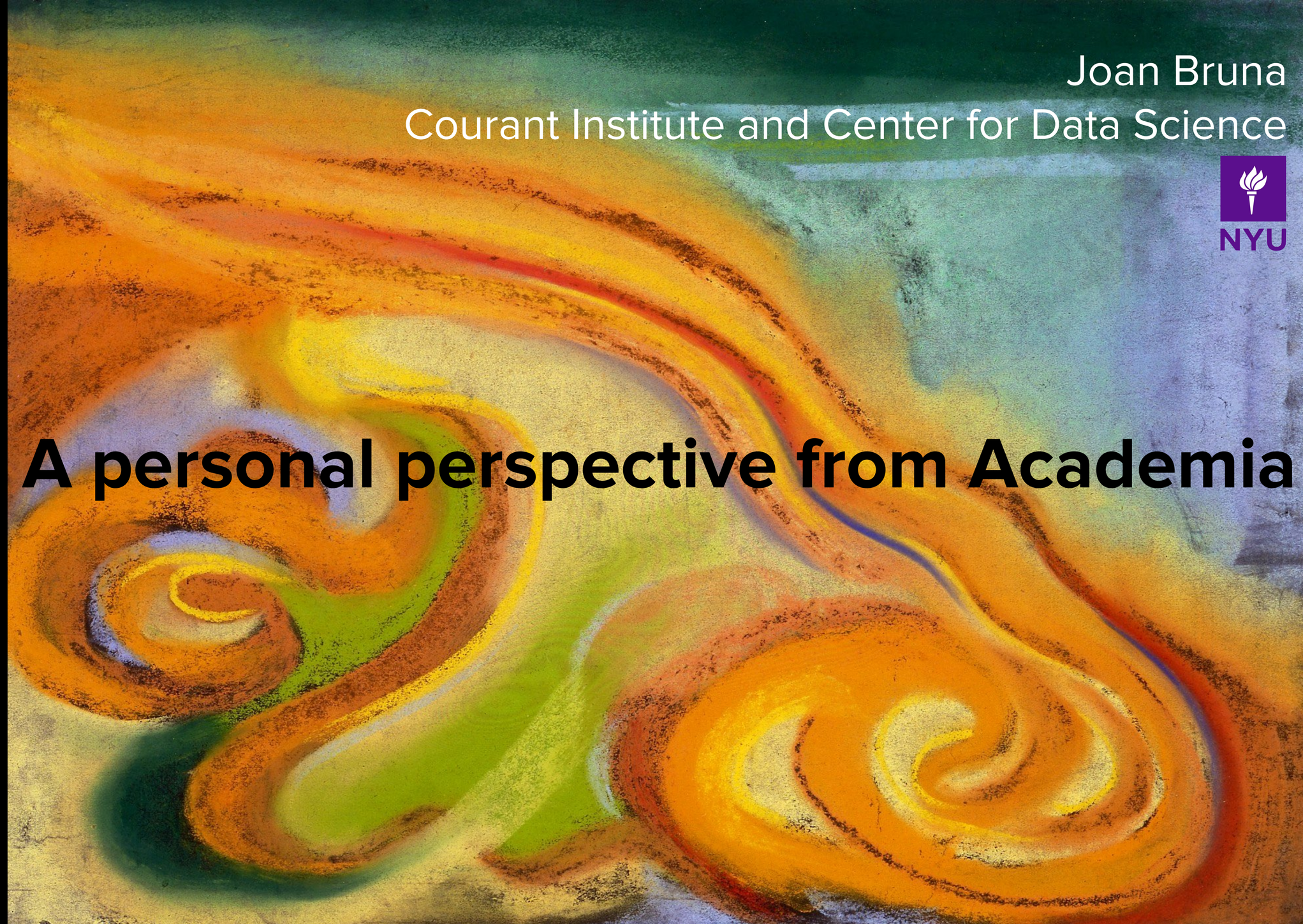
Joan Bruna
Courant Institute and Center for Data Science
NYU

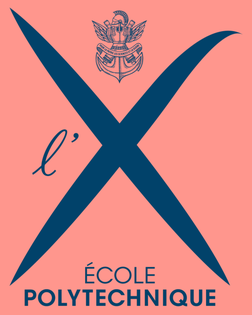
New in ML

A personal perspective from Academia

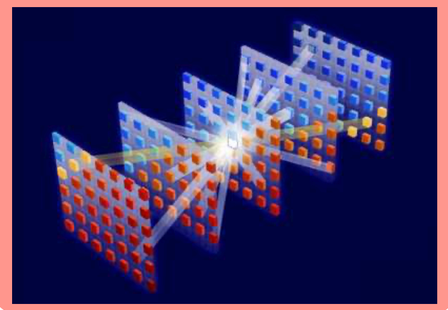


One Slide about myself

PhD
in Applied
Mathematics



5yr
Startup
experience between
MsC and PhD



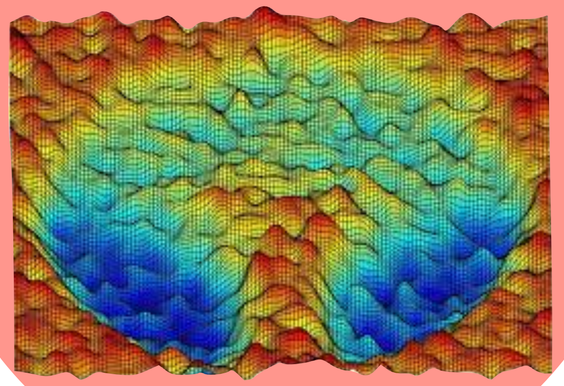
Visiting
positions at
industrial research
lab (Fair)

FACEBOOK AI

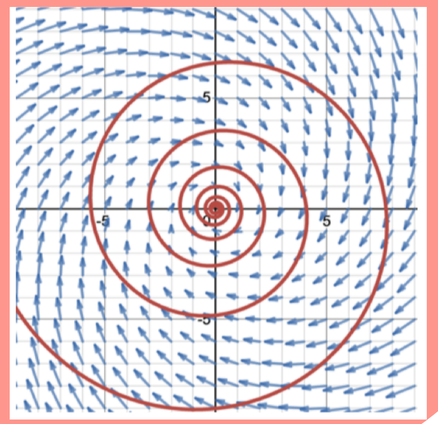
5yr
experience as
Assistant Prof. UC
Berkeley & NYU

One Slide about my group

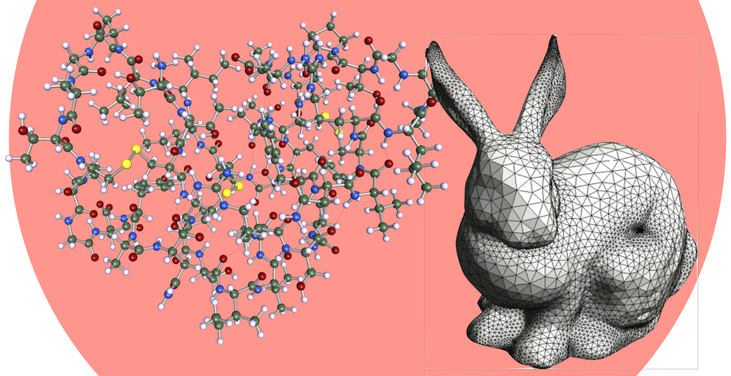
Mathematical Foundations of DL



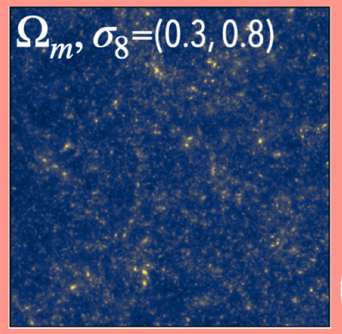
Foundations of RL

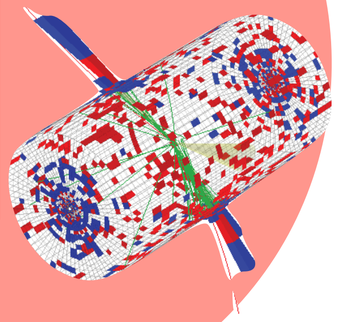


Geometric Deep Learning



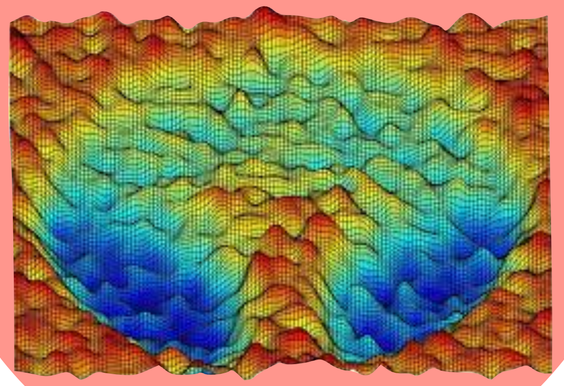
ML and Physics





One Slide about my group

Mathematical Foundations of DL



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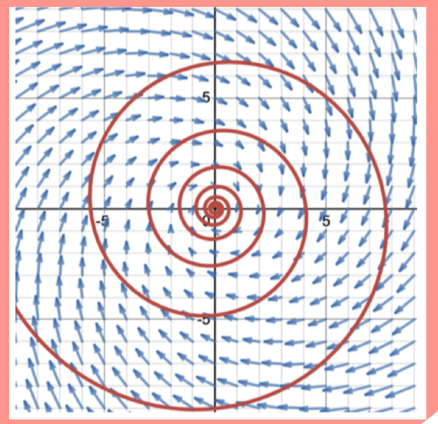
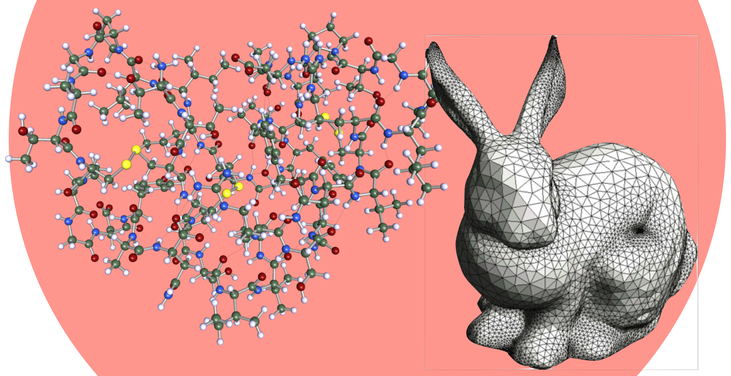


