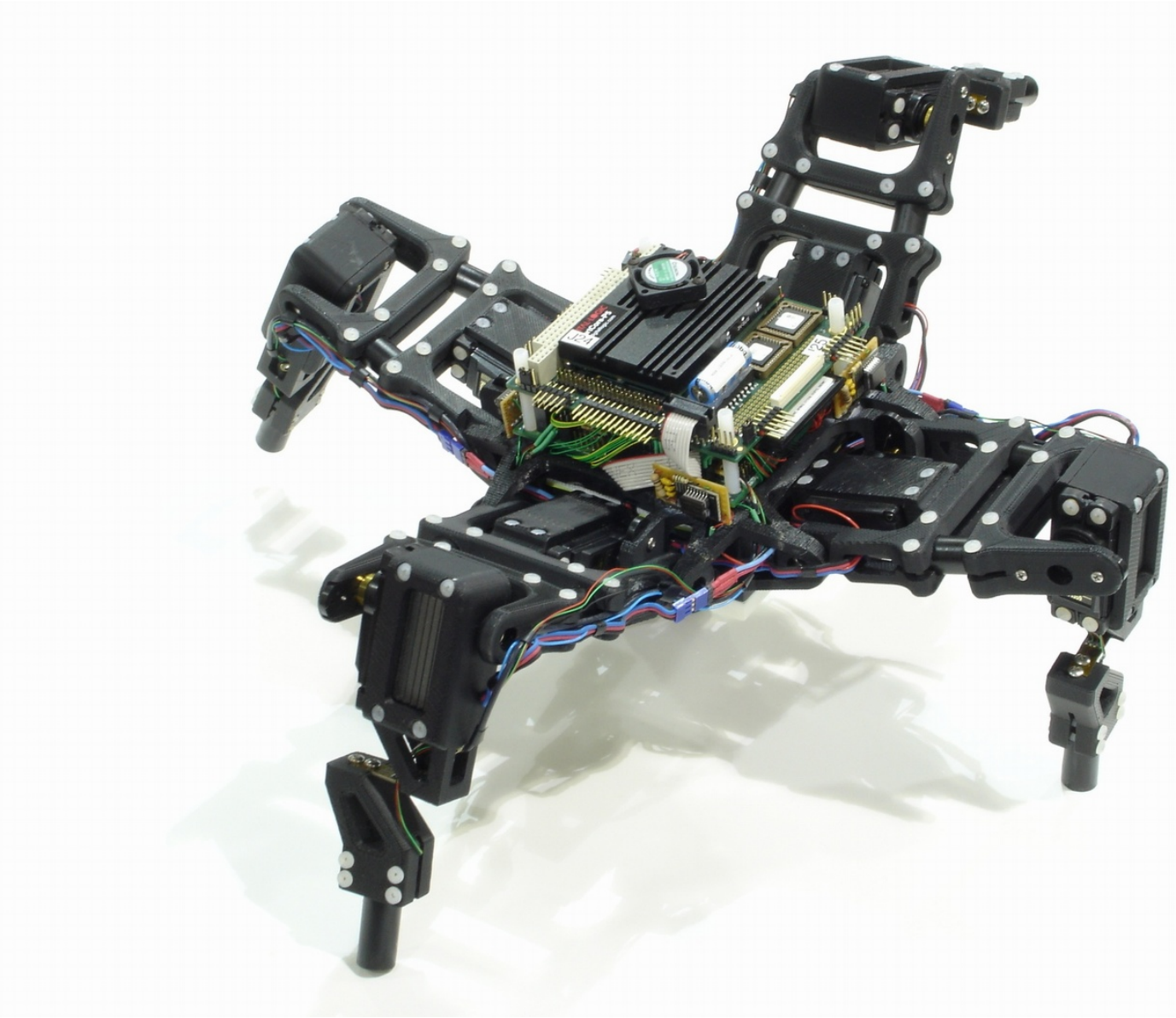

Using

evolutionary robotics

to study

embodied cognition.

