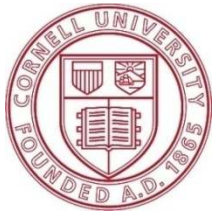


Scaling-up AI Systems: Insights from Computational Complexity

Bart Selman & Carla Gomes

Cornell University

Ryan Williams

Stanford → MIT

Computational Complexity Hierarchy

EXP-complete:
games like Go, …

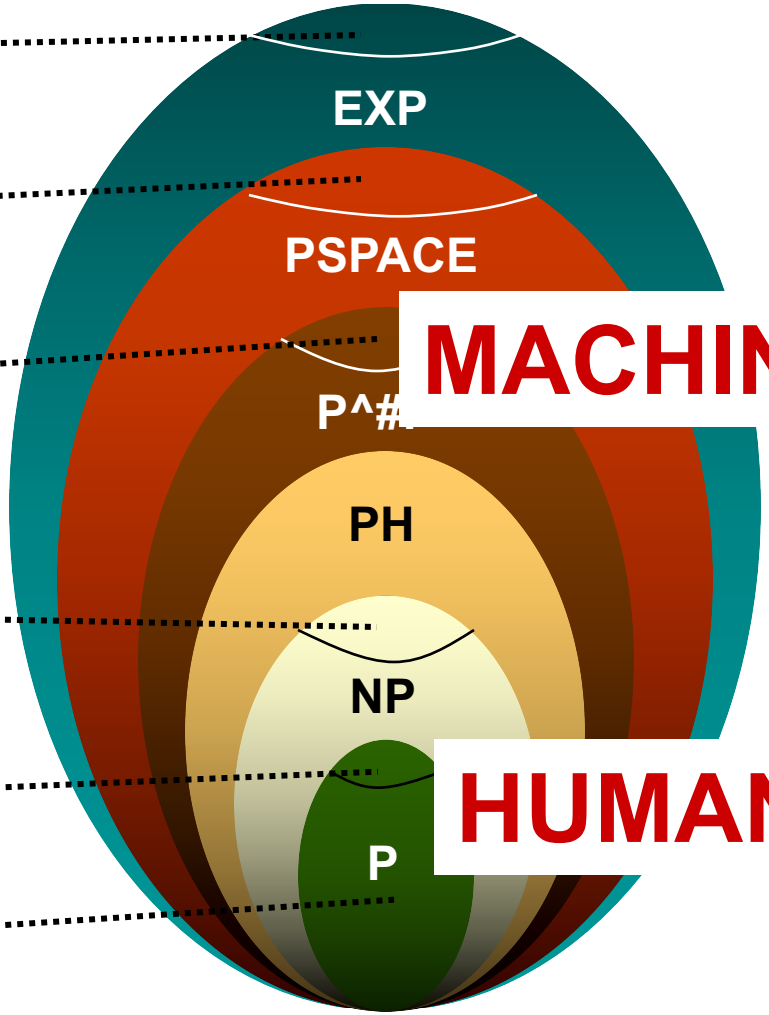
PSPACE-complete:
QBF, ***planning***, chess (bounded), …

#P-complete/hard:
#SAT, sampling, ***probabilistic inference***, …

NP-complete:
SAT, **deep learning, *propositional reasoning***, scheduling …

P-complete:
circuit-value, …

In P:
DB, sorting, shortest path, …



What are the implications for human understanding of machine intelligence?

