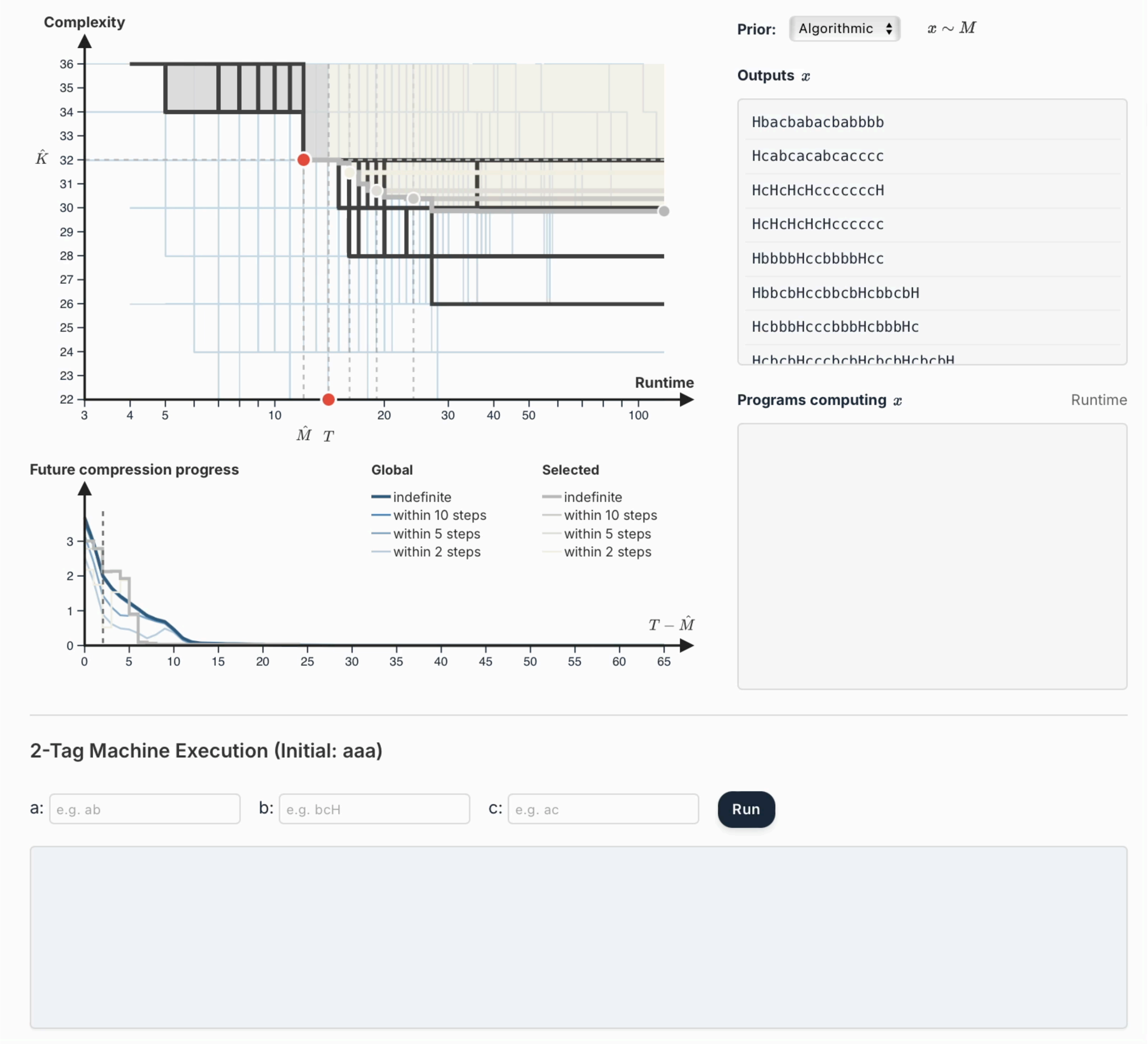
(i) *The ratio between the further drop probabilities is approximately linear in the remaining complexity gap $\hat{k} - t$:*

$$\frac{p_M(m_x \geq t \mid \hat{P})}{p_L(m_x \geq t \mid \hat{P})} \approx \hat{k} - t - 1.$$