10 PhDs
3 postdocs
1 MsC
1 undergrad

Geometric Deep Learning



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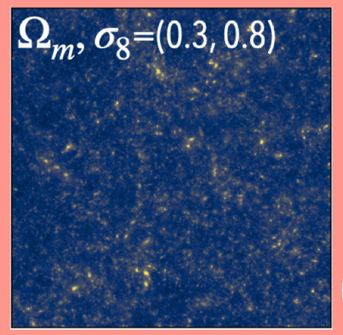

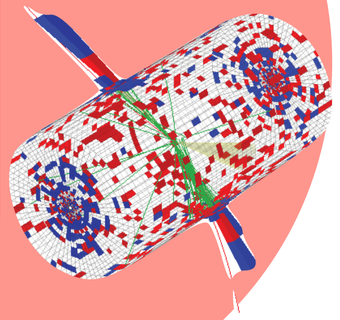

This talk

Scientific Context
2010s: DL Experimental Revolution

A PhD Journey
Calibrate expectations and gain independence

You & Peers
Being a good ML citizen and manage peer pressure

This talk

Scientific Context
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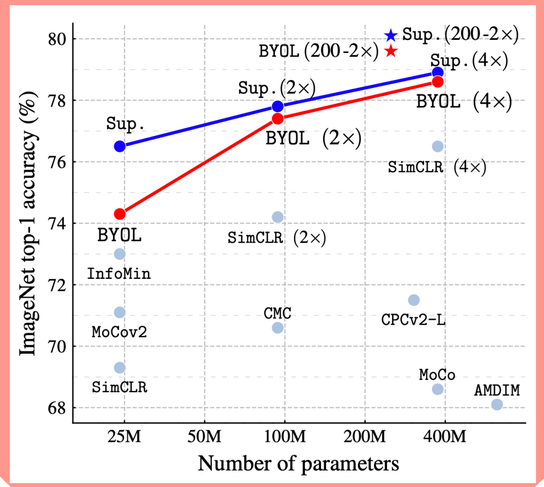
Aim
Academic Perspective of ML career: a **unique moment**

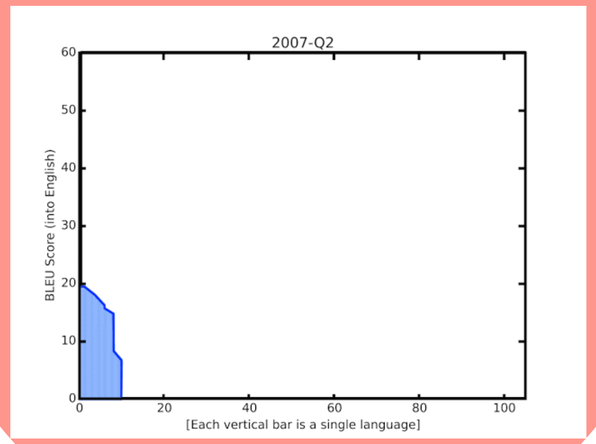
DL golden decade

Computer Vision



[Krizhevsky et al, 12-20]

Machine translation



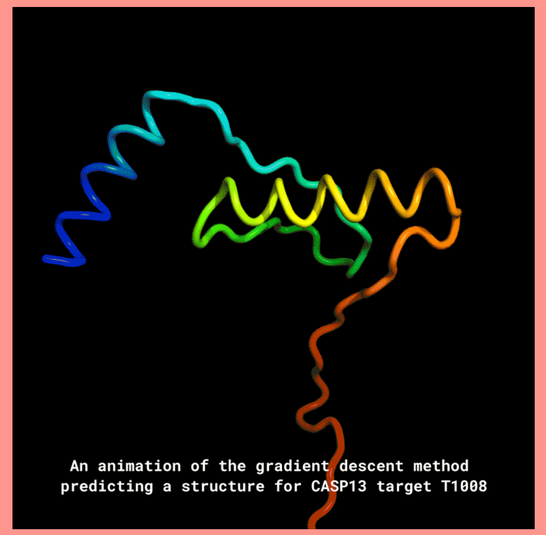
[Google, ’20]

Games

[AlphaGo, ’16]

[AlphaStar, ’19]

Science



[AlphaFold, ’19]

DL golden decade

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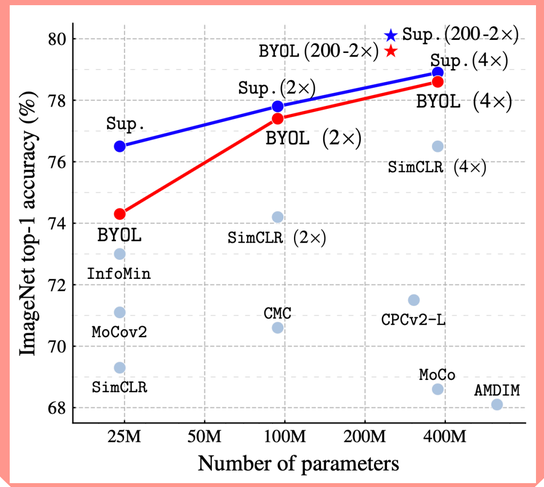

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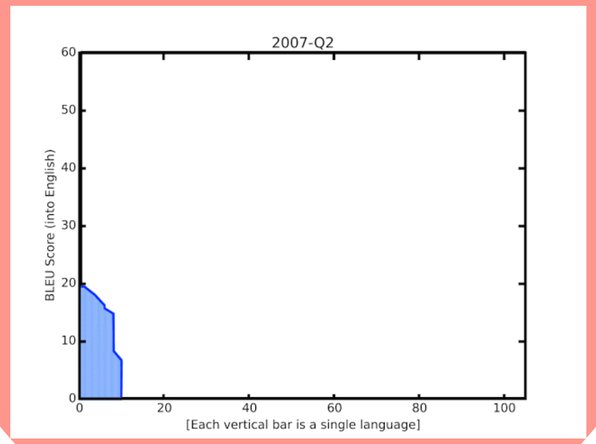

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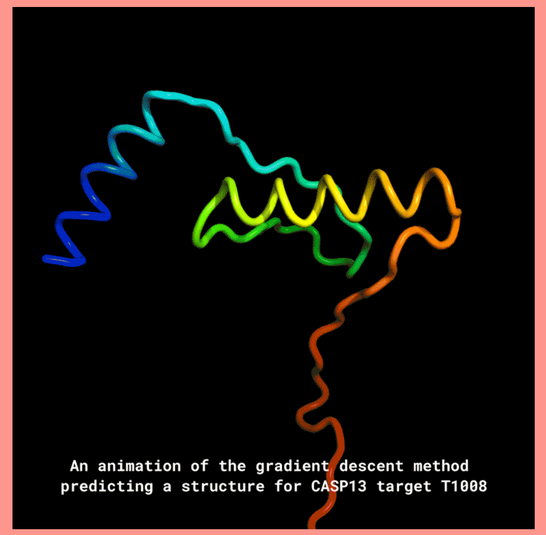
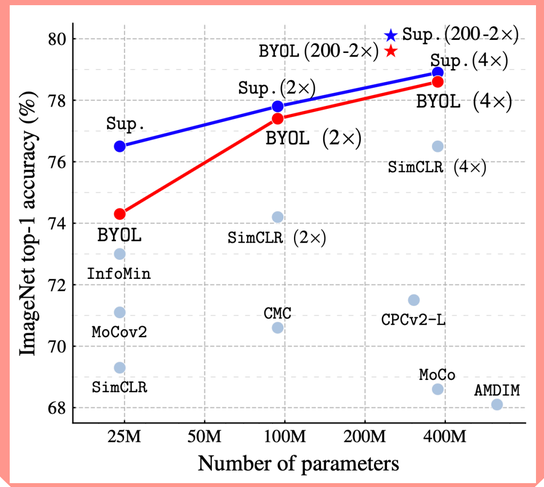


[AlphaFold, ’19]

DL golden decade

None of these problems was thought to be possible!

Computer Vision



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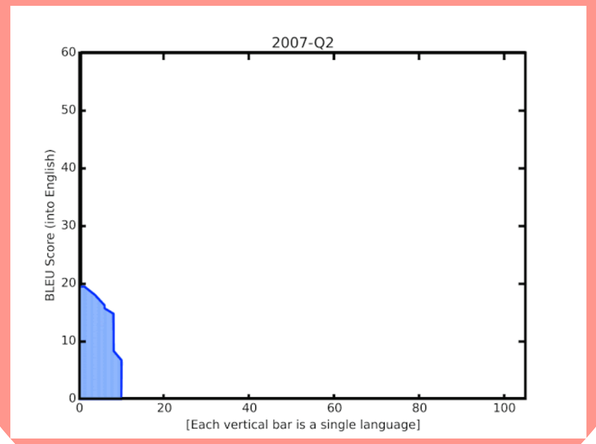

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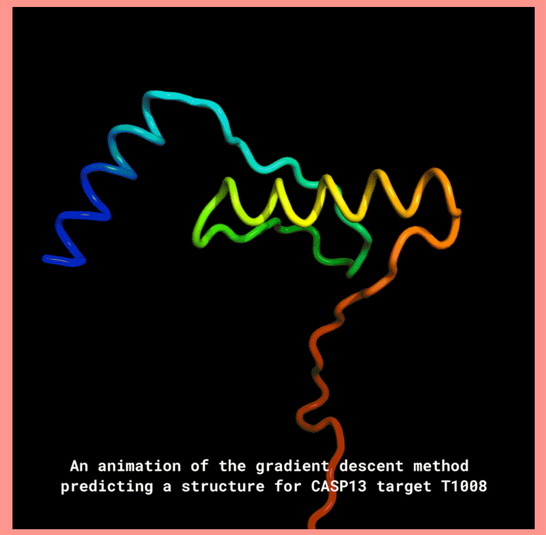

[AlphaFold, ’19]

Role of Theory so far?

For instance, there are many important questions regarding neural networks which are largely unanswered. There seem to be conflicting stories regarding the following issues:

- Why don't heavily parameterized neural networks overfit the data?
- What is the effective number of parameters?
- Why doesn't backpropagation head for a poor local minima?

