

A Model of Maxwell's demon

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The second law of thermodynamics

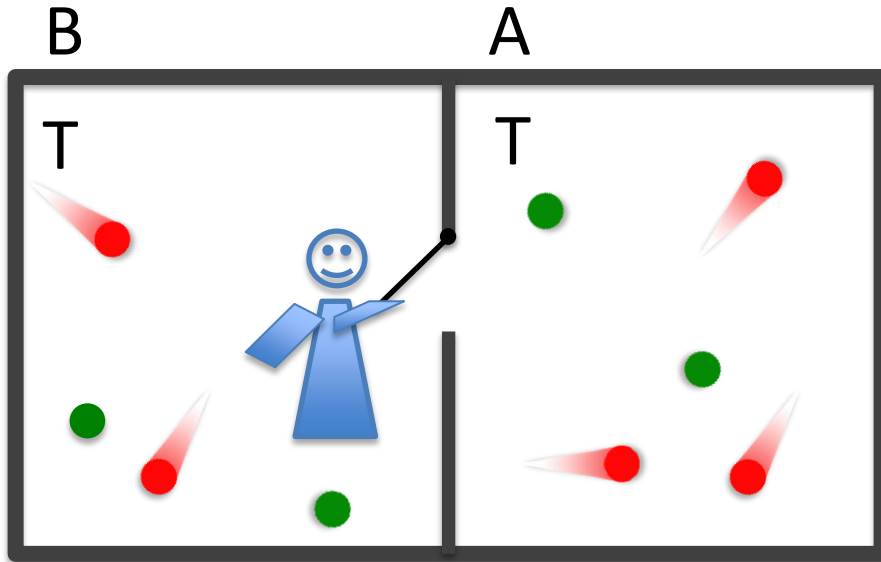
No process is possible whose **sole** result is the extraction of energy from a **single** heat bath and its conversion into work.

$$-W \geq 0$$

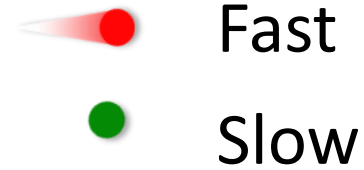
However ...

Maxwell's demon

(born in 1867)

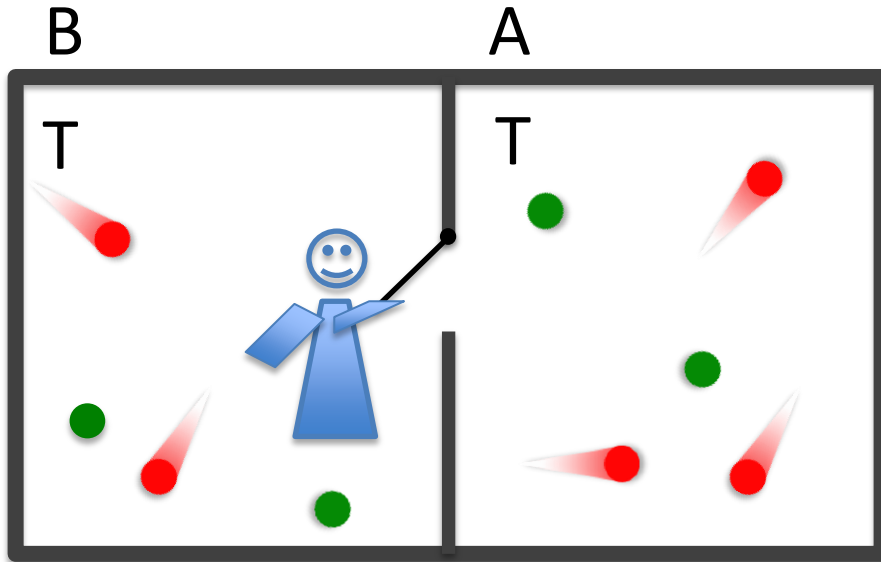


Before operation

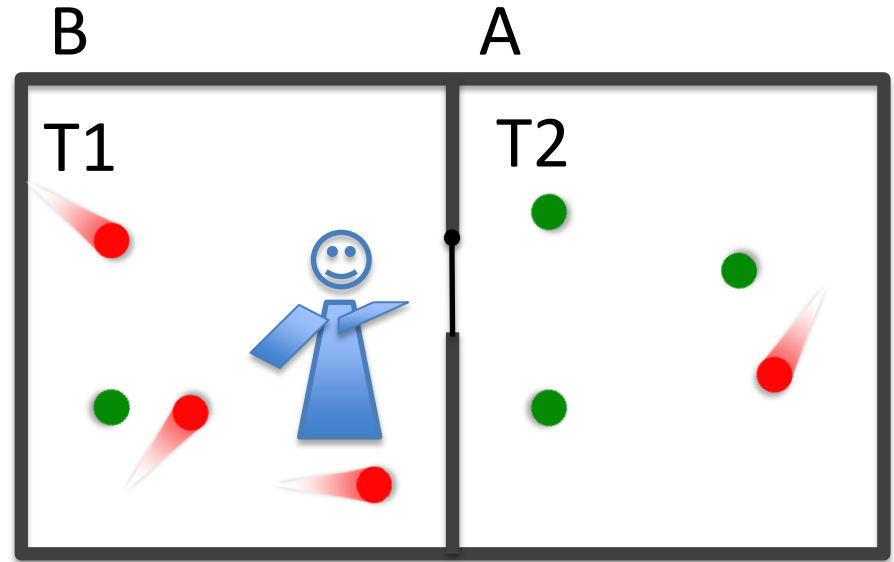


Maxwell's demon

(born in 1867)