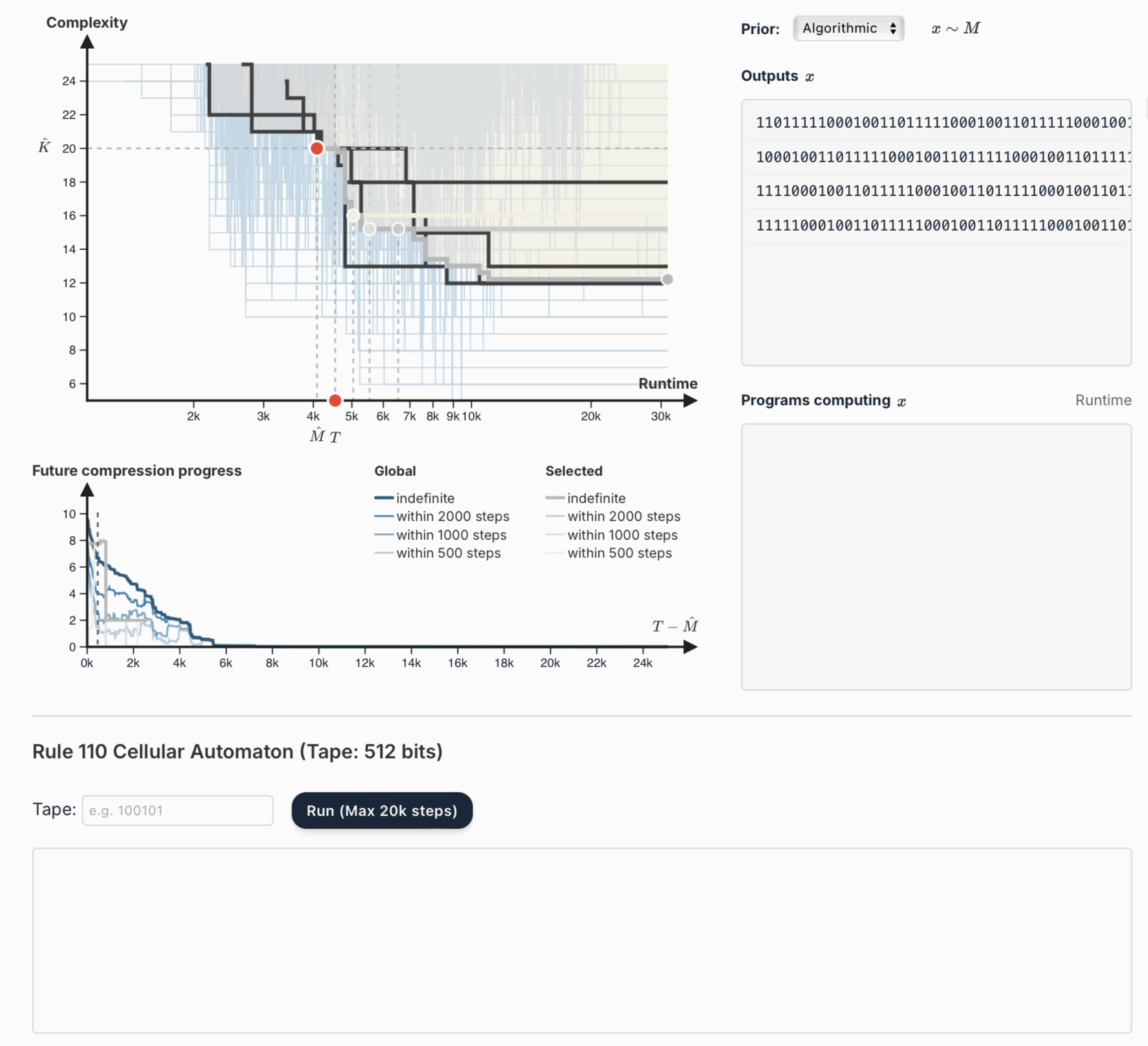
(ii) *The ratio between the expected further compression progress is approximately quadratic in the remaining complexity gap:*

$$\frac{\hat{k} - \mathbb{E}_{x\sim M}[k_x \mid \hat{P}]}{\hat{k} - \mathbb{E}_{x\sim L}[k_x \mid \hat{P}]} \approx \frac{1}{4}\left(\hat{k} - t - 1\right)\left(\hat{k} - t\right).$$