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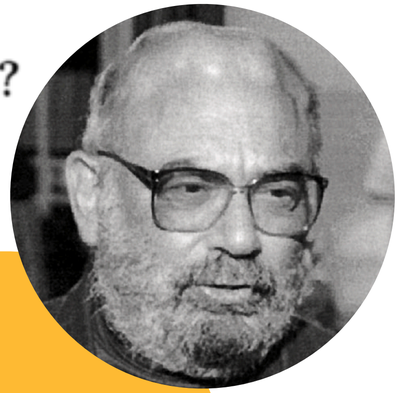

Leo Breiman
1995

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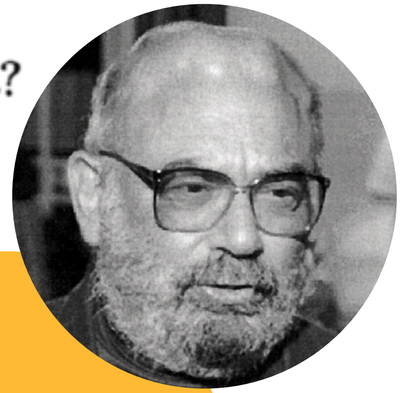

Leo Breiman
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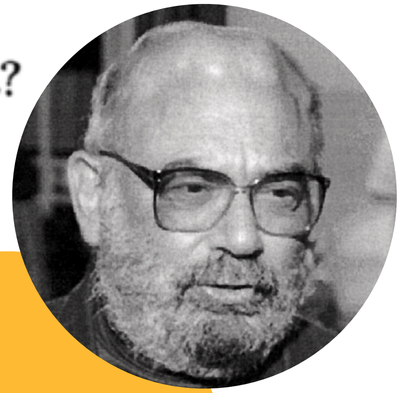

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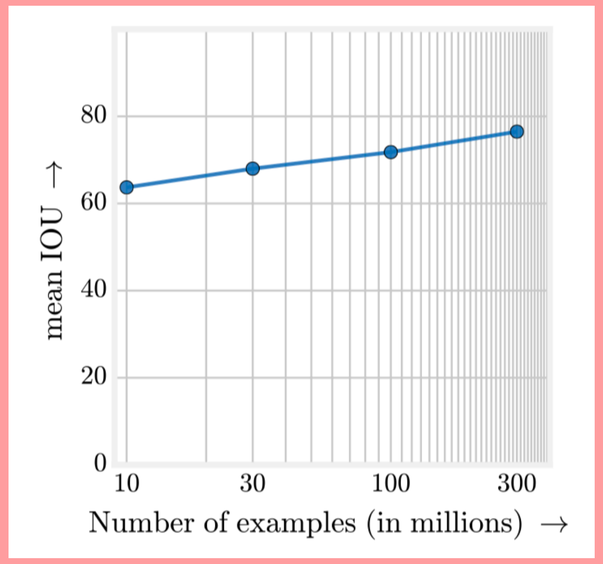
1995

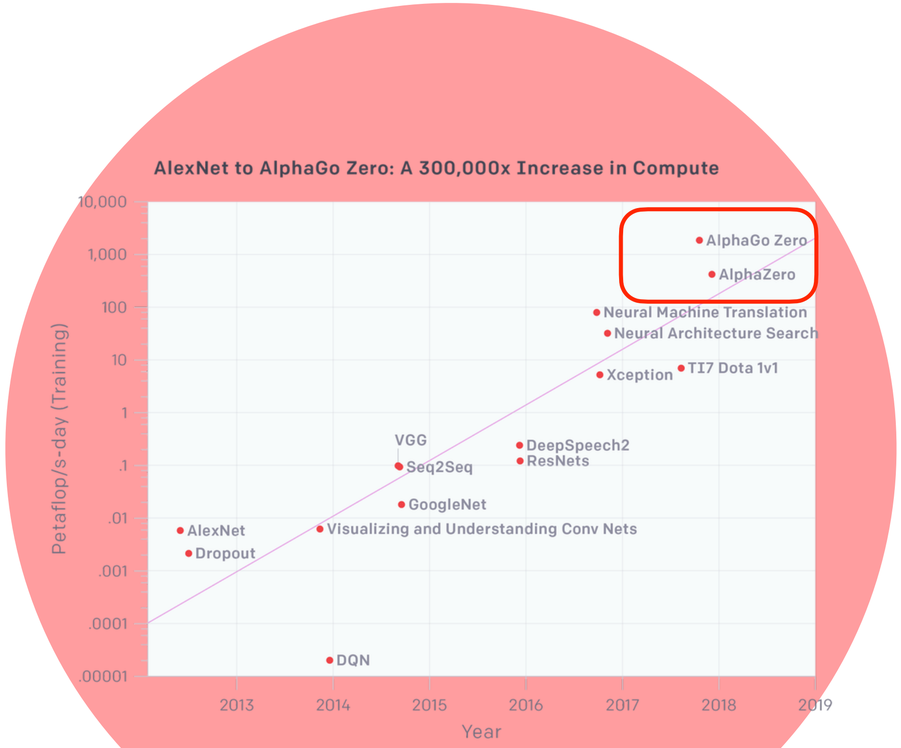
None of these questions is fully understood yet!

We need **YOUR** help!

Can this go on?



Data Hunger

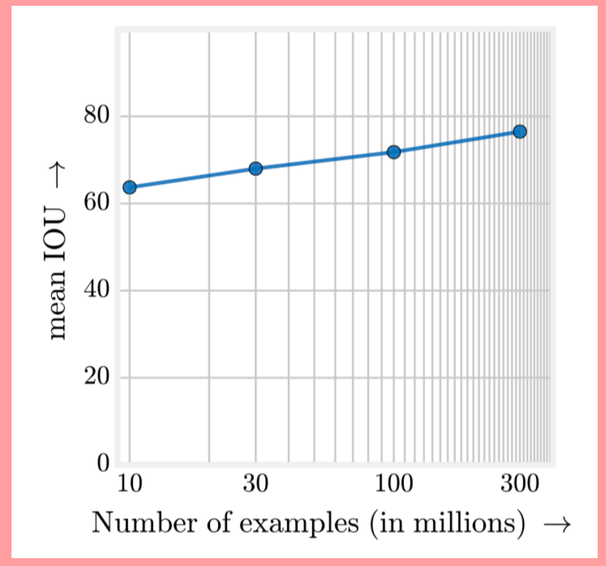


Compute Hunger

Can this go on?

Critical Need for Theory

Scaling-up approach unsustainable



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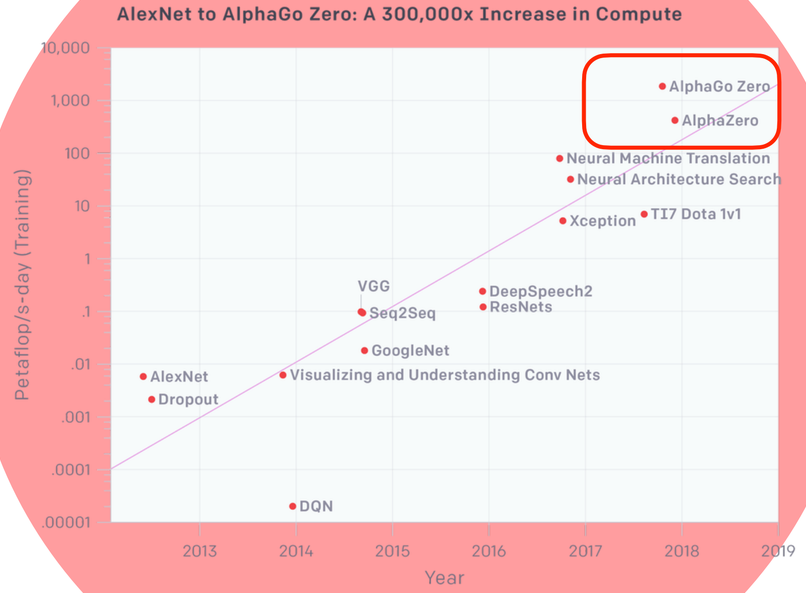

Compute Hunger

Role of ML Theory?