Before operation

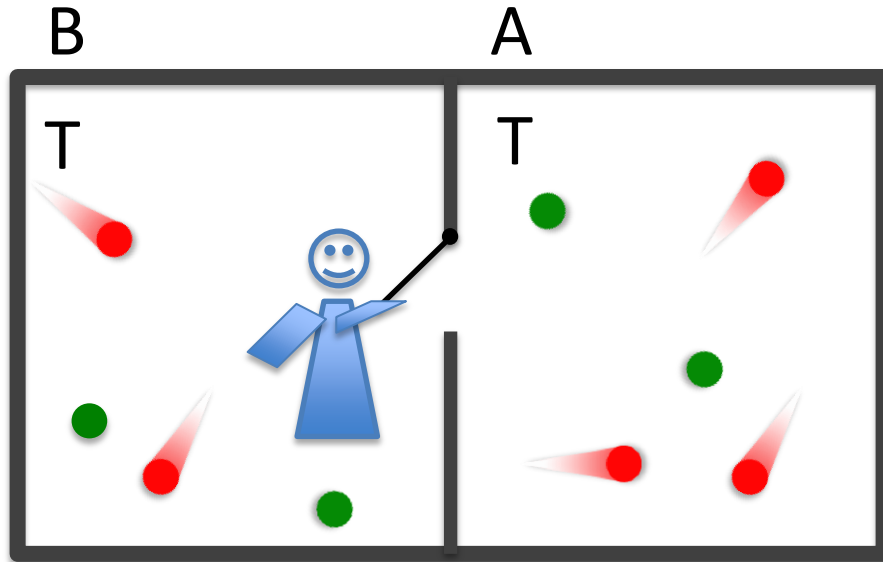


After operation

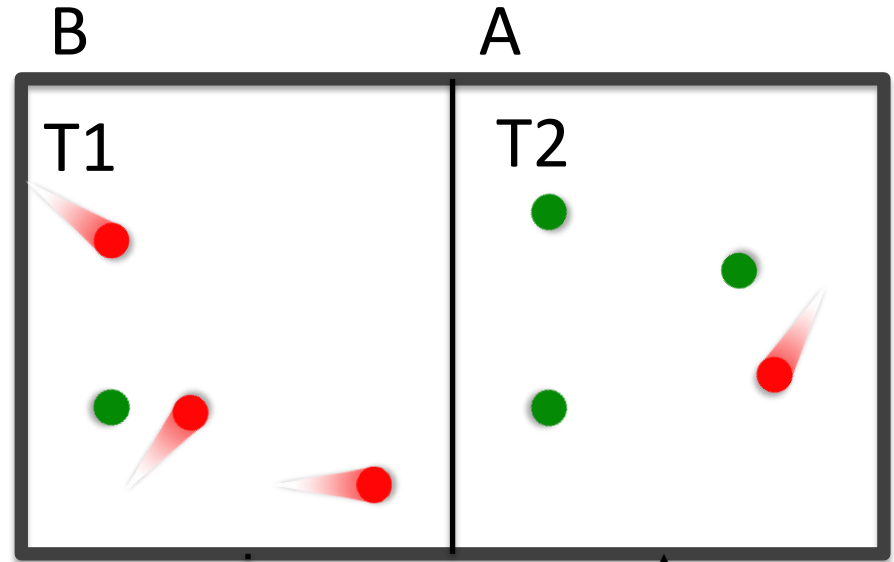
$$T1 > T > T2$$

Maxwell's demon

(born in 1867)