Josh Bongard
University of Vermont

Bemidji
Fargo
Superior National Forest
Lake Superior
Duluth
MINNESOTA
St Cloud
Minneapolis
WISCONSIN
Rochester
Oshkosh
Lake Michigan
Madison
Milwaukee
Grand Rapids
MICHIGAN
Lake Huron
Manitoulin Island
Sudbury
Algonquin Provincial Park
La Verendrye Wildlife Reserve
Ottawa
Montreal
Quebec City
Sherbrooke
NEW BRUNSWICK
Moncton
Fredericton
Saint John
NOVA SCOT
MAINE
VERMONT
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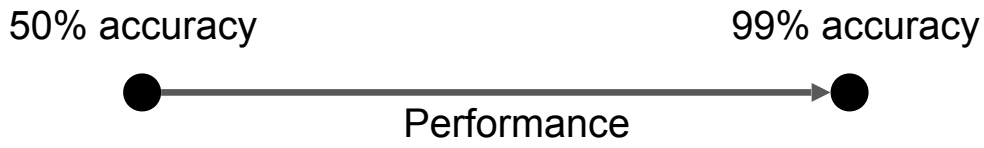
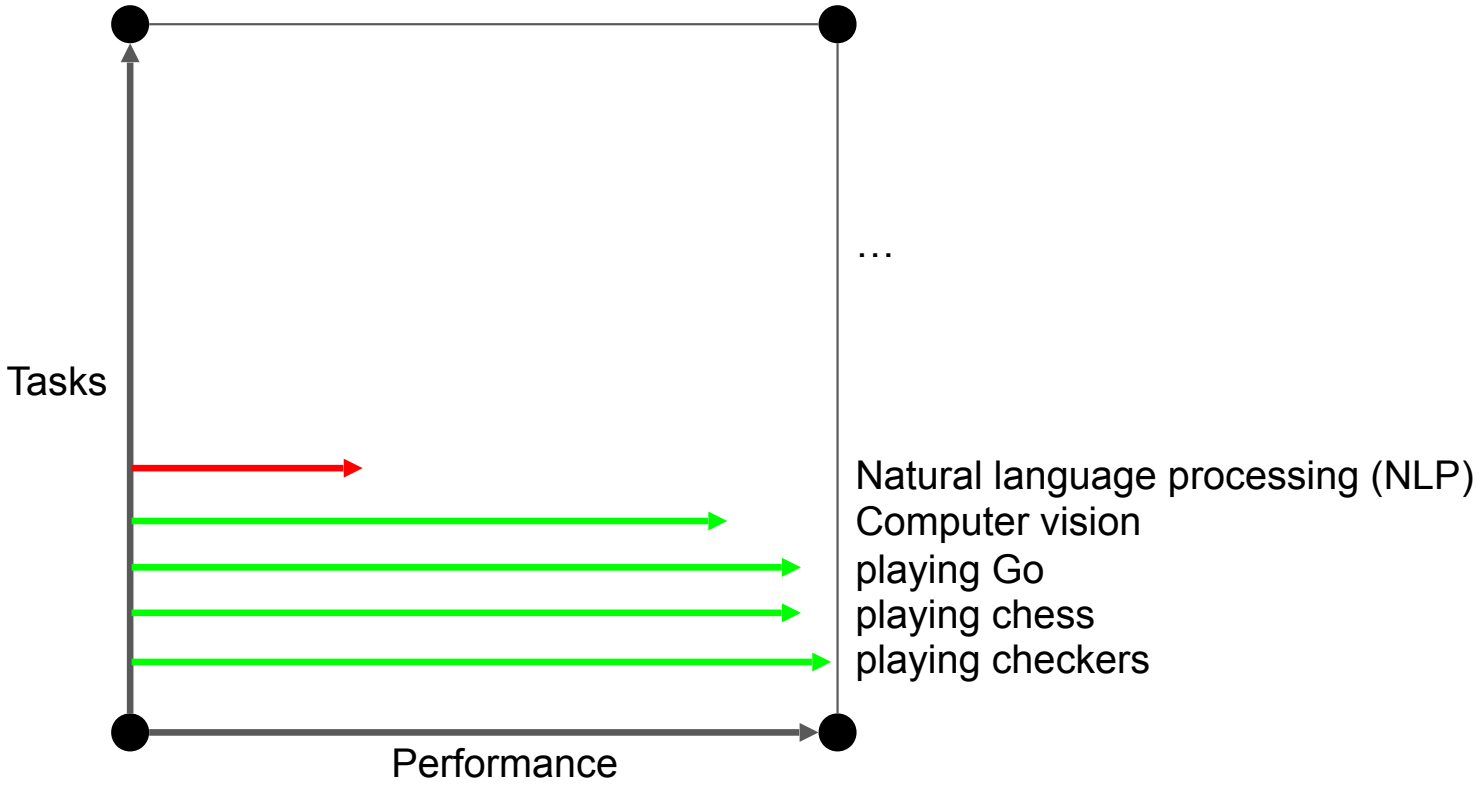
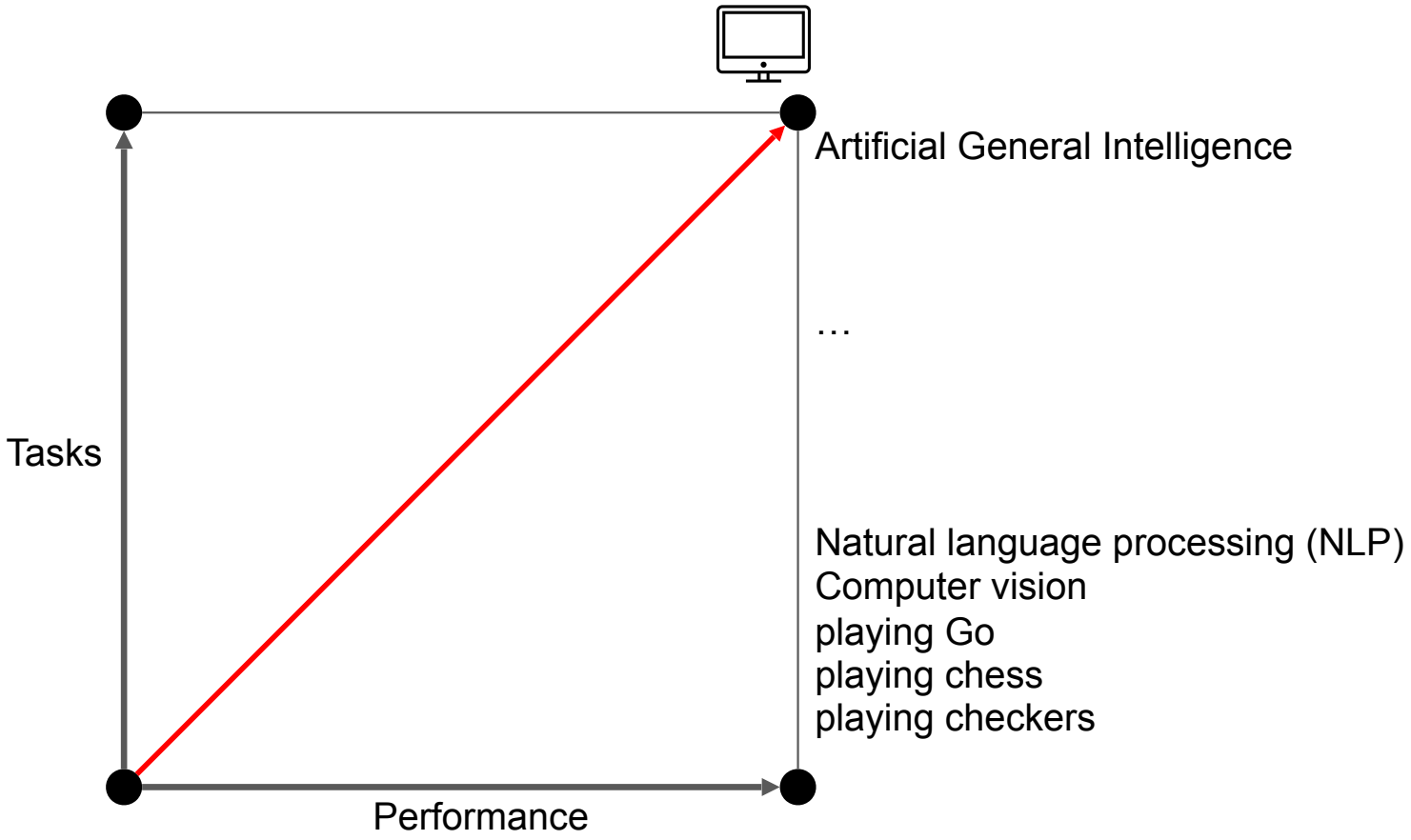
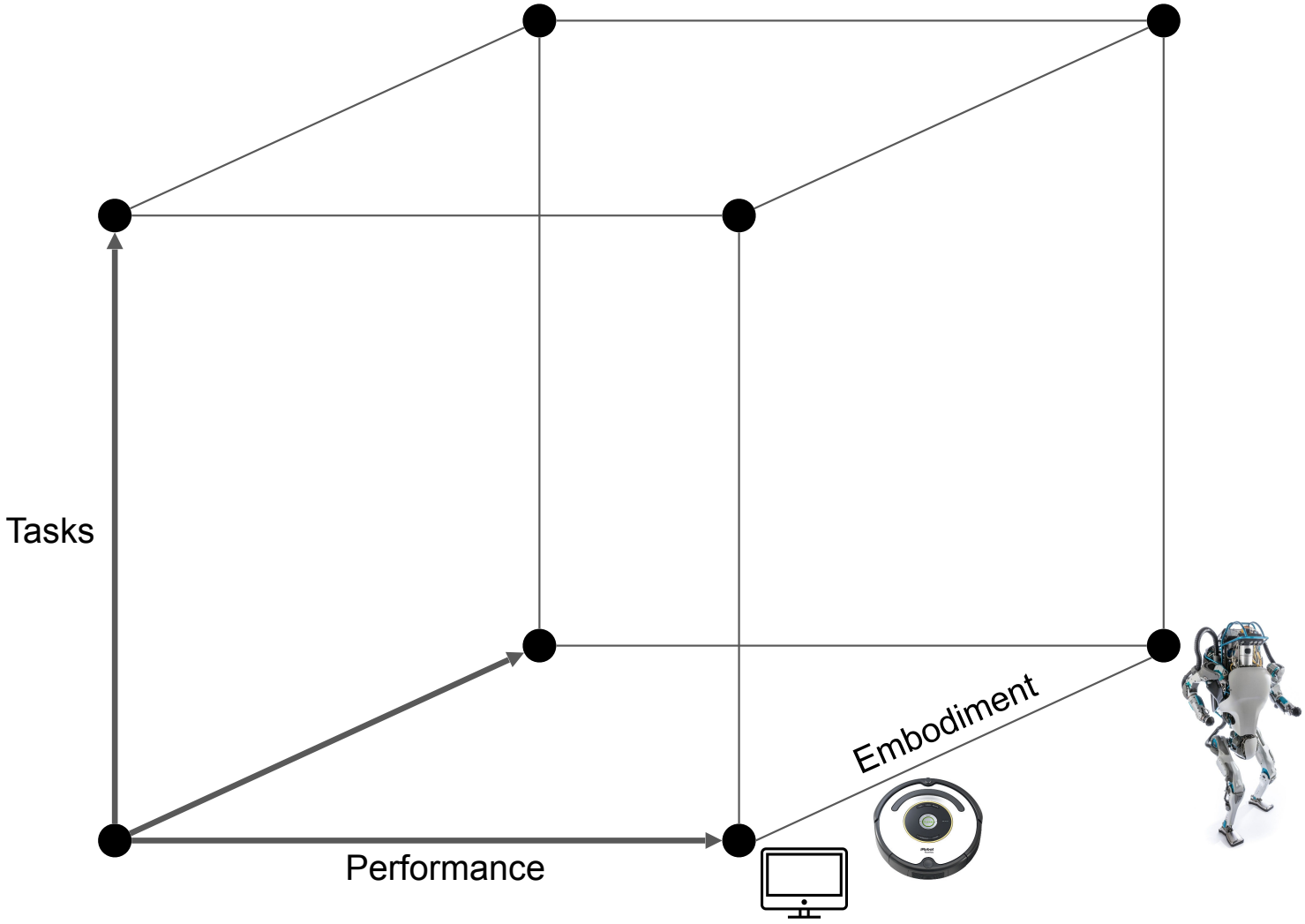
UVM Complex Systems Center @uvmcomplexity · 17h

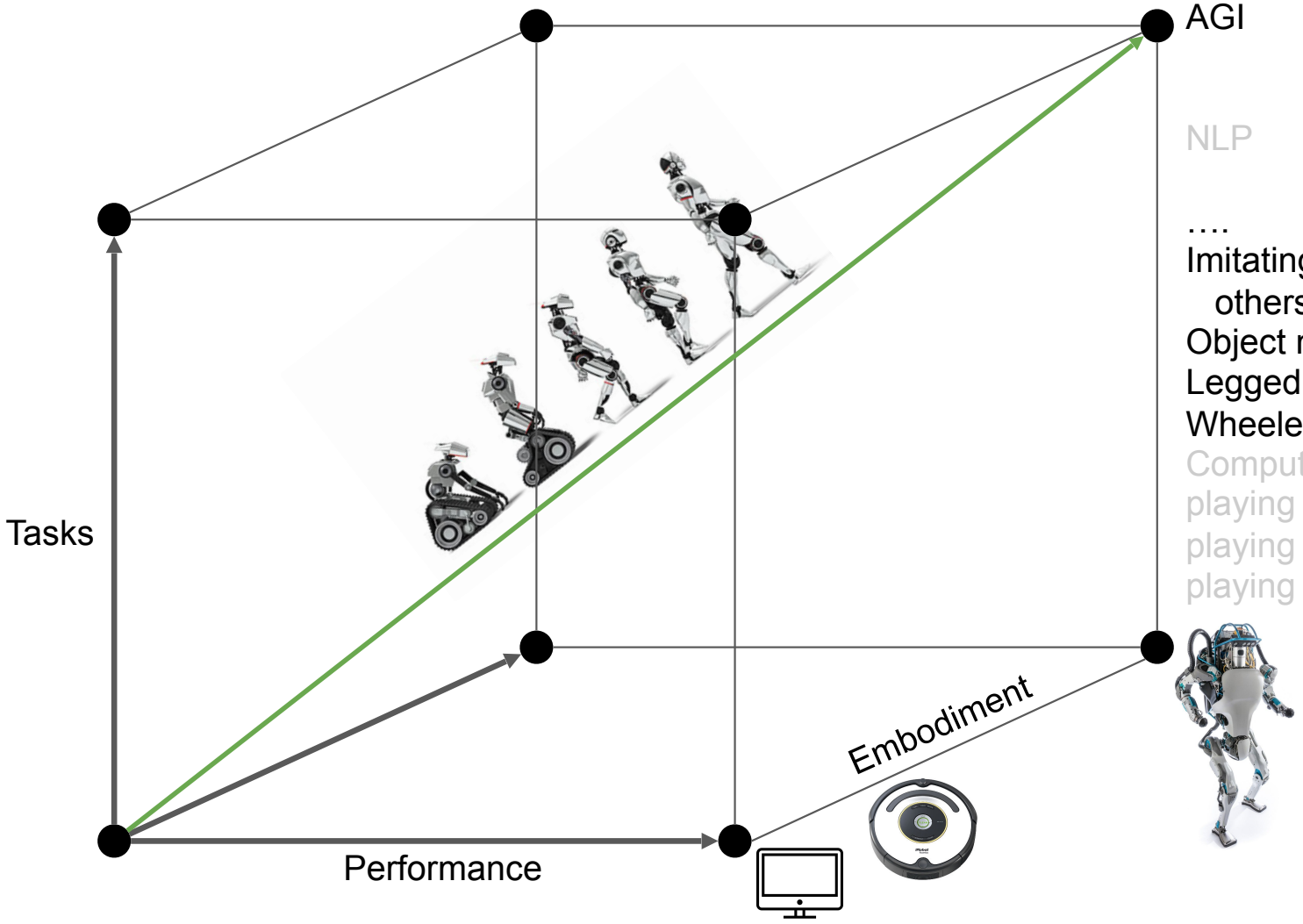
The **Vermont Complex** Systems Center has 7 Ph.D./Master's fellowships open in **Complex** Systems and Data Science. Applications are now open for Fall 2019. Help us spread the word! Learn more here bit.ly/complex-fellow…