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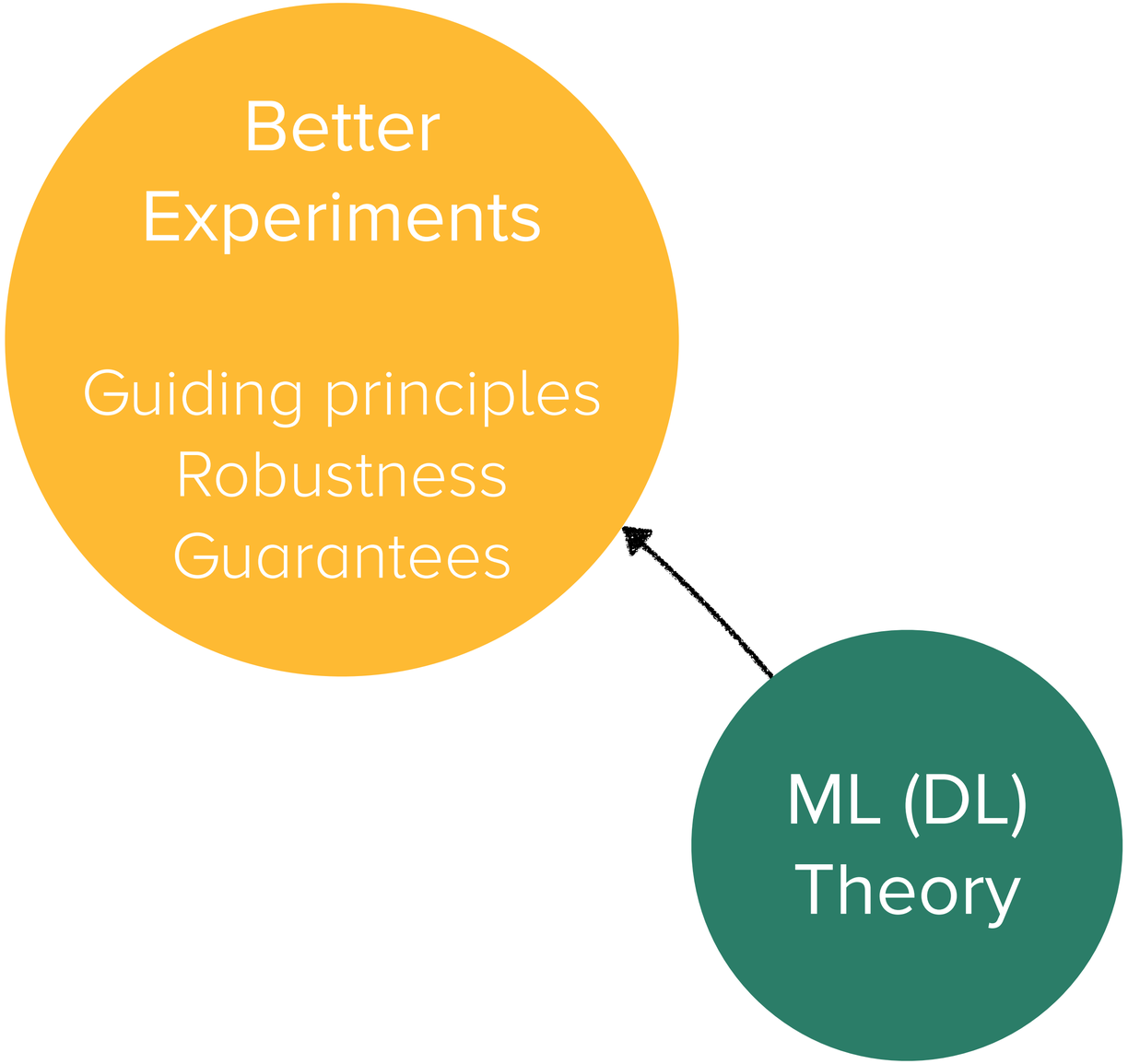
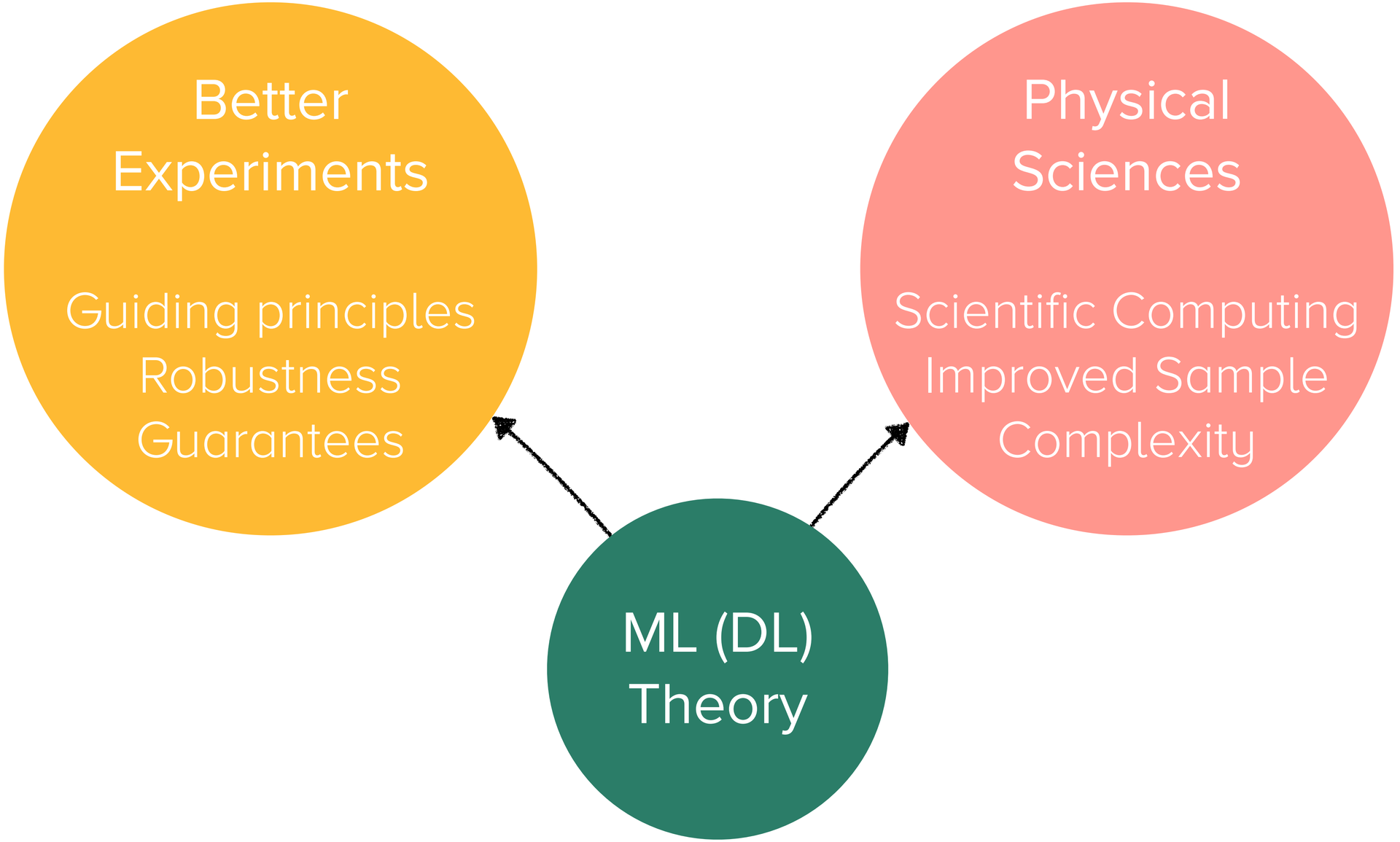
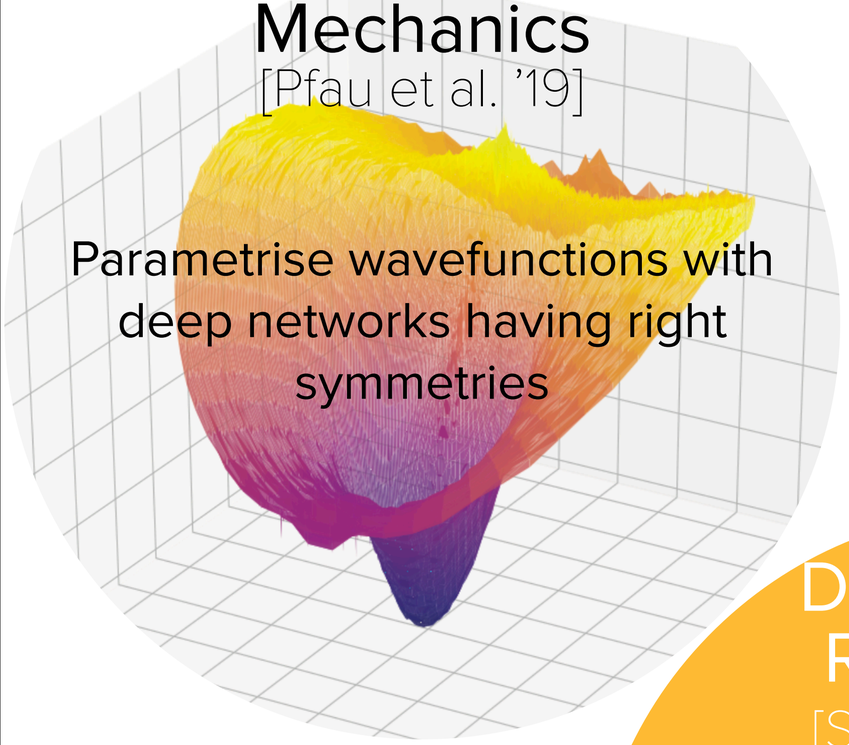


Role of ML Theory?



Vignettes

Quantum Mechanics
[Pfau et al. ’19]

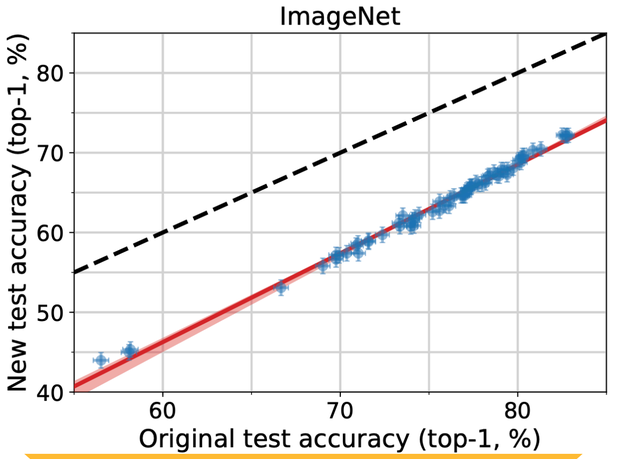


Parametrise wavefunctions with deep networks having right symmetries

Cosmology
[with B. Menard lab (JHU)]