Before operation

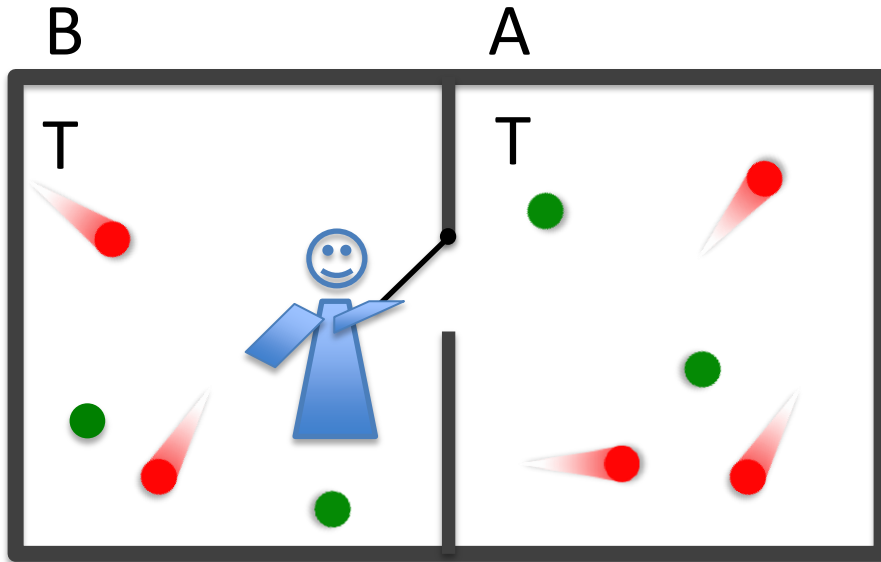


Work

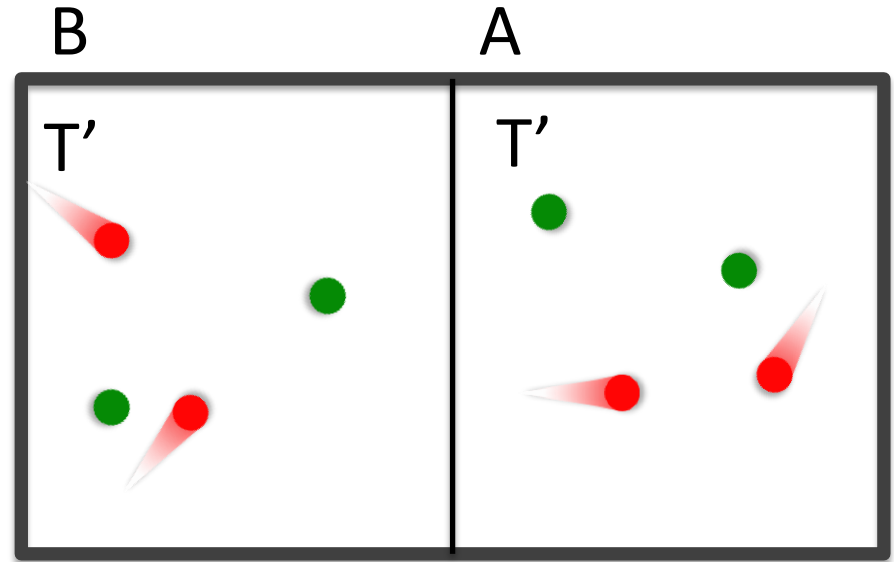
Heat

Maxwell's demon

(born in 1867)