50% accuracy
99% accuracy
Performance


Tasks
…
Natural language processing (NLP)
Computer vision
playing Go
playing chess
playing checkers
Performance

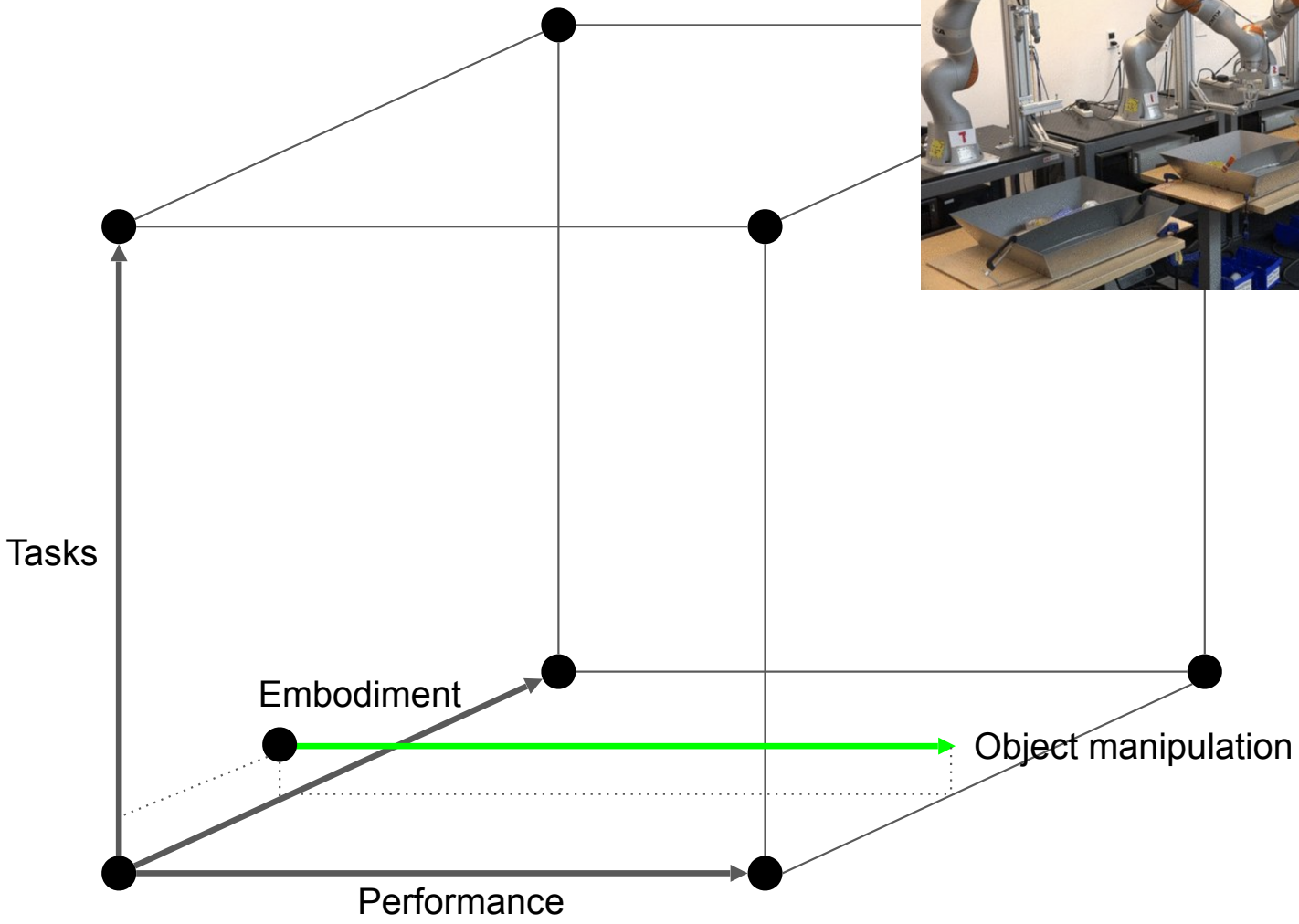

Artificial General Intelligence
…
Natural language processing (NLP)
Computer vision
playing Go
playing chess
playing checkers
Tasks
Performance