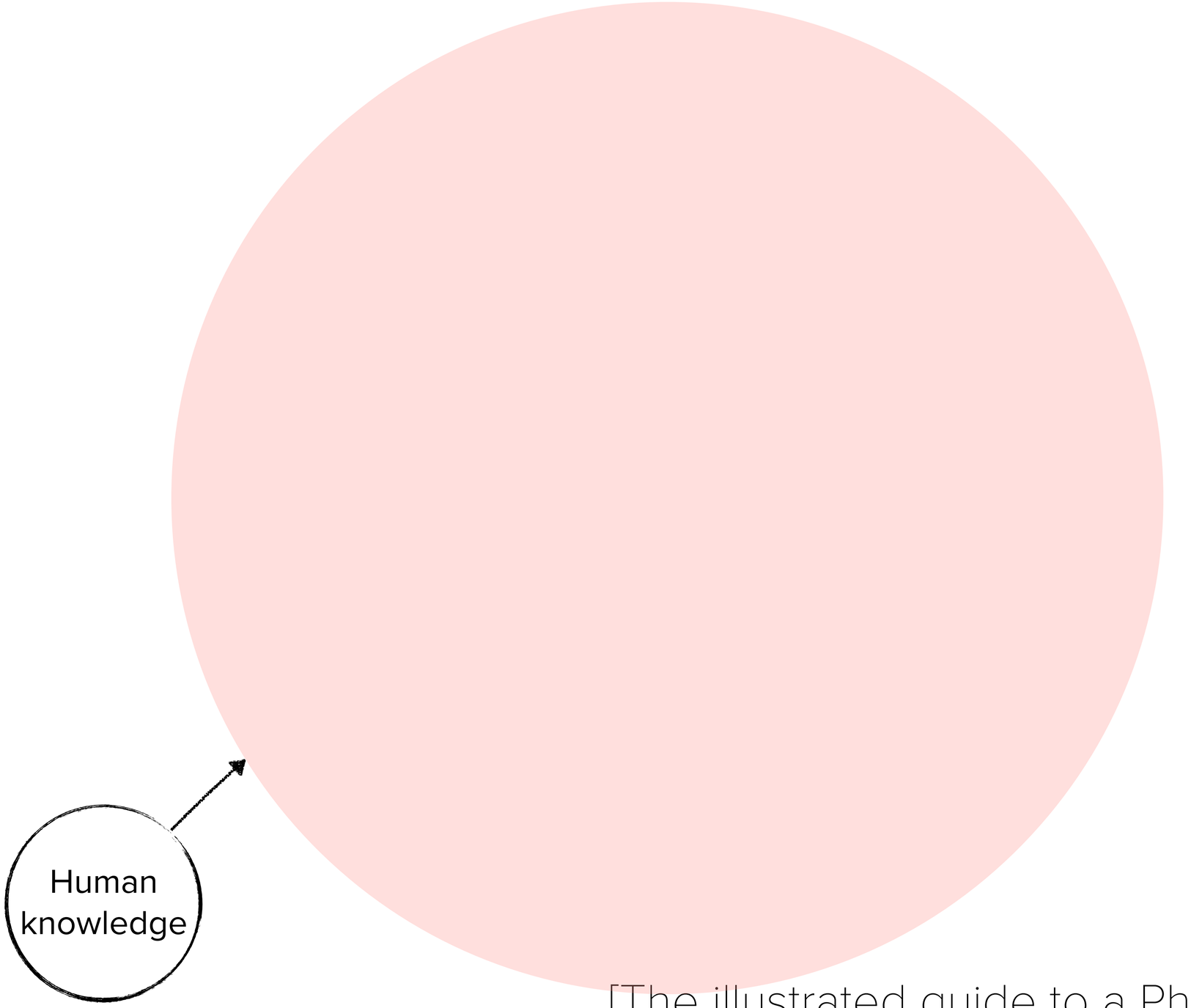
Build statistical models of early universe that explain expansion and non-Gaussianity

Distributional Robustness
[Schmidt et al.’19]



Questions so far?

A (standard) PhD Journey



[The illustrated guide to a Ph.D,.Matt Might]

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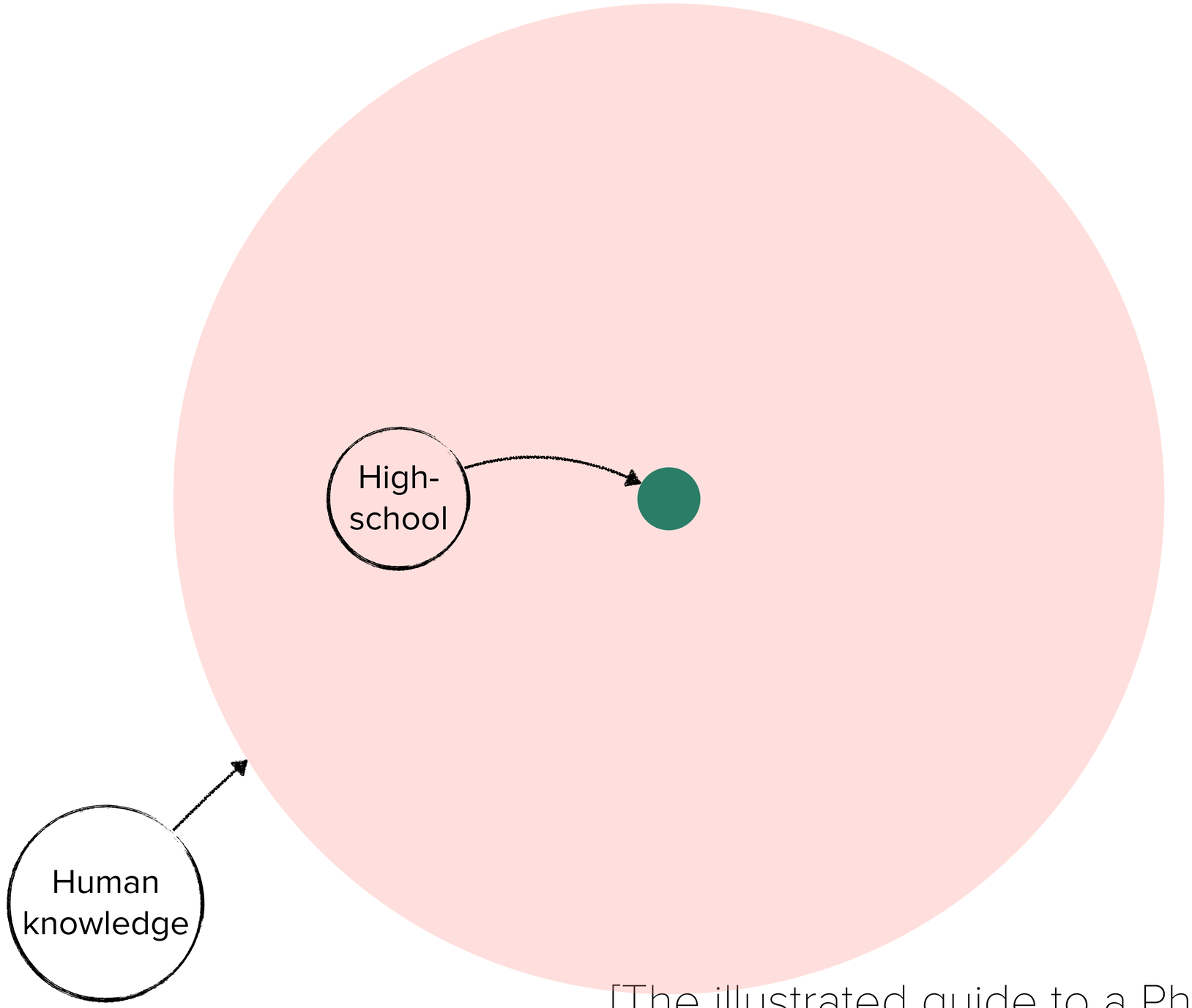

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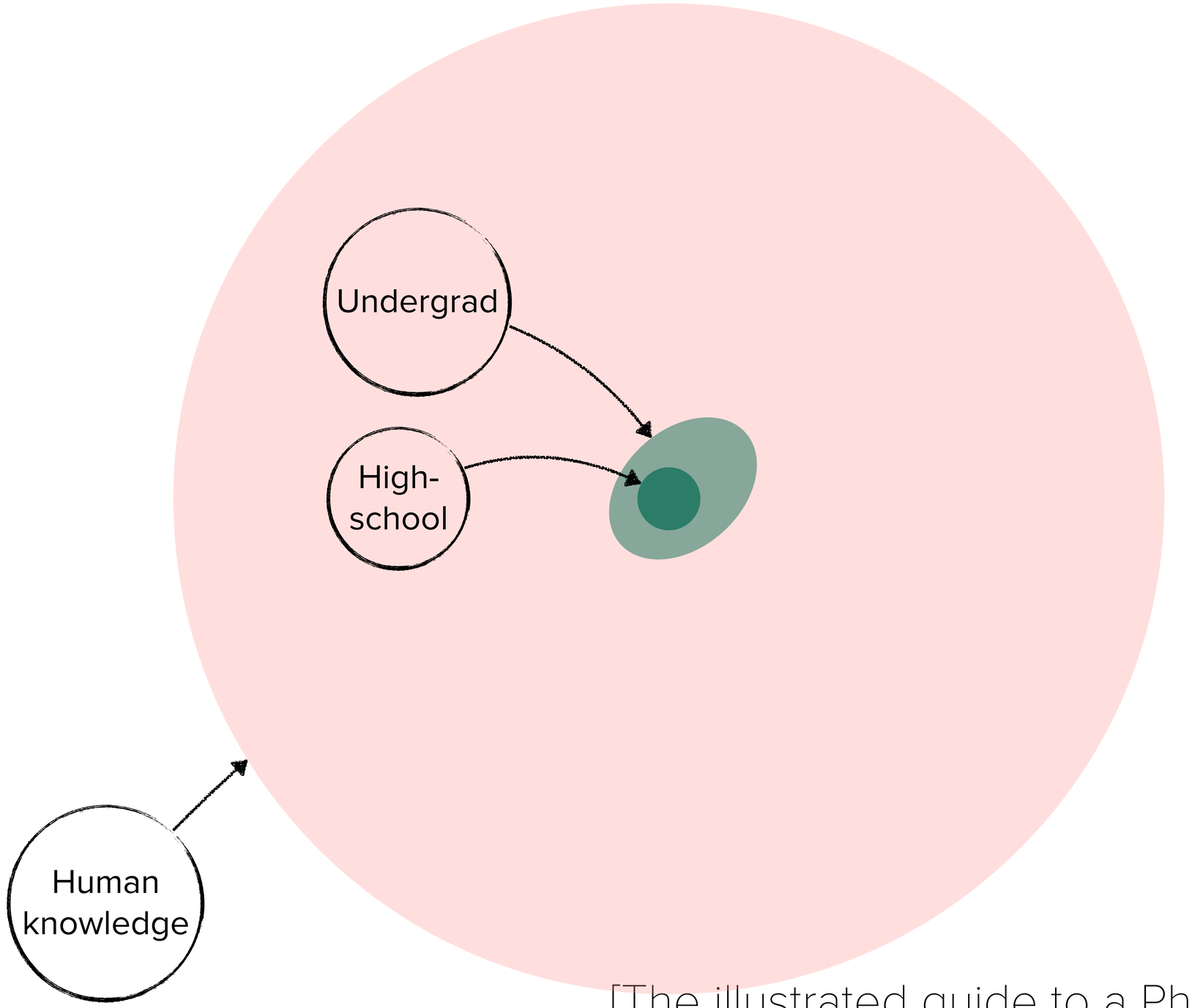