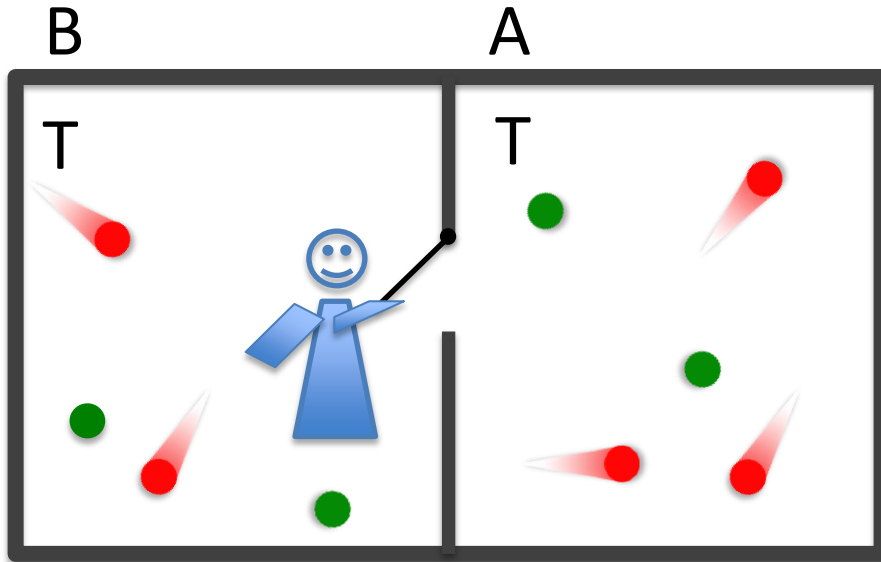
Before operation



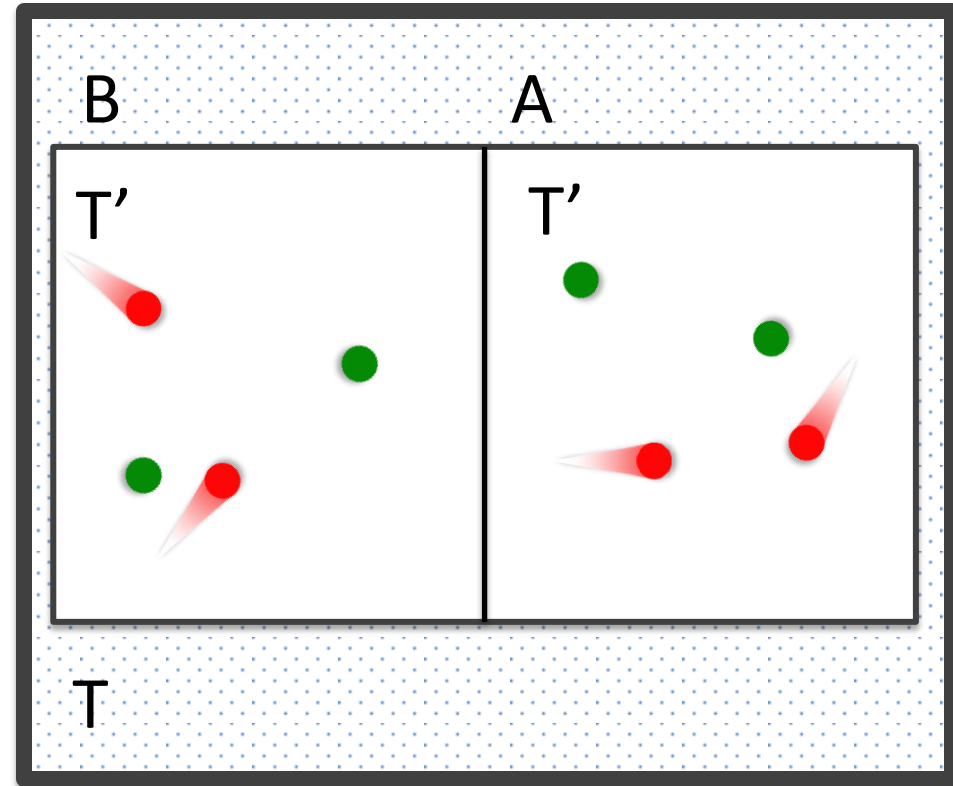
$$T' < T$$

Maxwell's demon

(born in 1867)



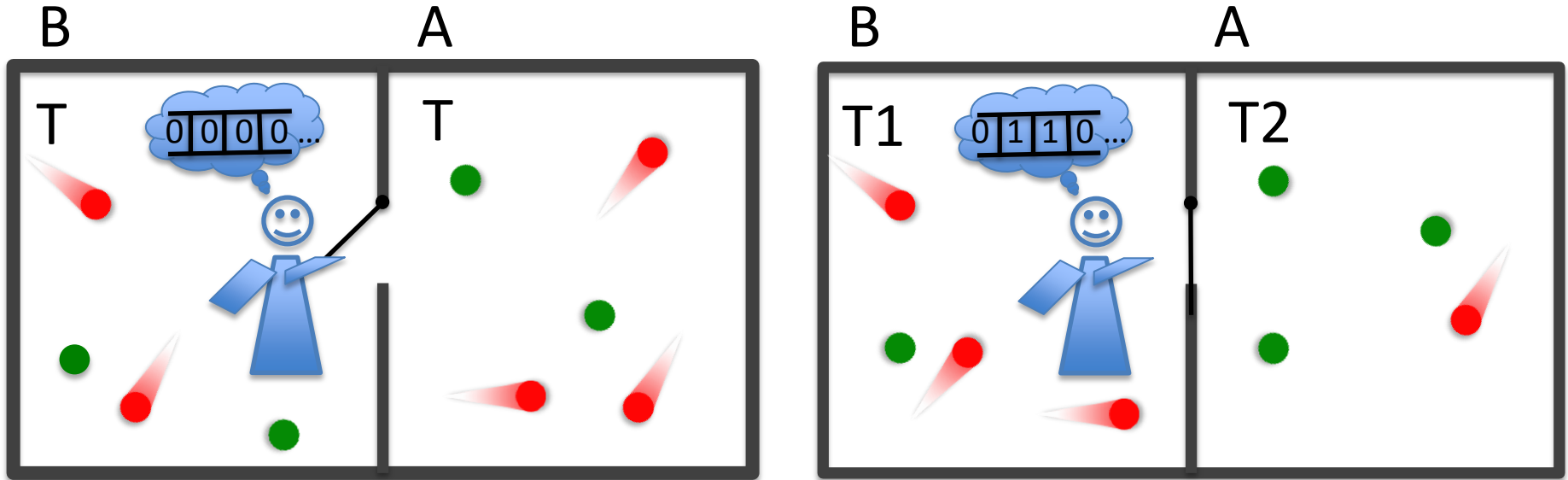
Before operation



Maxwell's demon violates the second law!