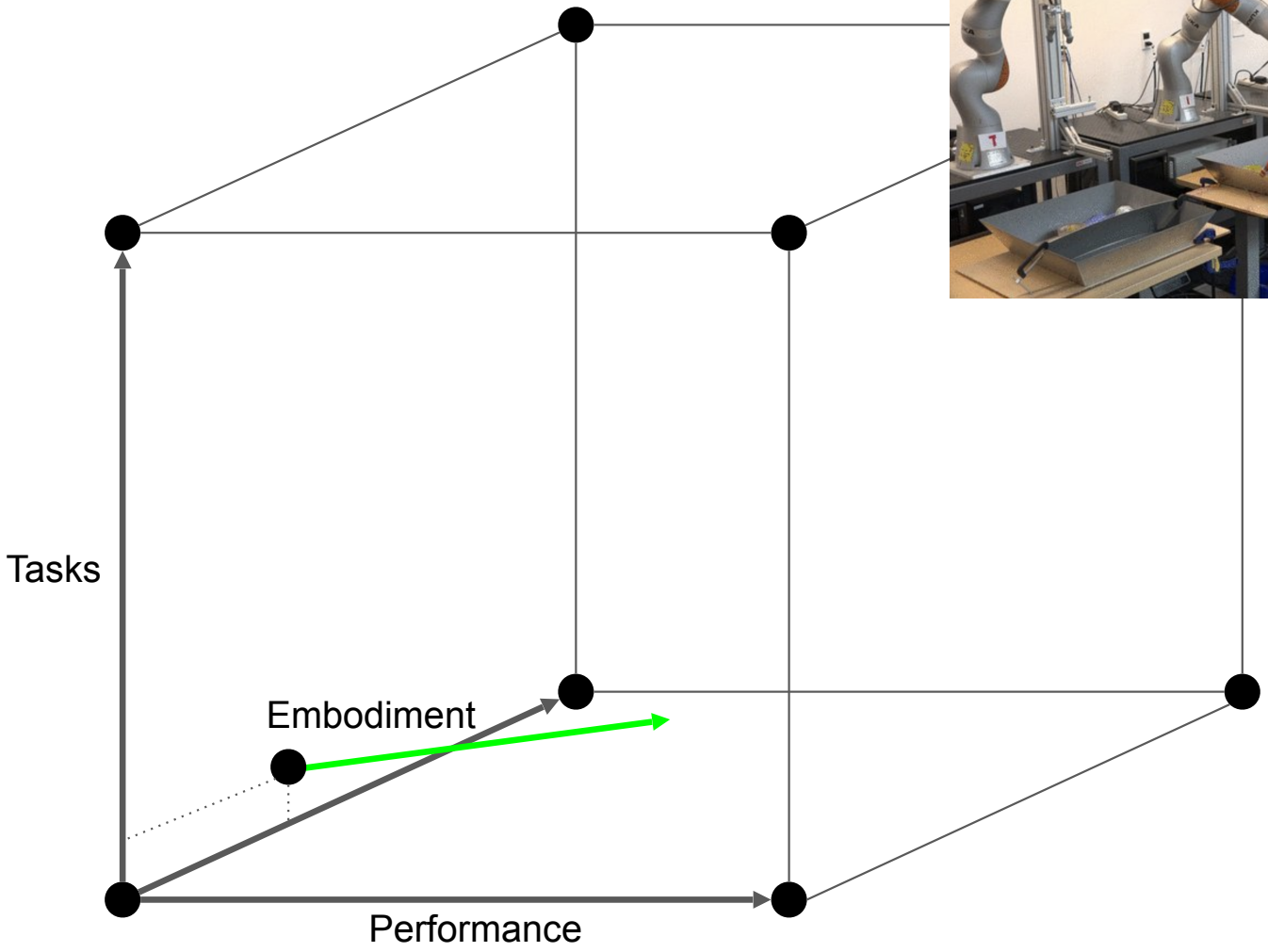

Tasks
Performance
Embodiment

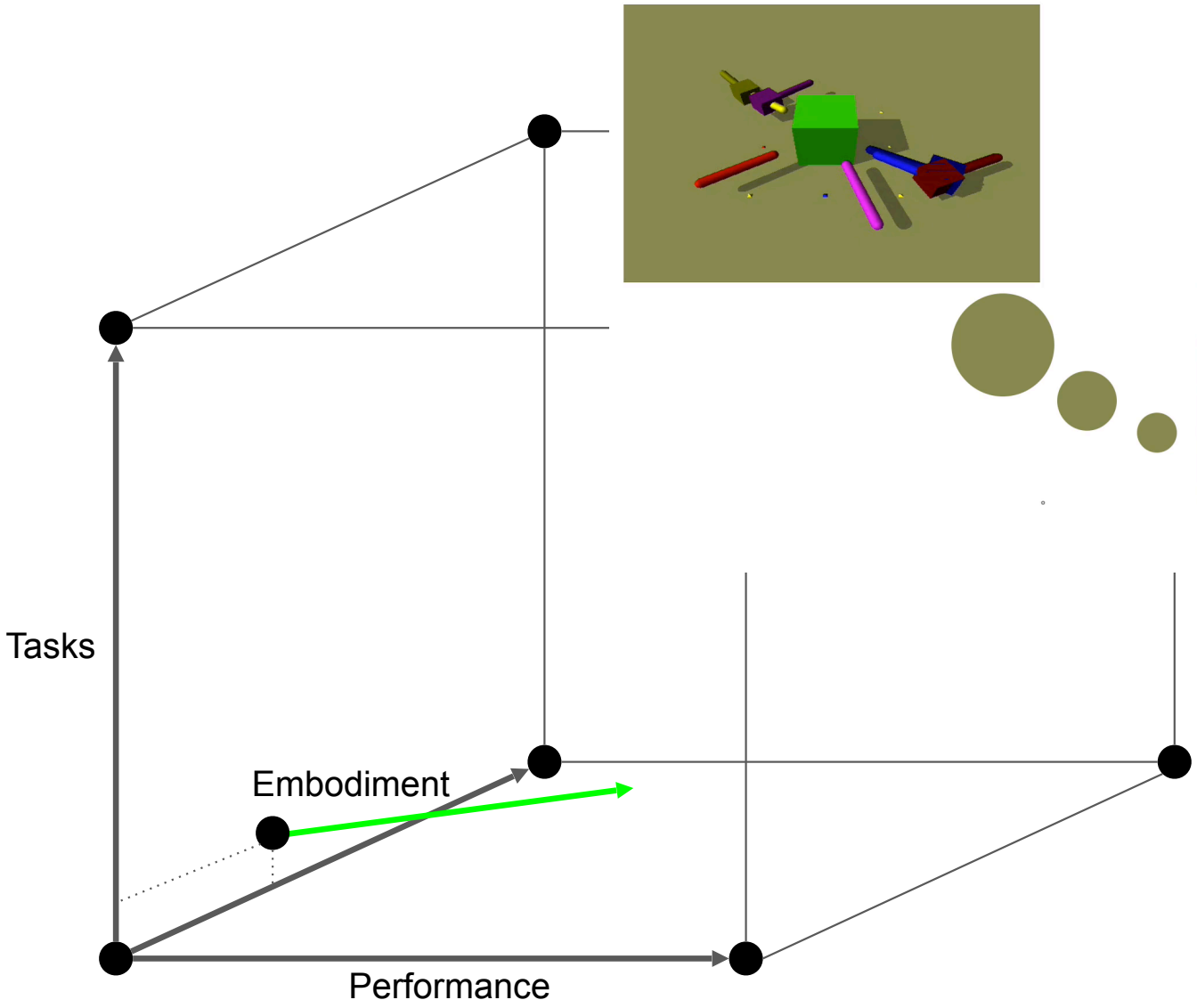

AGI
NLP
….
Imitating actions of others
Object manipulation
Legged locomotion
Wheeled locomotion
Computer vision
playing Go
playing chess
playing checkers
Tasks
Embodiment
Performance

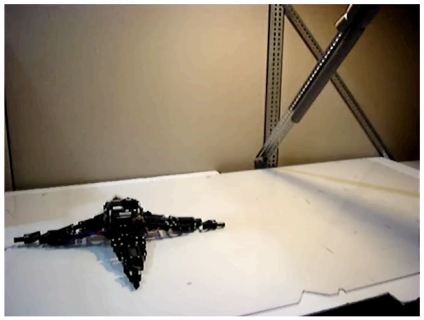
Andrej Karpathy @karpathy · Jun 30 2018

Scalable Deep Reinforcement Learning for Robotic Manipulation ai.googleblog.com/2018/06/scalab… hand-designed init -> 580k grasp attempts on 7 **robot** arms over 4 months (raw monocular RGB camera input) -> 1.2M param net -> **96**% successful test set grasps