2-Tag System


Complexity
$\hat{K}$
Runtime
$\hat{M}$ T
Prior: Algorithmic
$x \sim M$
Outputs x
Hbacbabacbabbbb
Hcabcacabcacccc
HcHcHcHcccccccH
HcHcHcHcHcccccc
HbbbbHccbbbbHcc
HbbcbHccbbcbHcbbcbH
HcbbbHcccbbbHcbbbHc
Programs computing x
Runtime
Future compression progress
Global
indefinite
within 10 steps
within 5 steps
within 2 steps
Selected
indefinite
within 10 steps
within 5 steps
within 2 steps
$T - \hat{M}$
2-Tag Machine Execution (Initial: aaa)
a: e.g. ab
b: e.g. bcH
c: e.g. ac
Run

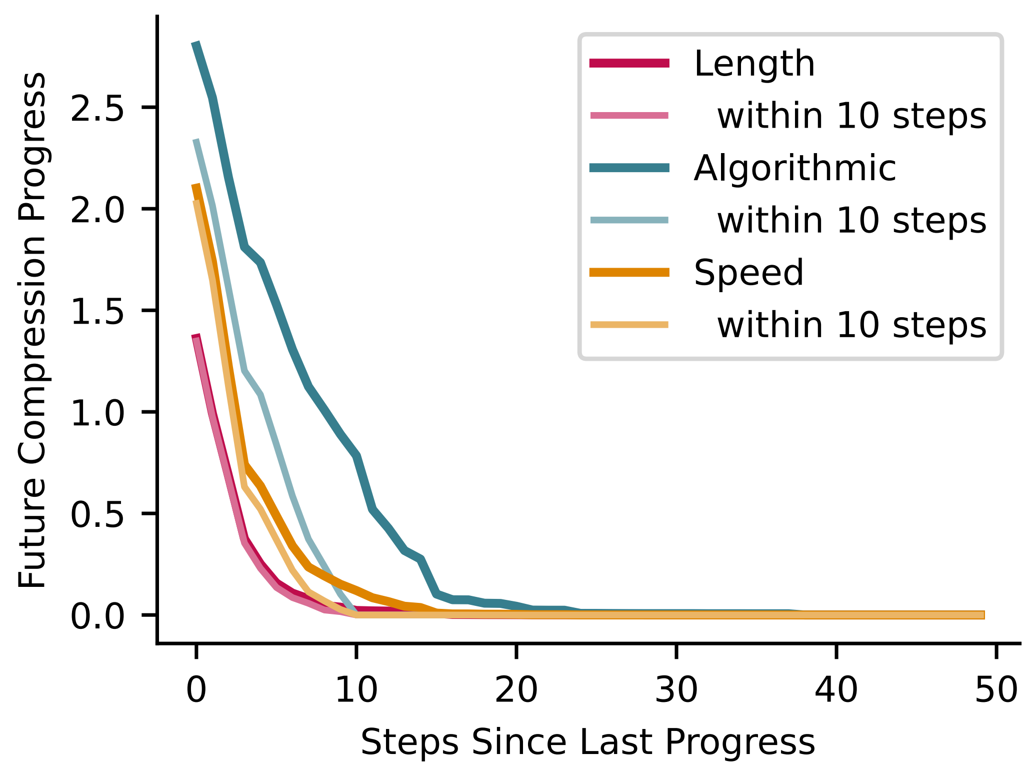
Rule 110 ECA


Complexity
$\hat{K}$
24
22
20
18
16
14
12
10
8
6
Runtime
2k
3k
4k
5k
6k
7k
8k
9k
10k
20k
30k
$\hat{M}$ T
Prior: Algorithmic
$x \sim M$
Outputs x
1101111110001001101111110001001101111110001001
1000100110111111000100110111111000100110111111
1111000100110111111000100110111111000100110111
111110001001101111110001001101111110001001101
Programs computing x
Runtime
Future compression progress
Global
indefinite
within 2000 steps
within 1000 steps
within 500 steps
Selected
indefinite
within 2000 steps
within 1000 steps
within 500 steps
10
8
6
4
2
0
$T - \hat{M}$
0k
2k
4k
6k
8k
10k
12k
14k
16k
18k
20k
22k
24k
Rule 110 Cellular Automaton (Tape: 512 bits)
Tape:
e.g. 100101
Run (Max 20k steps)