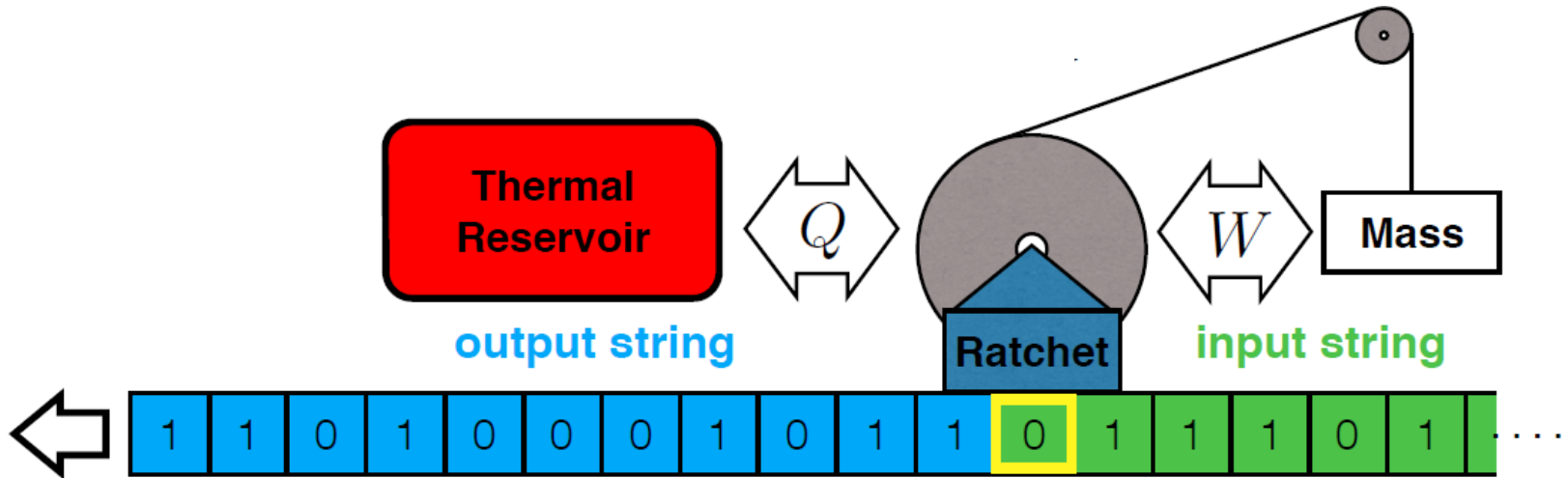
A process seems possible whose **sole** result is
the extraction of energy from a **single** heat bath
and its conversion into work!

Missing piece: Information processing!



Landauer's principle: $kT \ln(2)$ of work to erase one bit of information

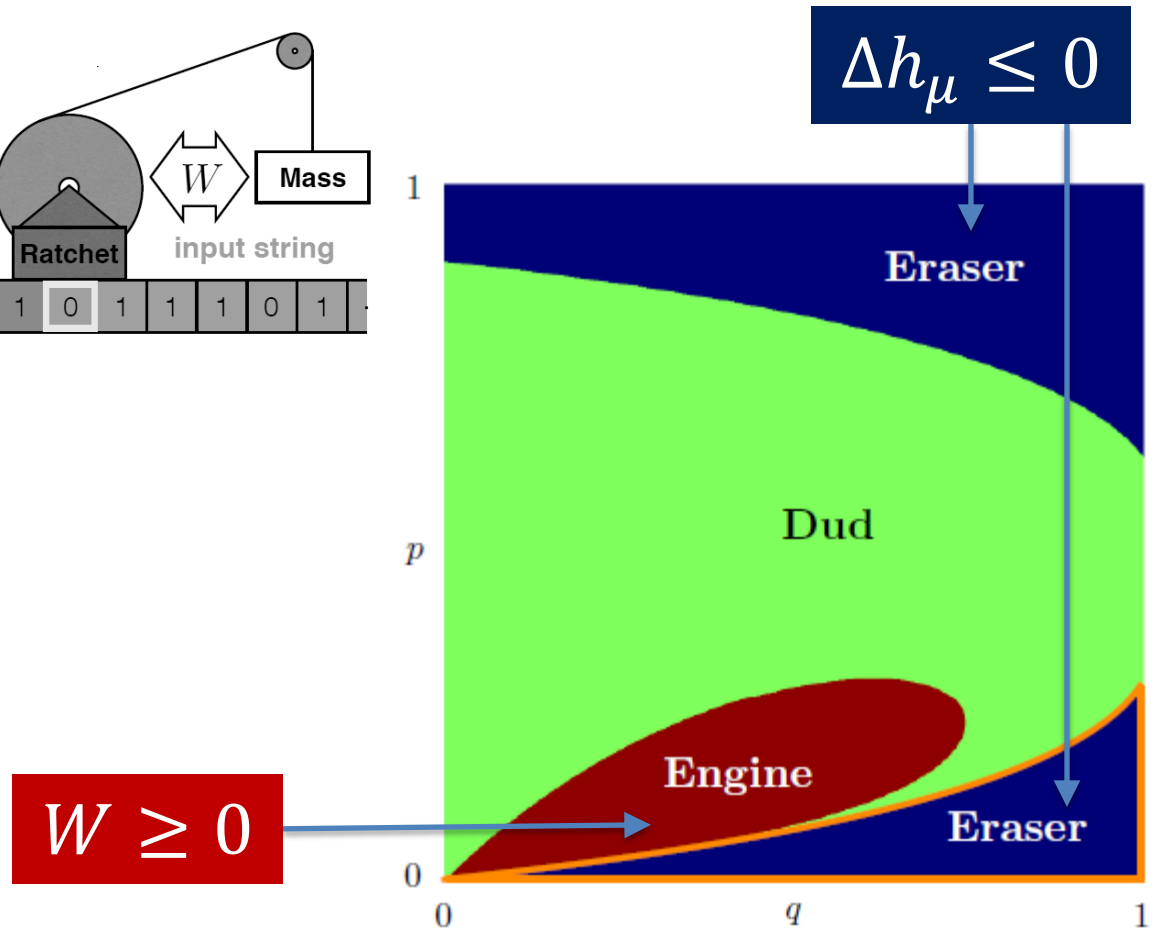
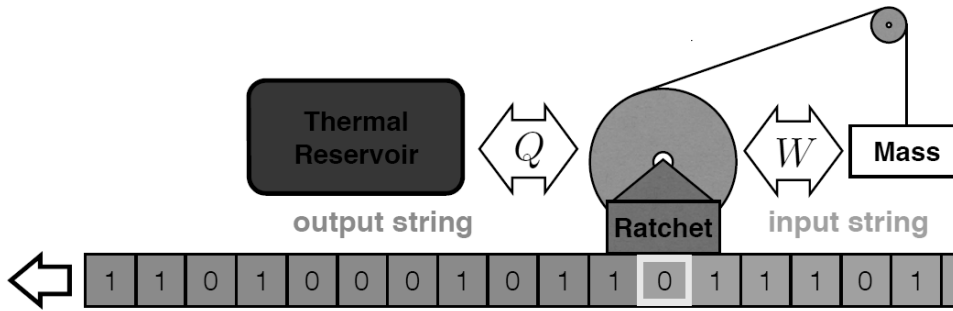
Tape model of Maxwell's demon