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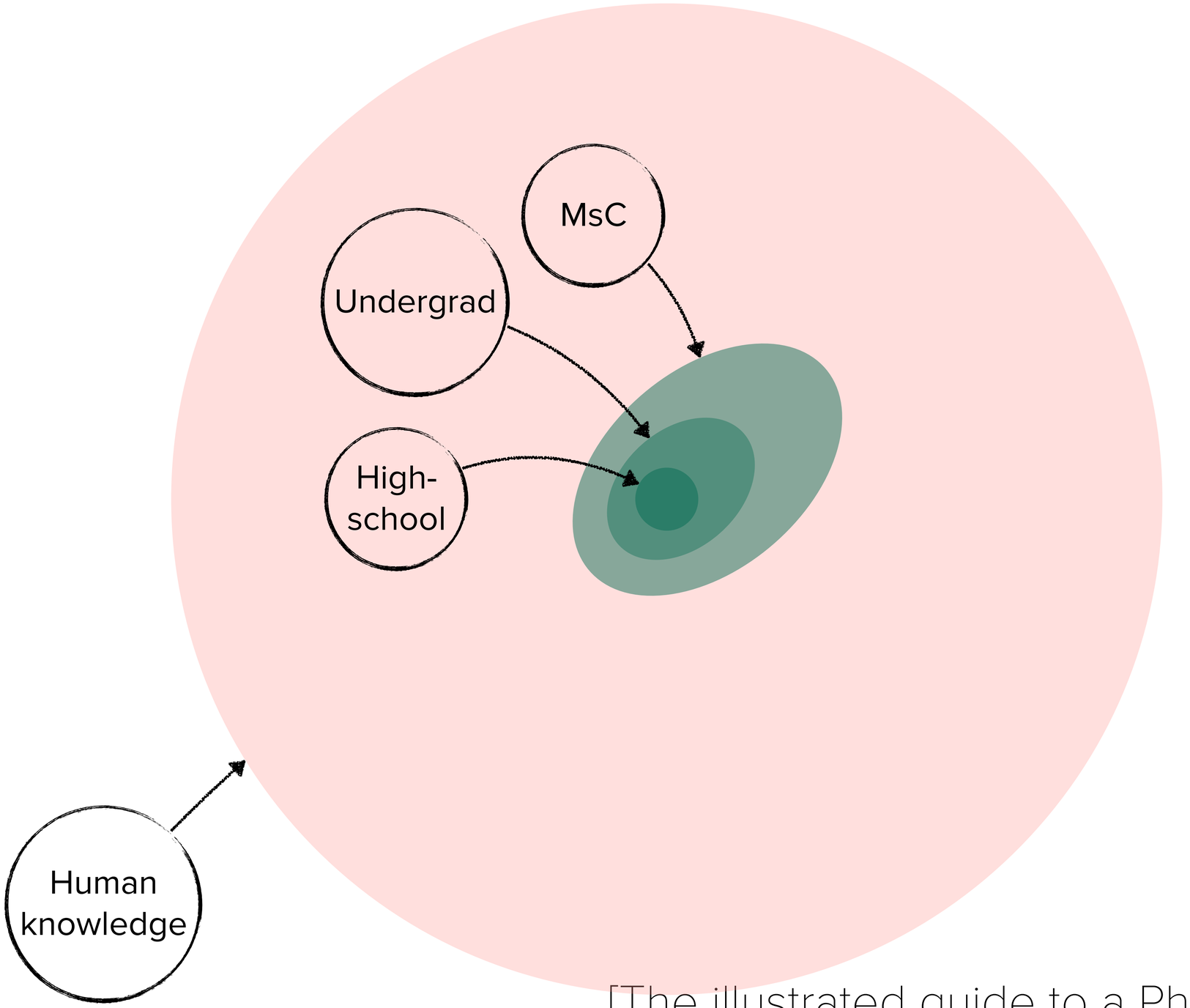

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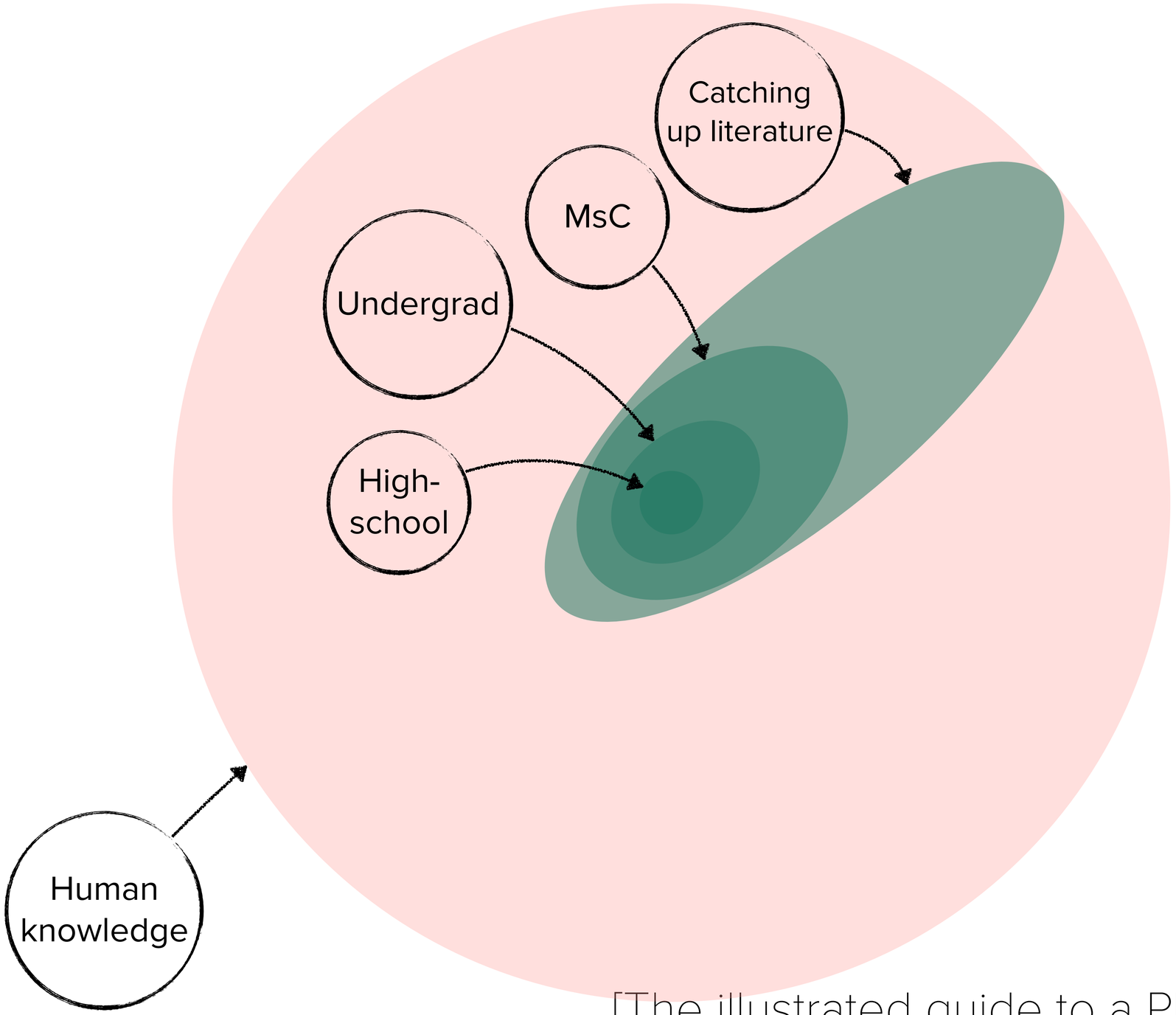

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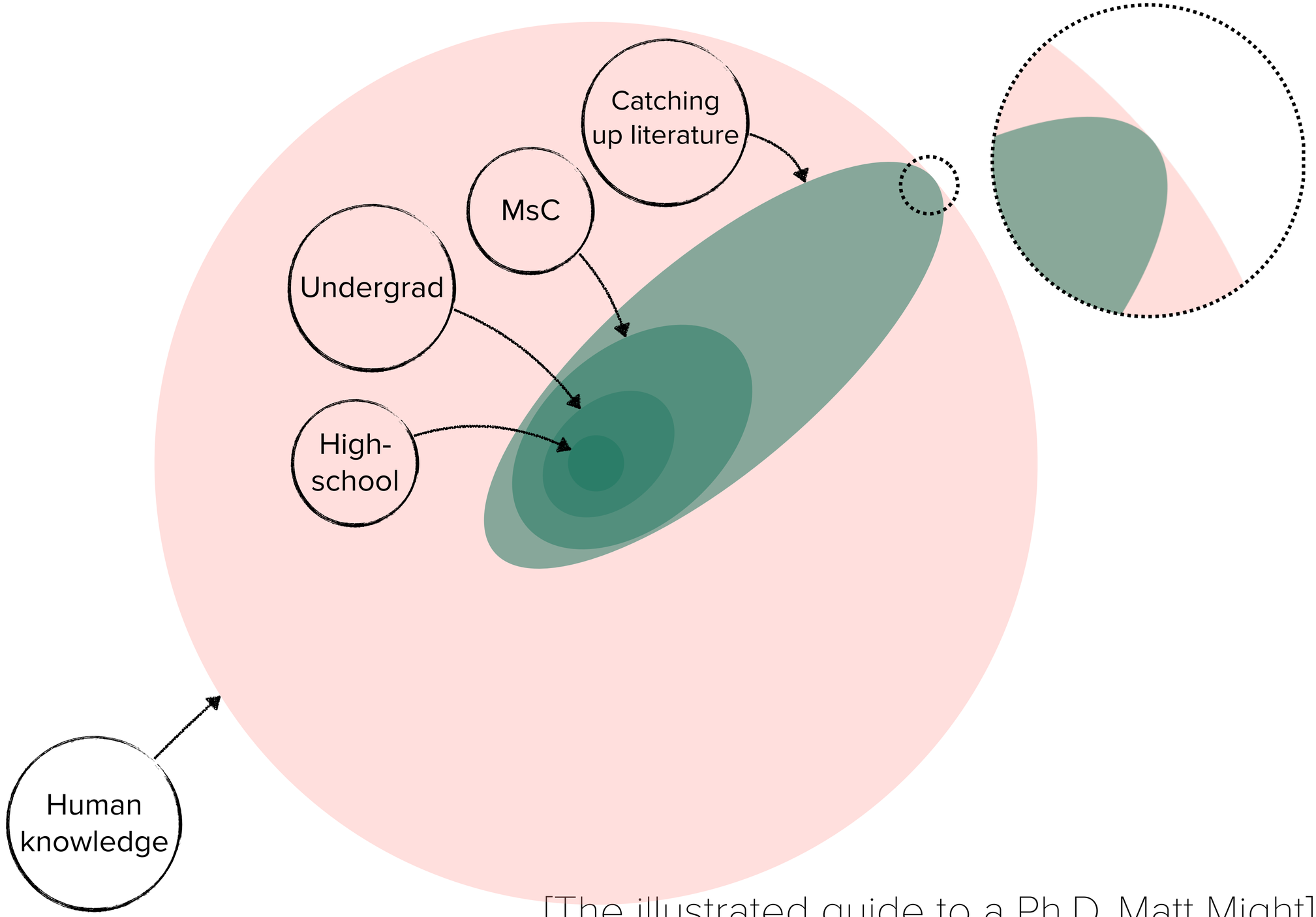