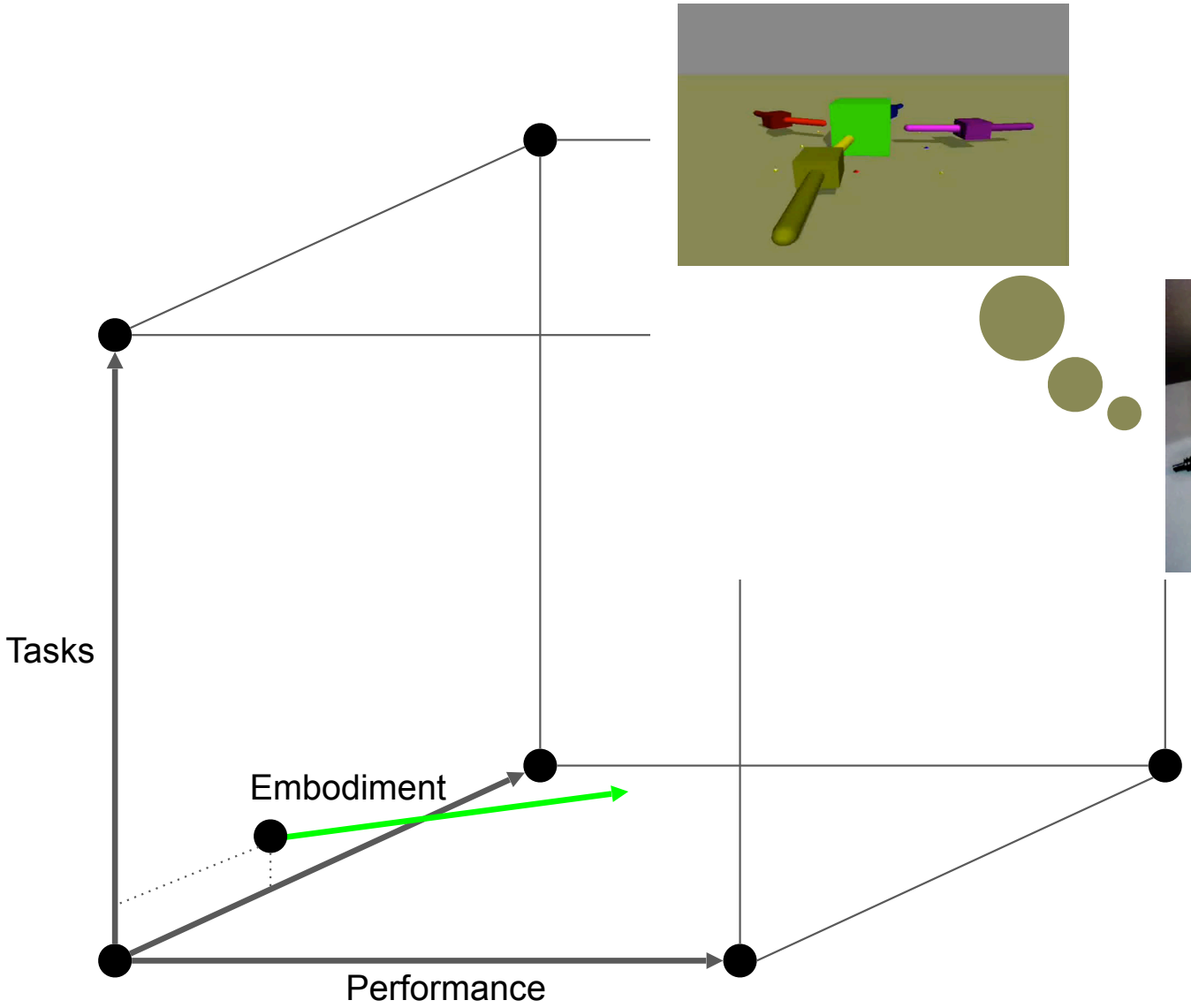

Tasks
Embodiment
Object manipulation
Performance

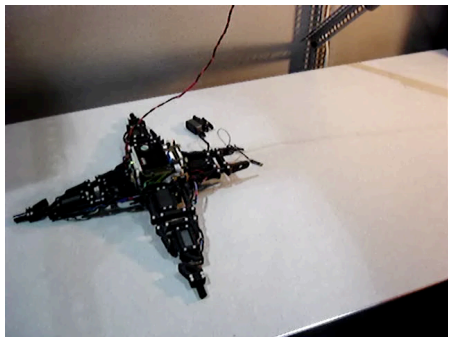

Tasks
Embodiment
Performance



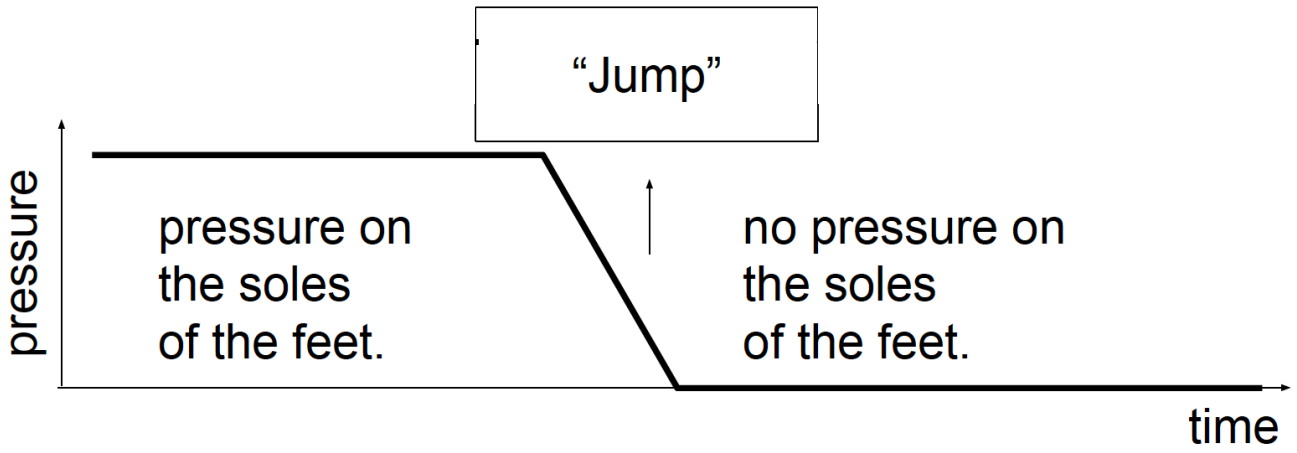


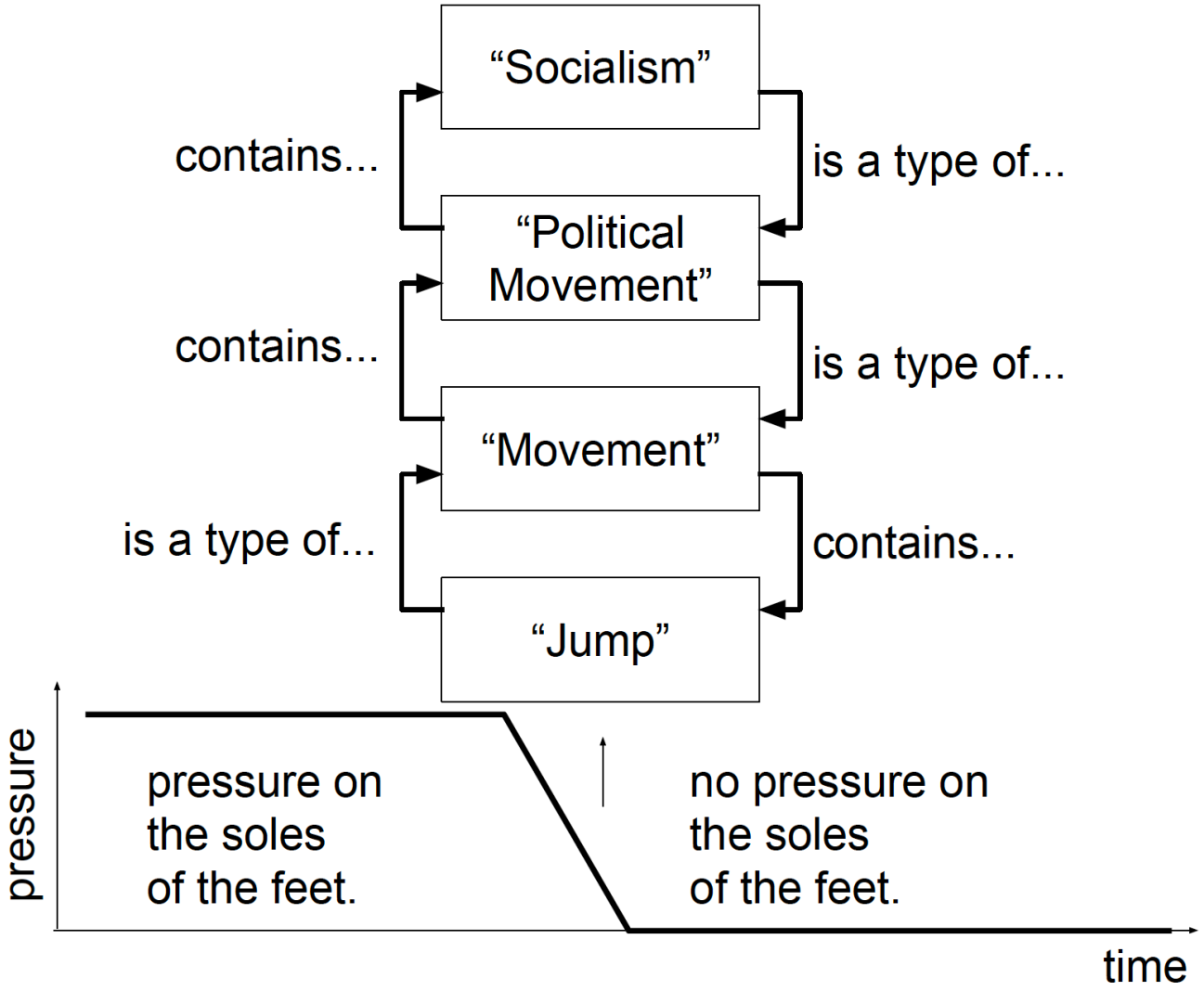
Bongard, Zykov, Lipson (2006).
Science



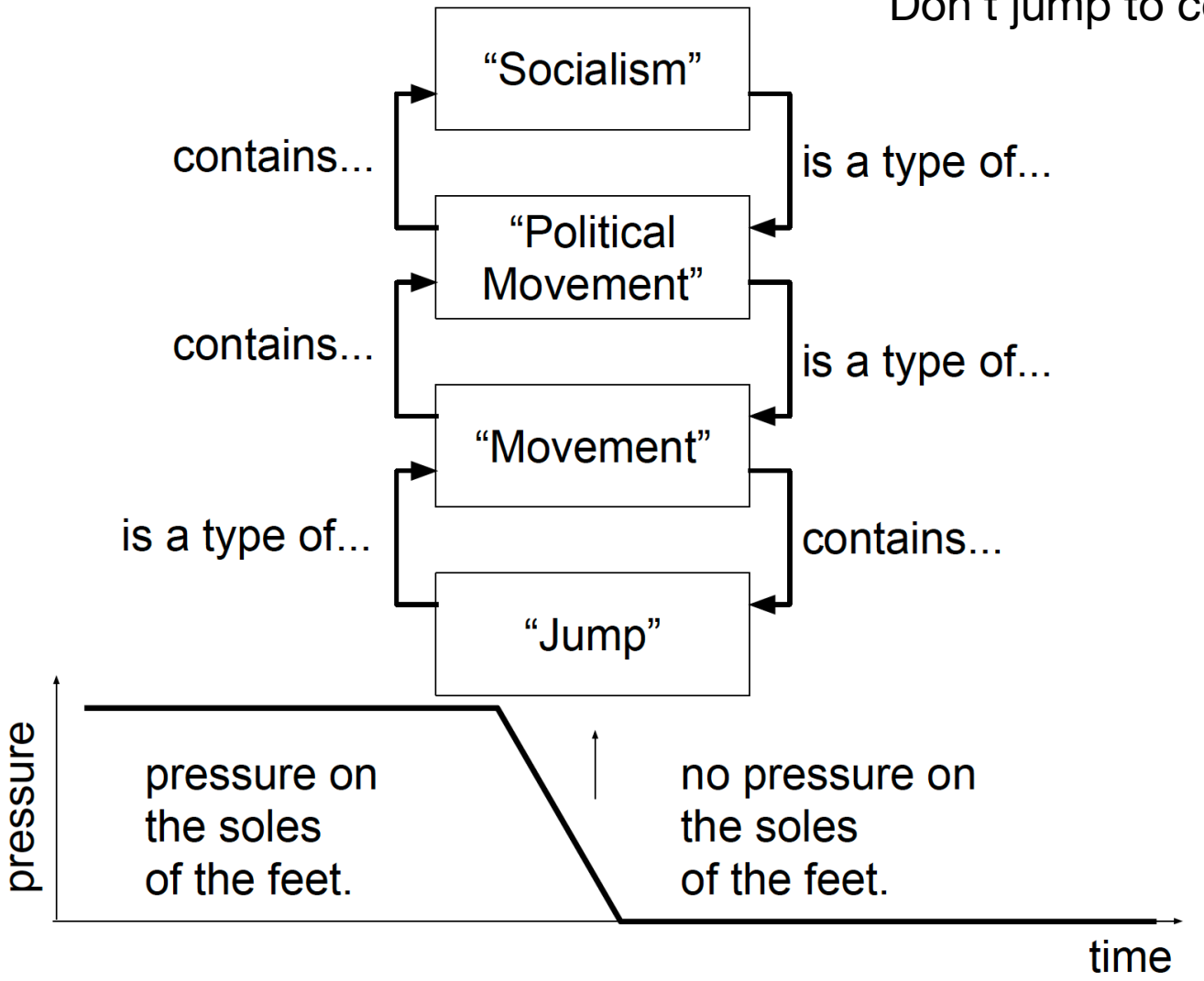


Bongard, Zykov, Lipson (2006). ***Science***


“Jump”
pressure
pressure on
the soles
of the feet.
no pressure on
the soles
of the feet.
time