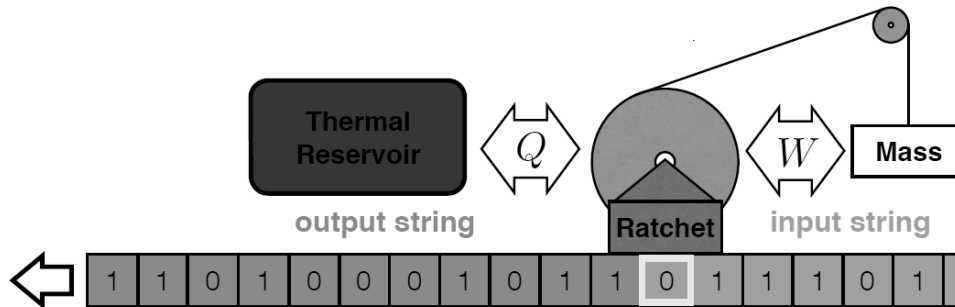
Quantities of interest

- W : Average work / bit
- Δh_μ : Change in information / bit

Phase diagram



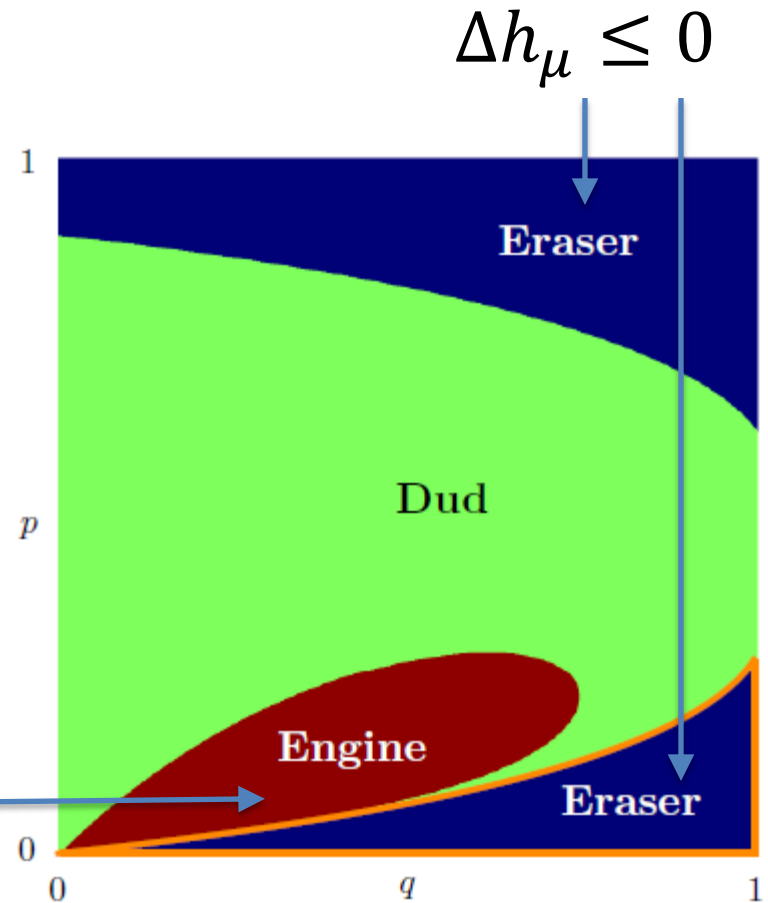
Second law of information processing



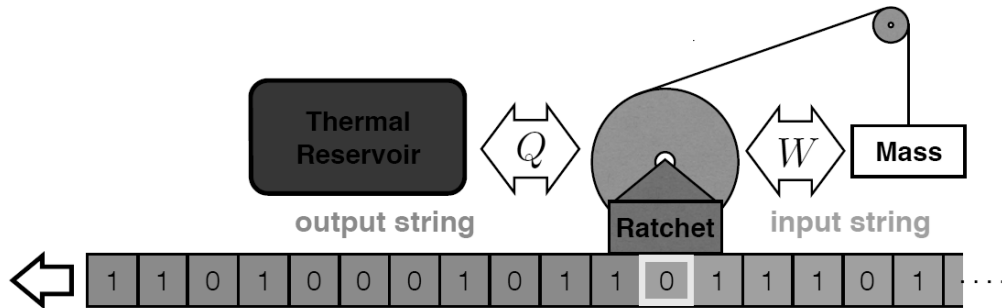