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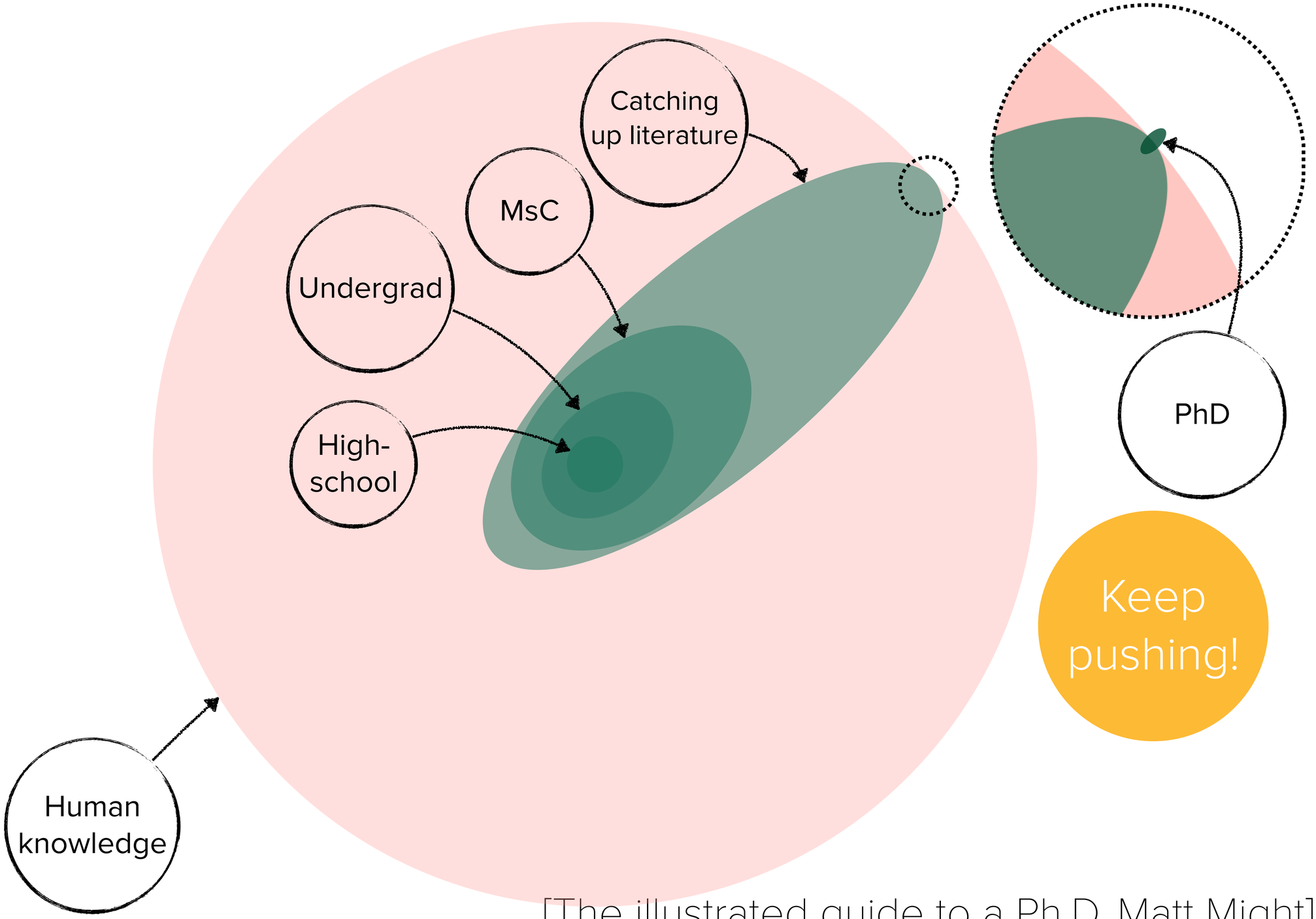

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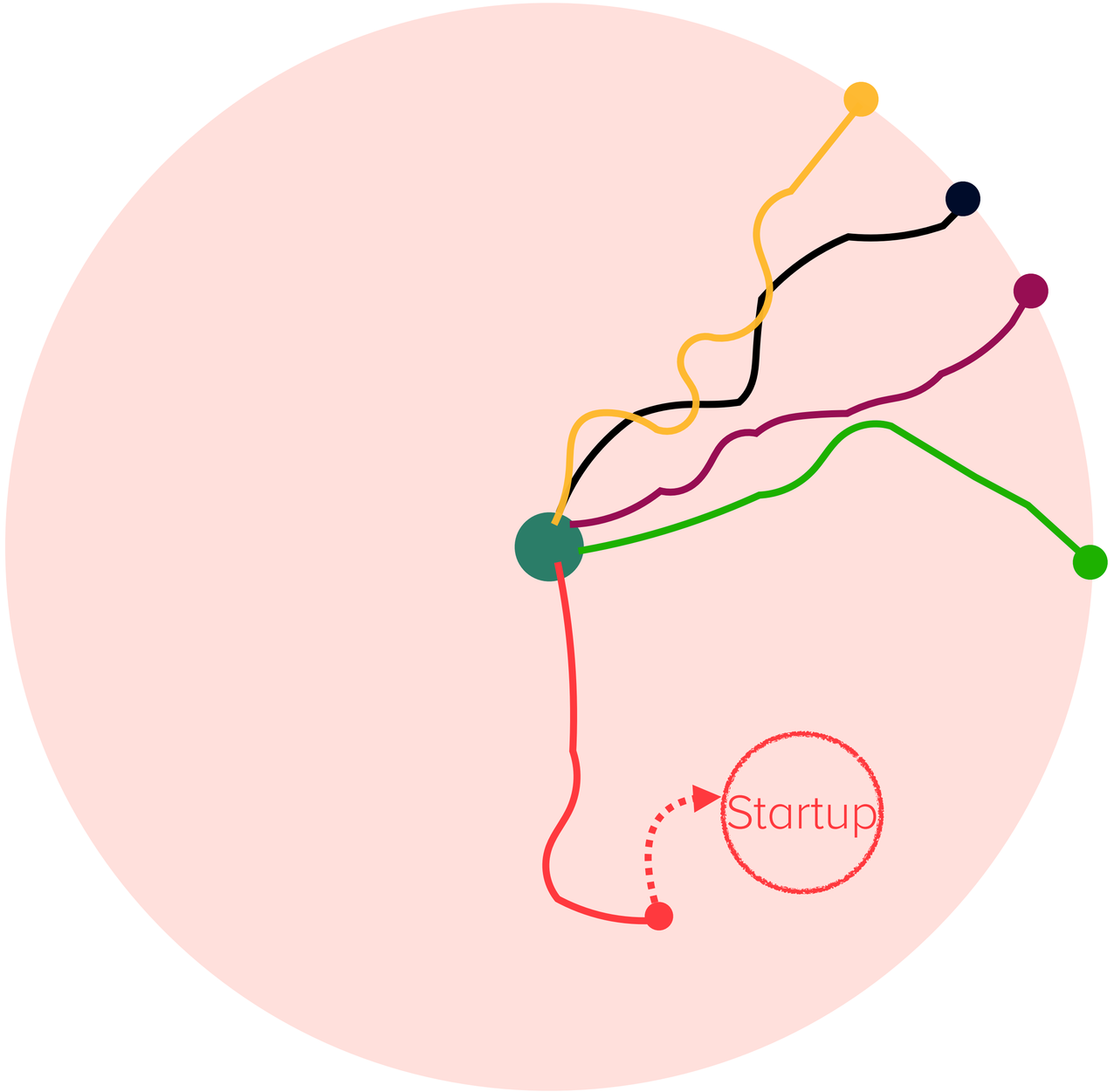
Some naive opinions