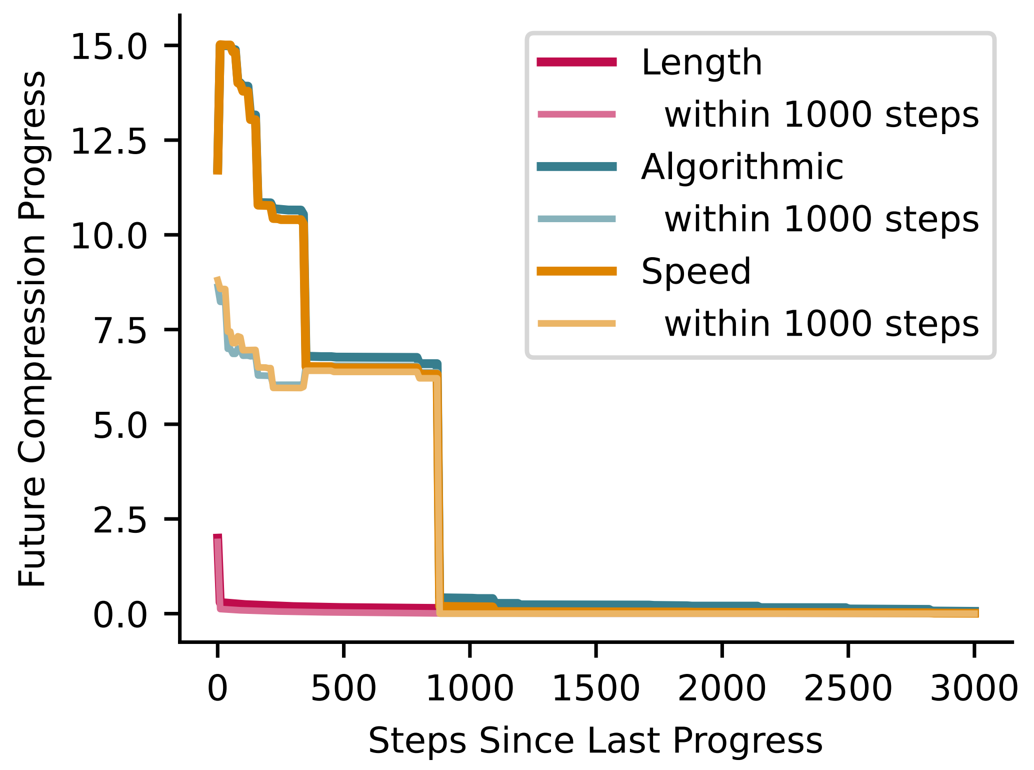
Inductive Interestingness

Experiments

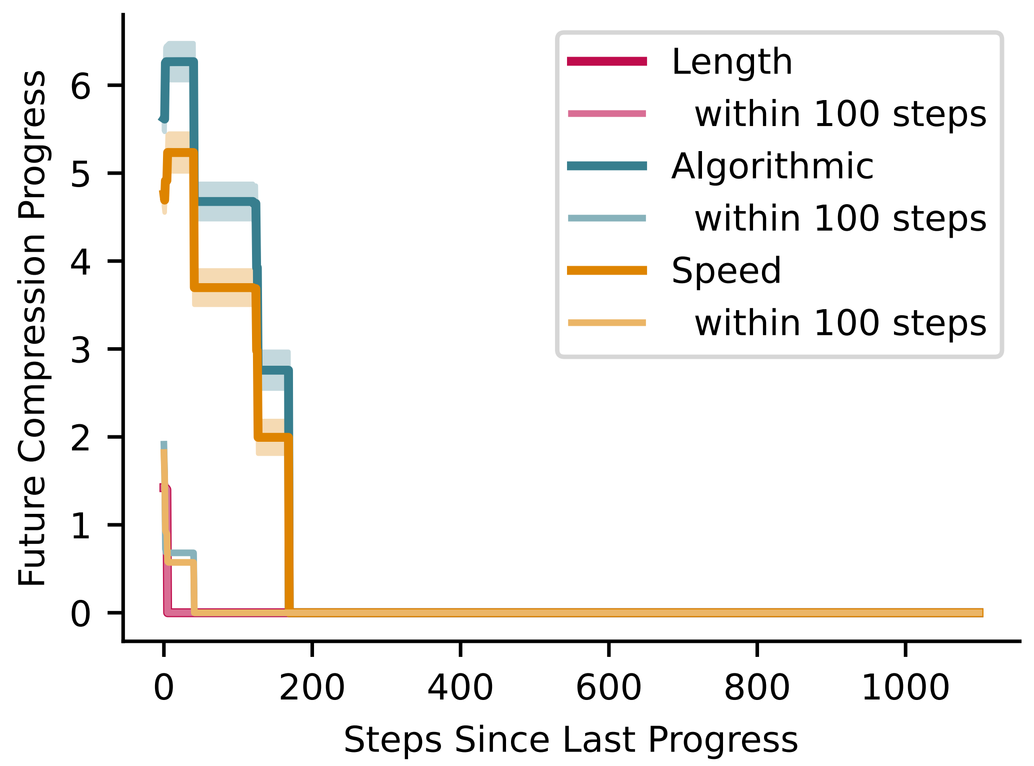
2-Tag



Rule 110

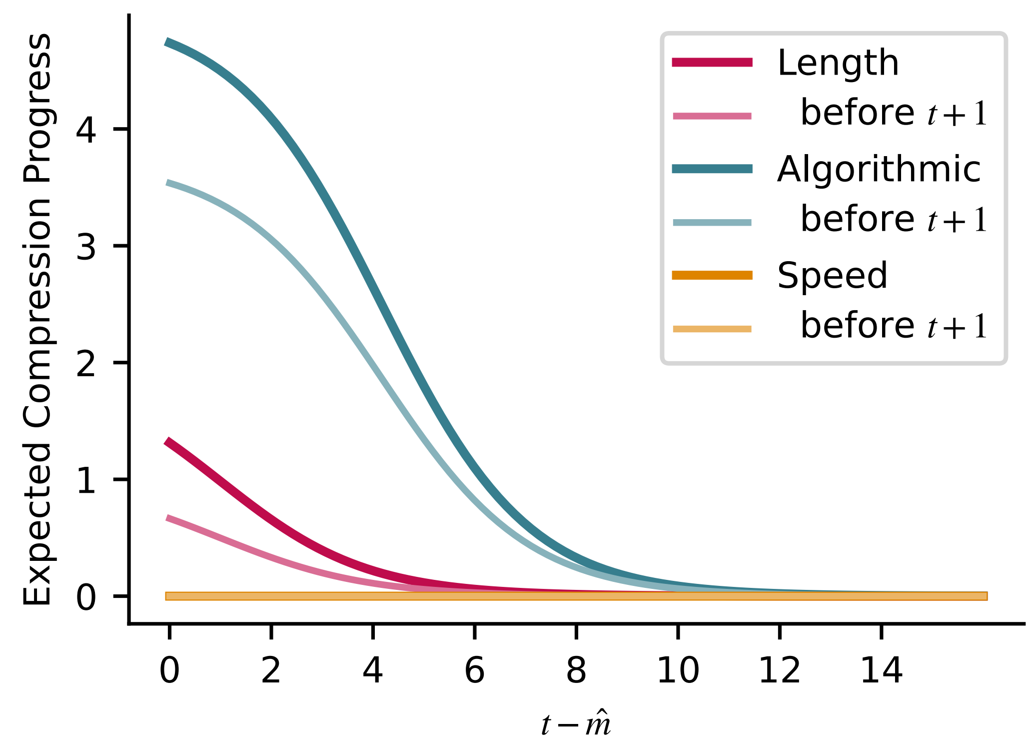


Brainfuck



- Neural Networks & Stochastic Gradient Descent
- Reasoning & Chain-of-Thought
- Model Scaling
- …

Theory



Paper &
Interactive Diagrams

https://inductive-interestingness-2026.github.io/future-compression-progress/