Second law

$$W \leq k_B T \ln 2 \Delta h_\mu$$

$$W \geq 0$$



Second law of information processing

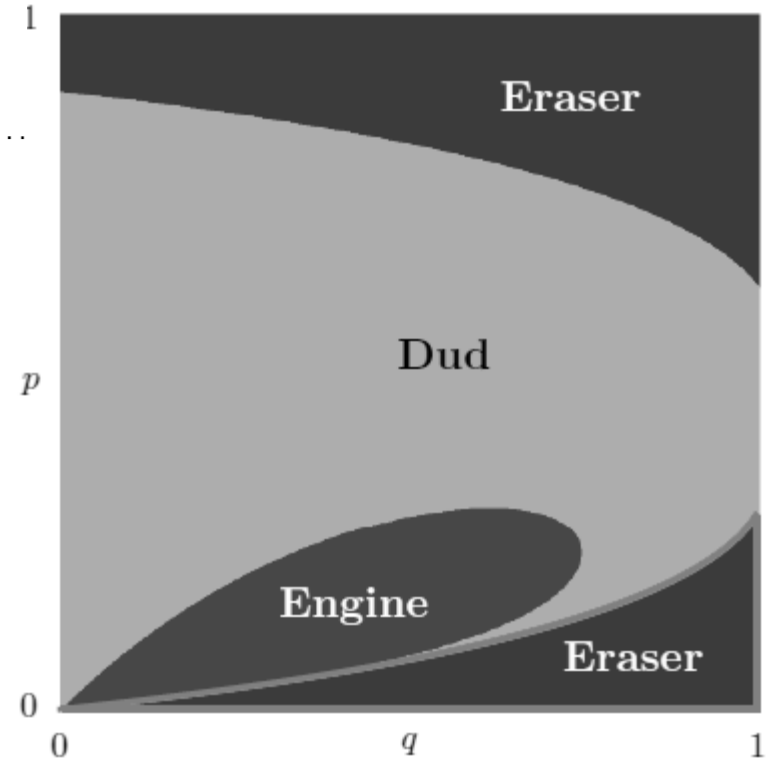


Second law

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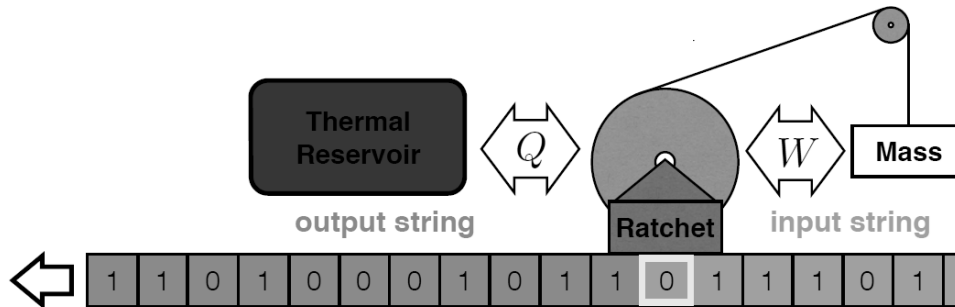
“Rival”