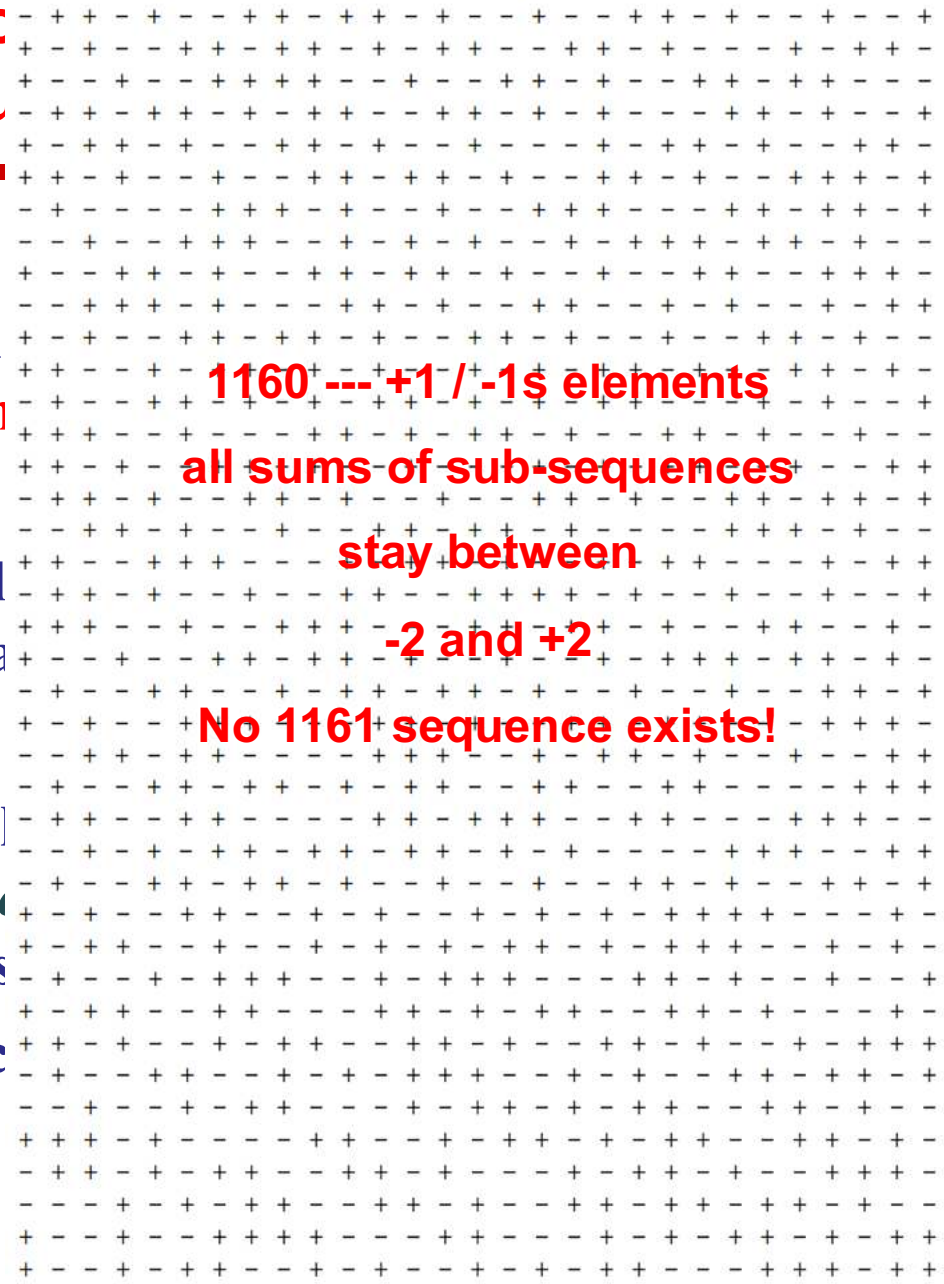
Focus: Human understanding of super-intelligent machines

Hypothesis: Even though machines are moving to higher levels of the computational complexity hierarchy, it may not necessarily be the case that humans won't be able to understand their behaviors/decisions.

Why? In earlier work, we showed how automated reasoning on very large reasoning problems (millions of variables) can often be understood in terms of the behavior of a small set (a few dozen) of key variables ("backdoor variables"). The machine can provide the backdoor variables (i.e., **explains itself**).

$B(n)$	deterministic	randomized	heuristic
n/k	small $exp(n)$	smaller $exp(n)$	tiny $exp(n)$
$O(\log n)$	$\left(\frac{n}{\sqrt{\log n}}\right)^{O(\log n)}$	$\left(\frac{n}{\log n}\right)^{O(\log n)}$	$poly(n)$
$O(1)$	$poly(n)$	$poly(n)$	$poly(n)$

Fc
su



1160 ---+1 / -1s elements

all sums of sub-sequences

stay between

-2 and +2

No 1161 sequence exists!

So, at least in …here is hope for human un… …ning.

More formall… …r complex computationa… …typical case)

Concrete cha… …he *Erdos discrepancy c…* …*2014)*. Does a human access…

(likely… we c…