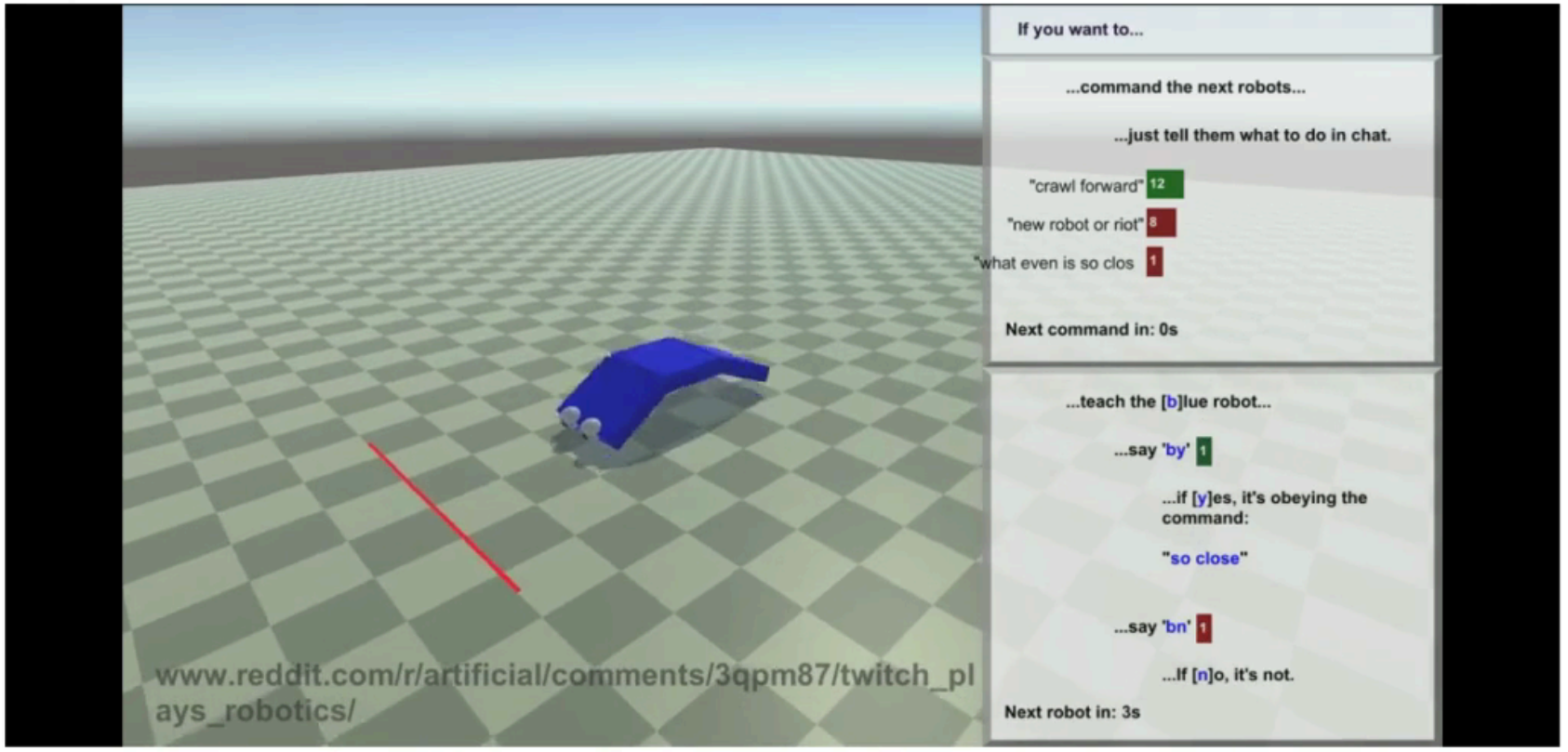

“Socialism”
contains...
is a type of...
“Political Movement”
contains...
is a type of...
“Movement”
is a type of...
contains...
“Jump”
pressure
pressure on the soles of the feet.
no pressure on the soles of the feet.
time

“Don’t jump to conclusions”



Twitch Plays Robotics

Janetsbe



Follow Share

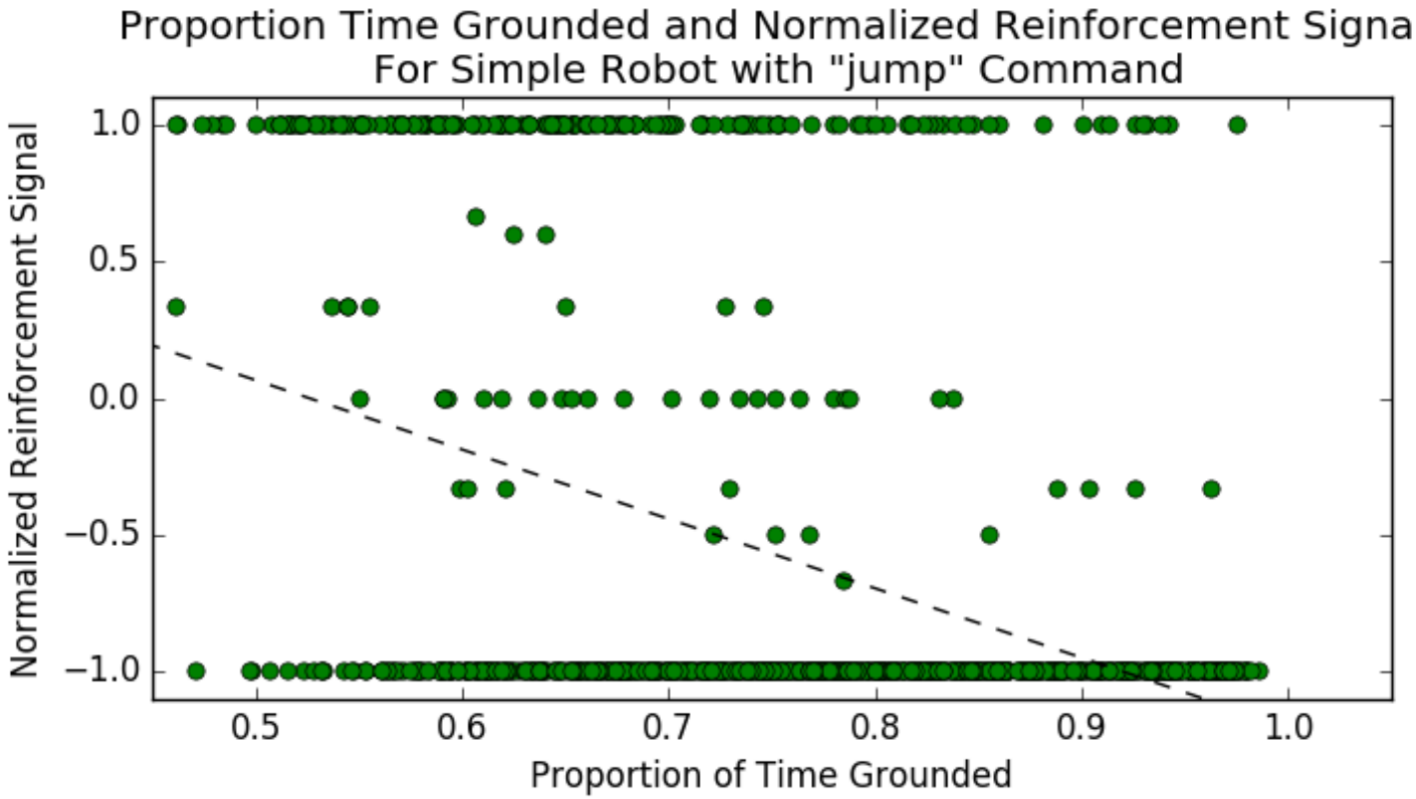
30 147 3

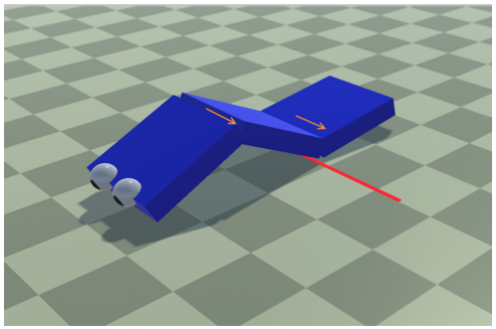
janetsbe

2:12 TCGMYT: hey, does it count multiple times?
2:12 kssummer: crawl forward
2:12 TCGMYT: crawl forward
2:12 IcelceChafey: Crawl forward
2:12 ArmyOfAnarchists: new robot or riot
2:12 Kinrany: moonwalk
2:12 ApatheticWrath: pitchforks ready ----------E ----------E
2:13 Rinsmaster: crawl forward
2:13 jojo_321: crawl forward
2:13 kssummer: bn
2:13 ArmyOfAnarchists: new robot or riot
2:13 kssummer: crawl forward
2:13 ArmyOfAnarchists: new robot or riot
2:13 ArmyOfAnarchists: new robot or riot
2:13 ArmyOfAnarchists:
2:13 kssummer: bn
2:13 TCGMYT: crawl forward
2:13 Lukelinic1: crawl forward
2:13 kssummer: crawl forward
2:14 ArmyOfAnarchists: vy
2:14 ArmyOfAnarchists: by
2:14 kssummer: bn
2:14 kssummer: crawl forward
2:14 TCGMYT: crawl forward