$$W \leq k_B T \ln 2 \Delta H$$



- Single-symbol entropy
- Doesn't care correlations

Second law of information processing

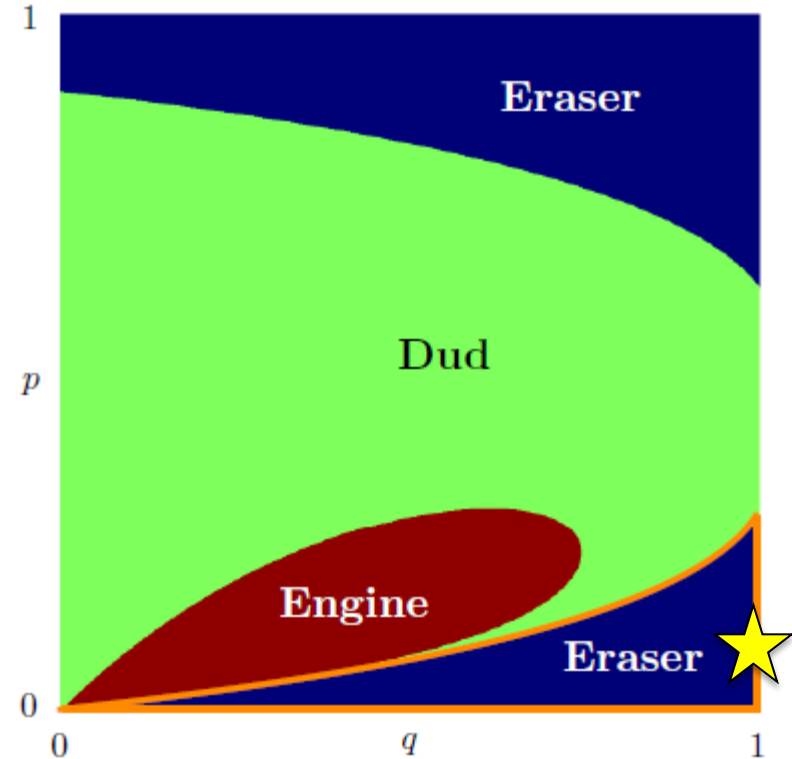


Second law

$$W \leq k_B T \ln 2 \Delta h_\mu$$

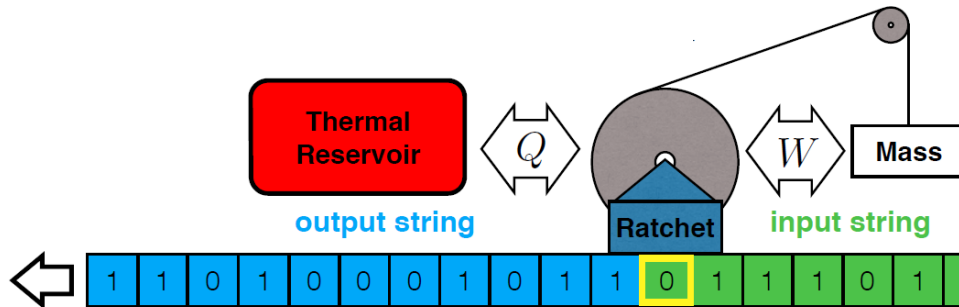
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Second law of information processing



Second law

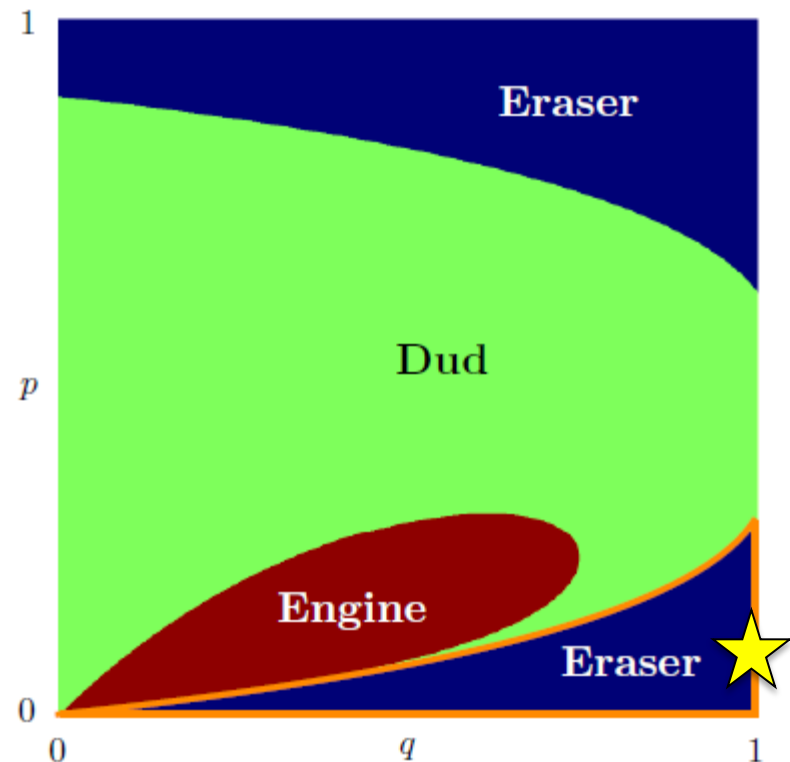


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“Rival”



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