Send a message

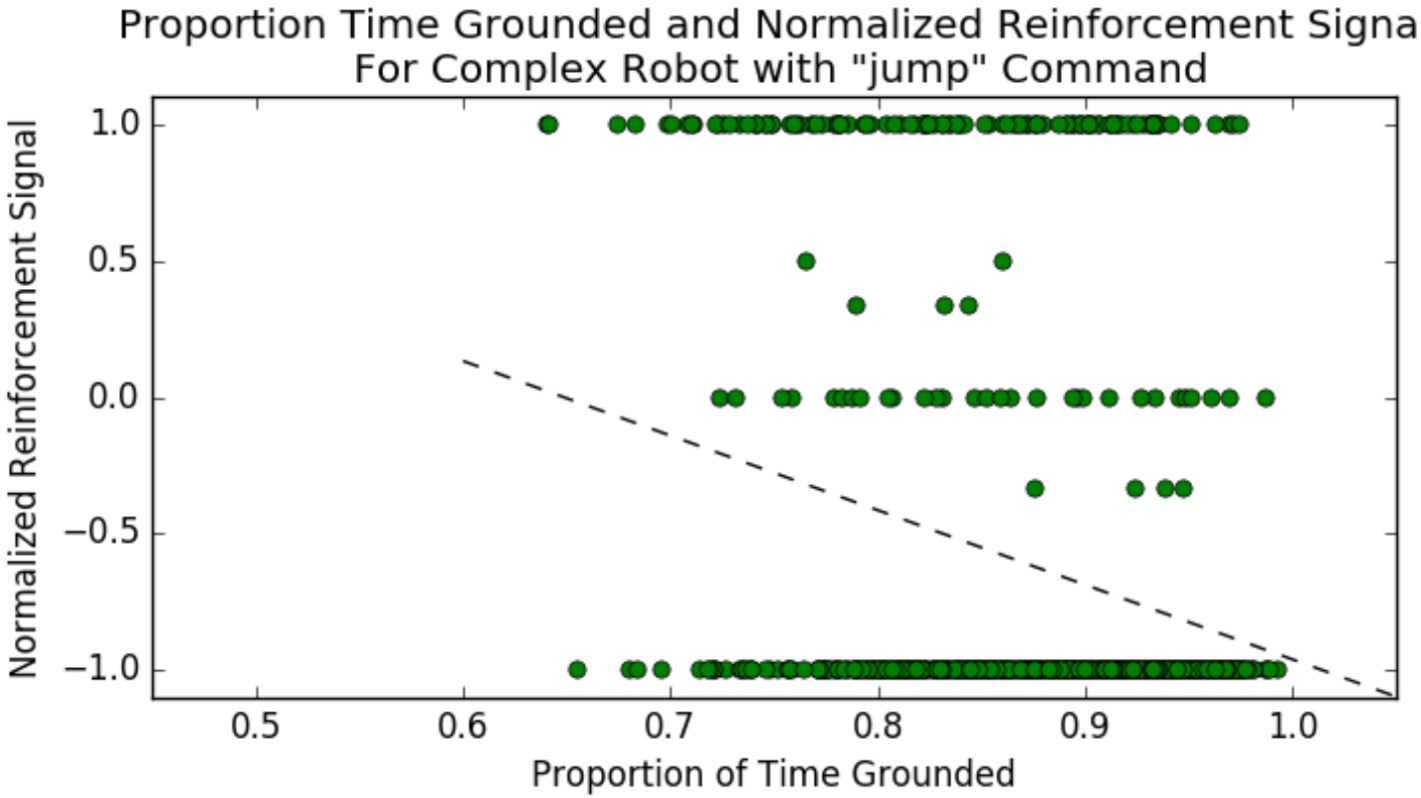
Chat

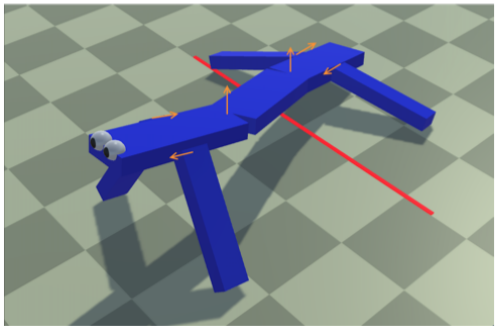




Anetsberger & Bongard (2016). *Procs of ALife*.

twitch.tv/twitchplaysrobotics





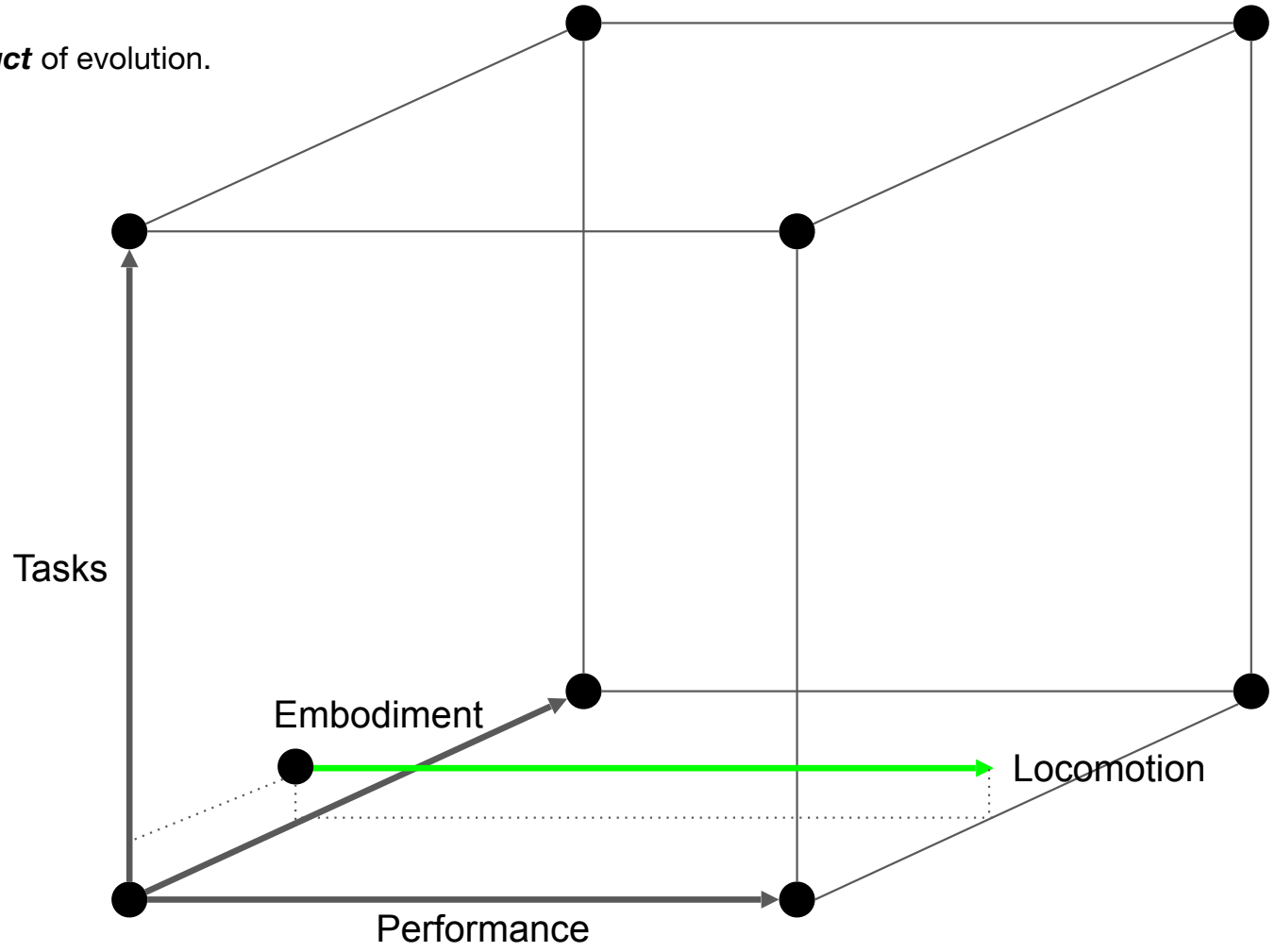
Anetsberger & Bongard (2016). *Procs of ALife*.

twitch.tv/twitchplaysrobotics

Tinbergen: ***Proximate*** mechanisms.

How does legged locomotion work?

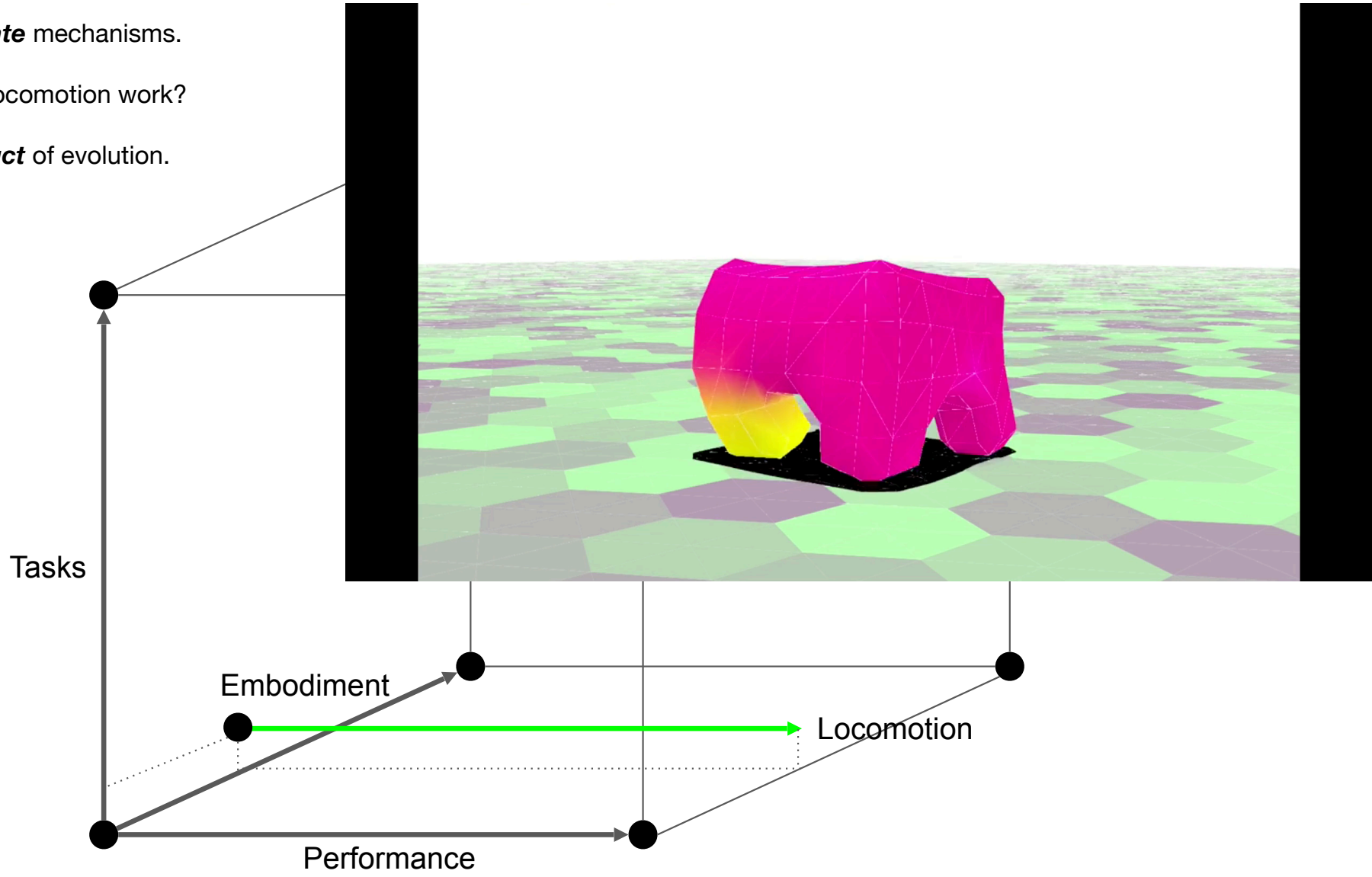
Replicating a ***product*** of evolution.



Tinbergen: ***Proximate*** mechanisms.

How does legged locomotion work?

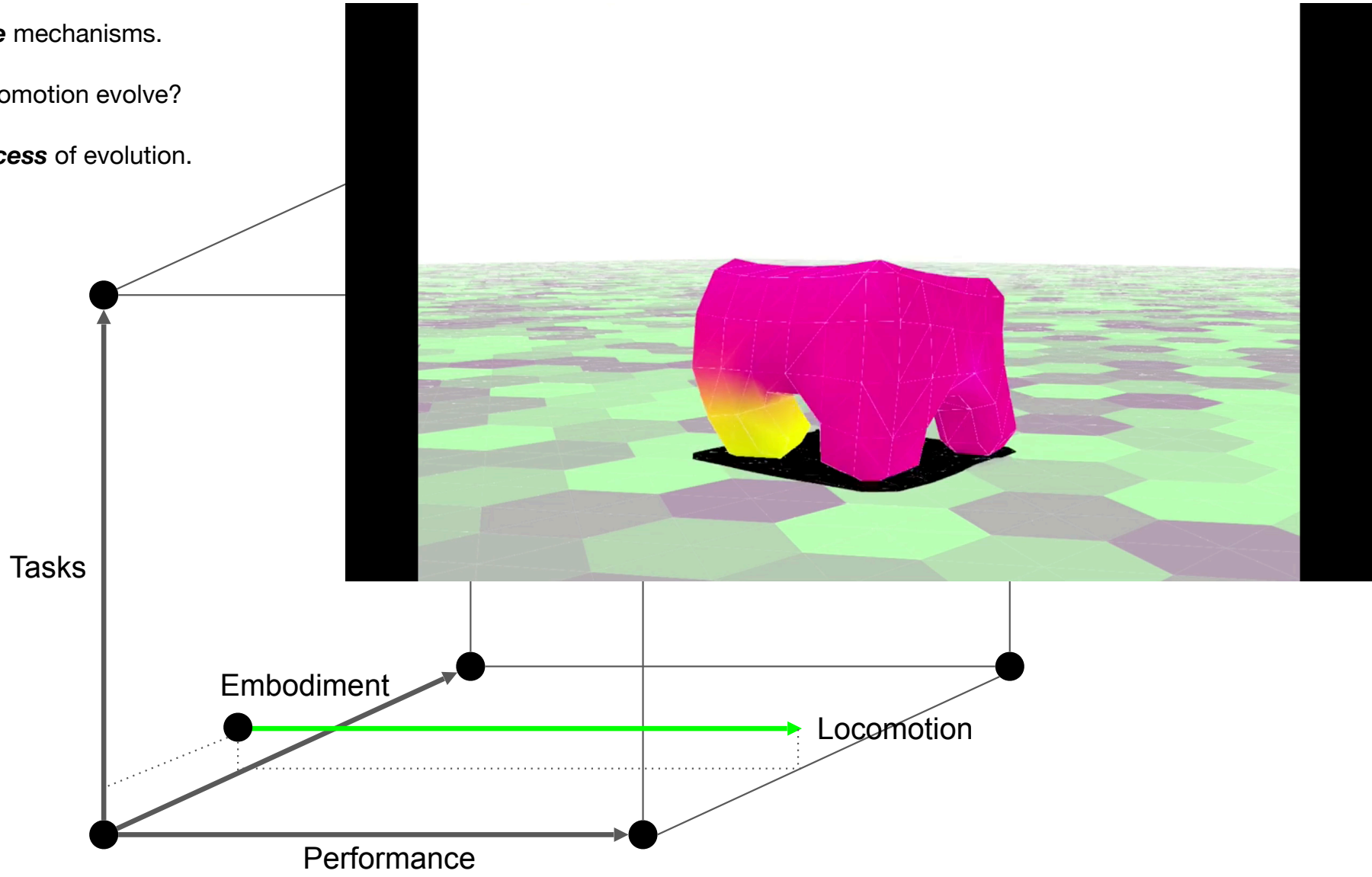
Replicating a ***product*** of evolution.



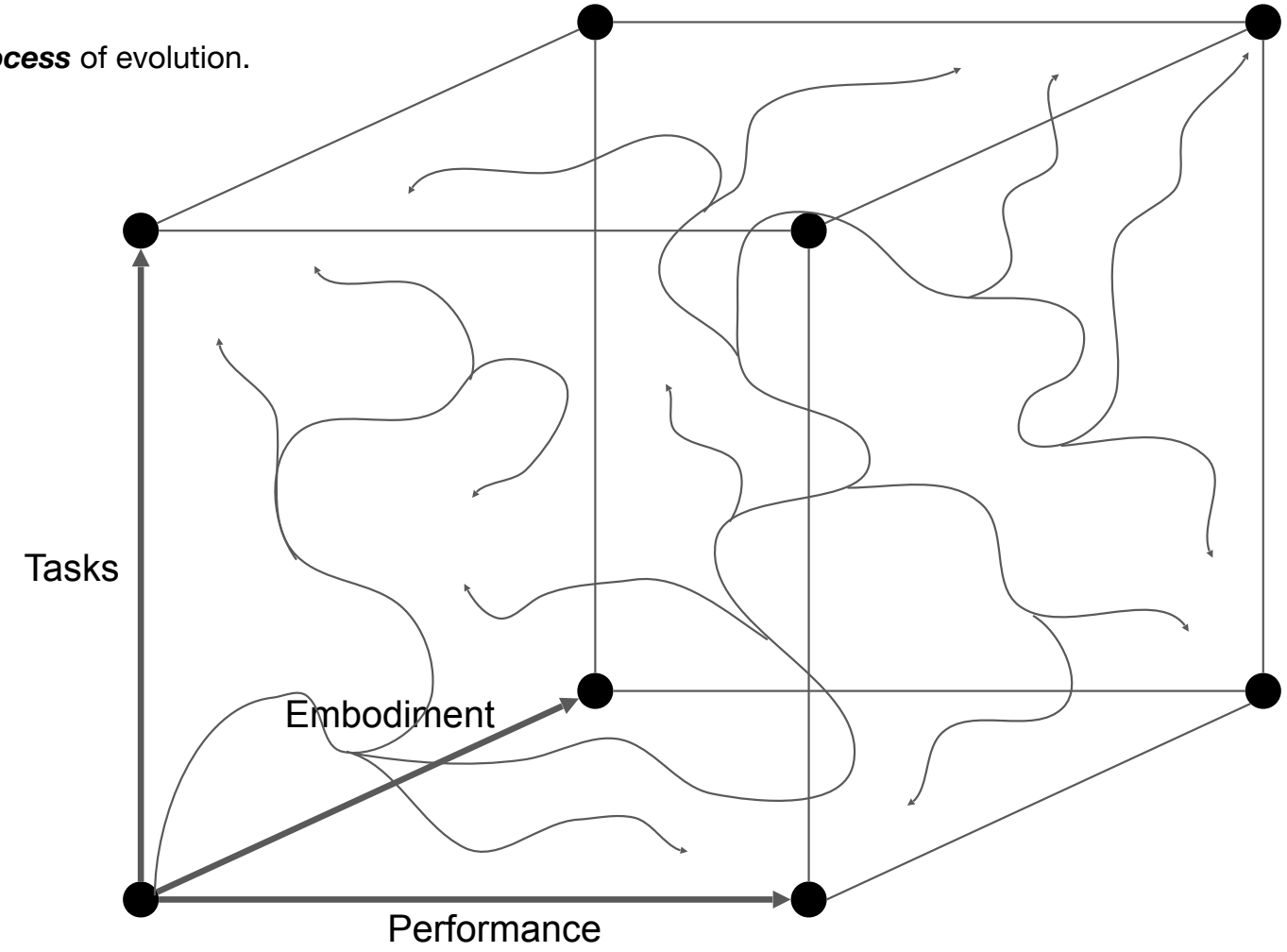
Tinbergen: ***Ultimate*** mechanisms.

Why did legged locomotion evolve?

Replicating the ***process*** of evolution.



Tinbergen: ***Ultimate*** mechanisms.

Why did legged locomotion evolve?

Replicating the ***process*** of evolution.