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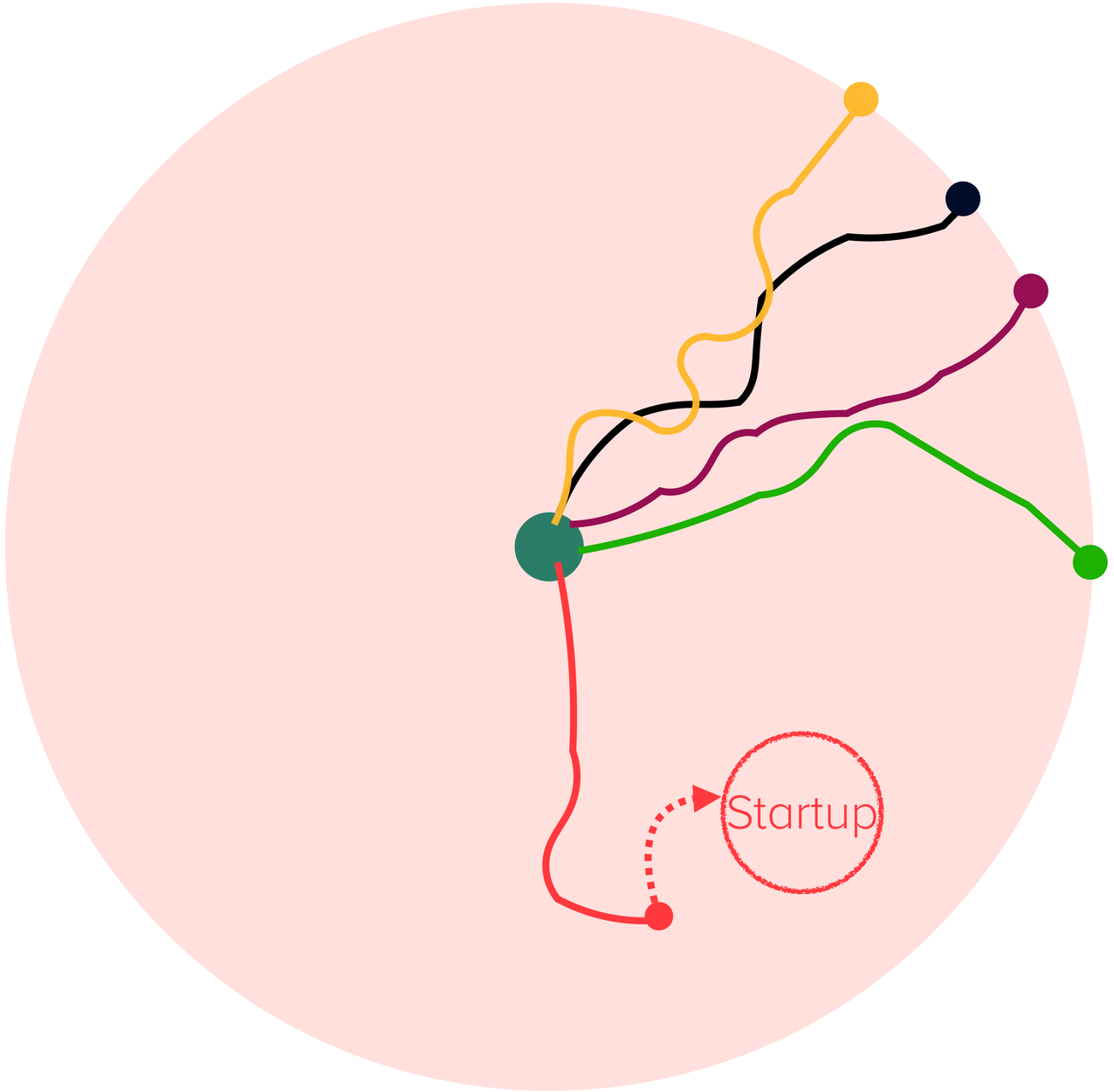

No trajectory is better than others

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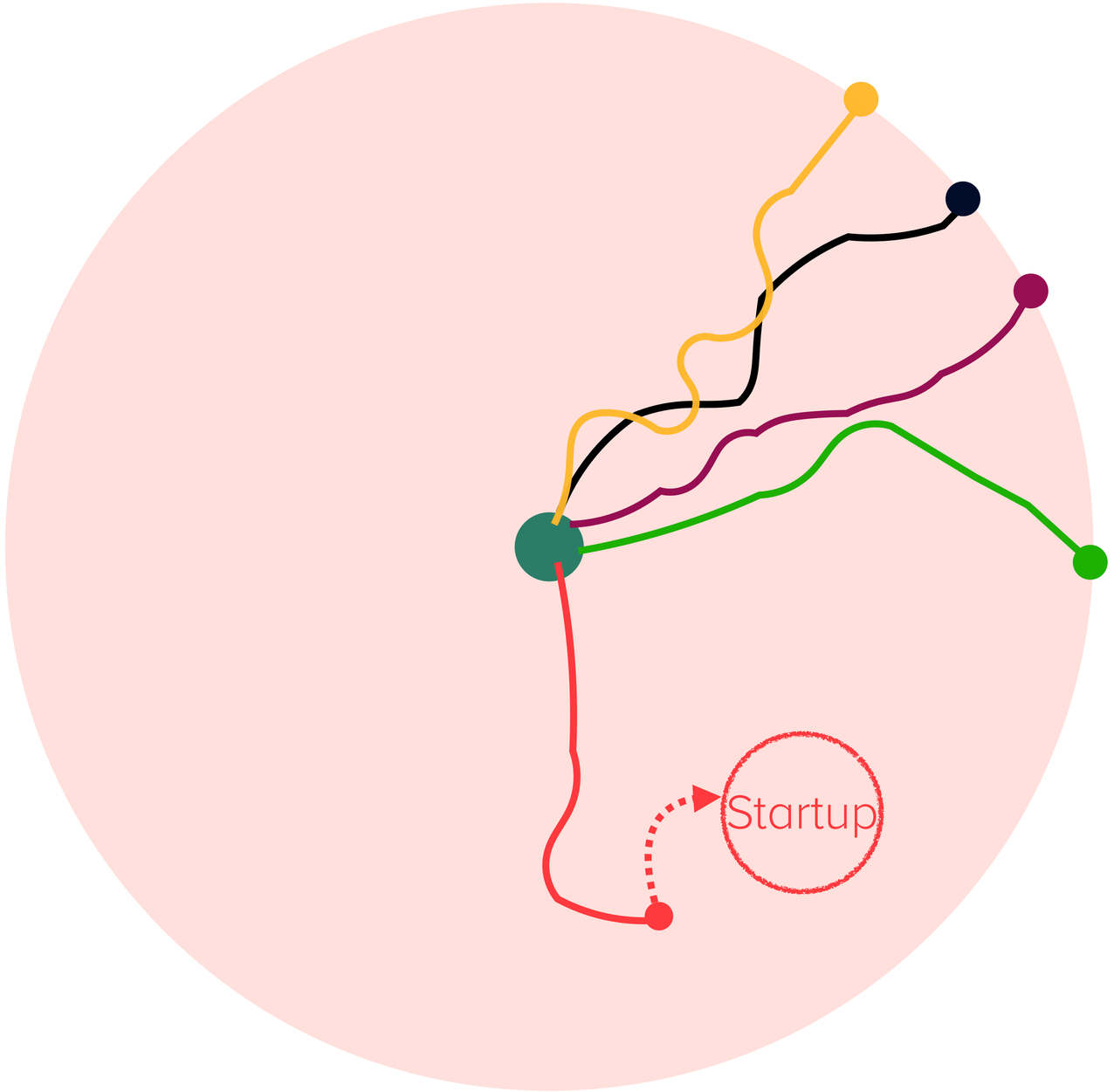

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Non-markovian random process

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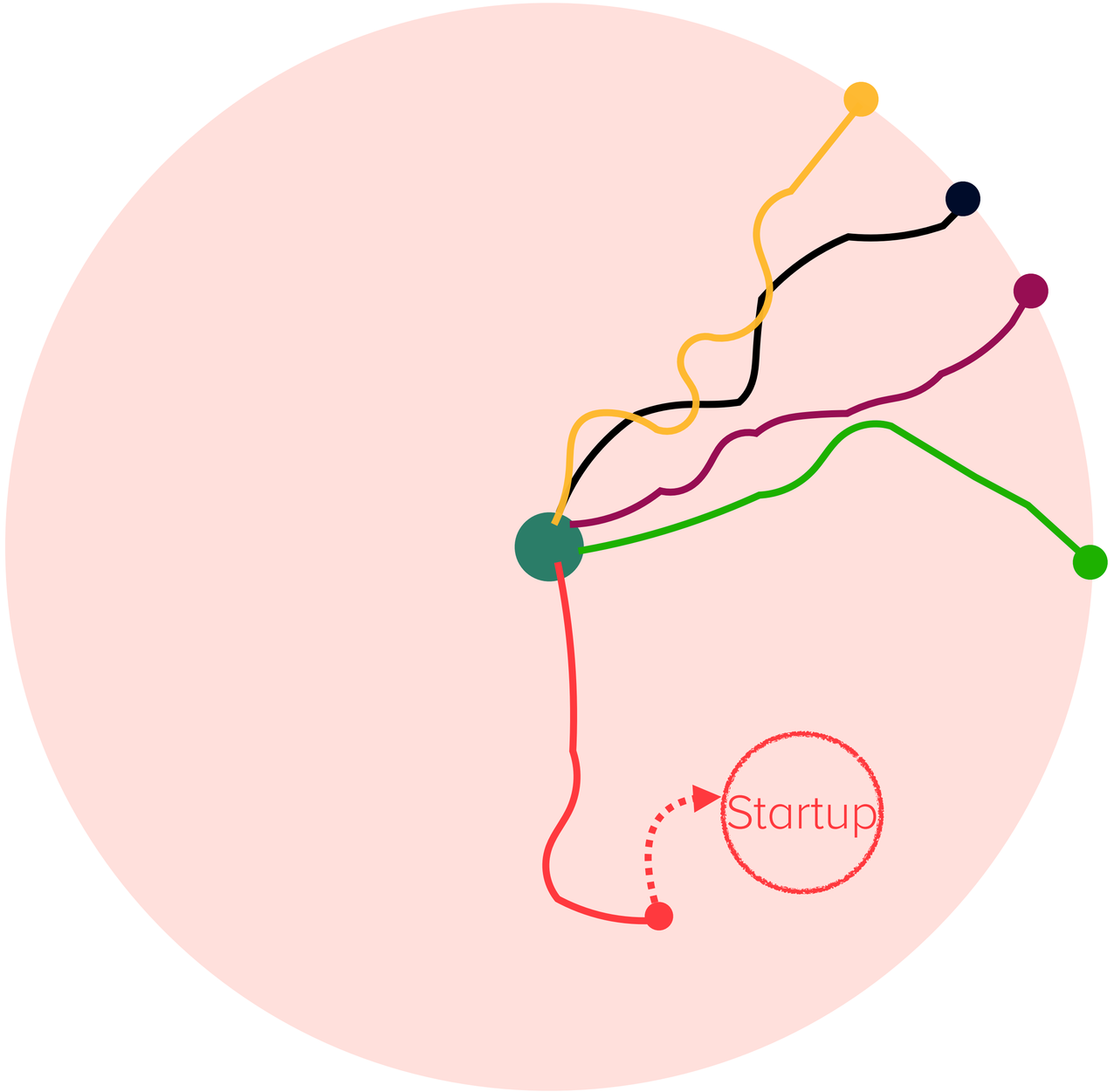
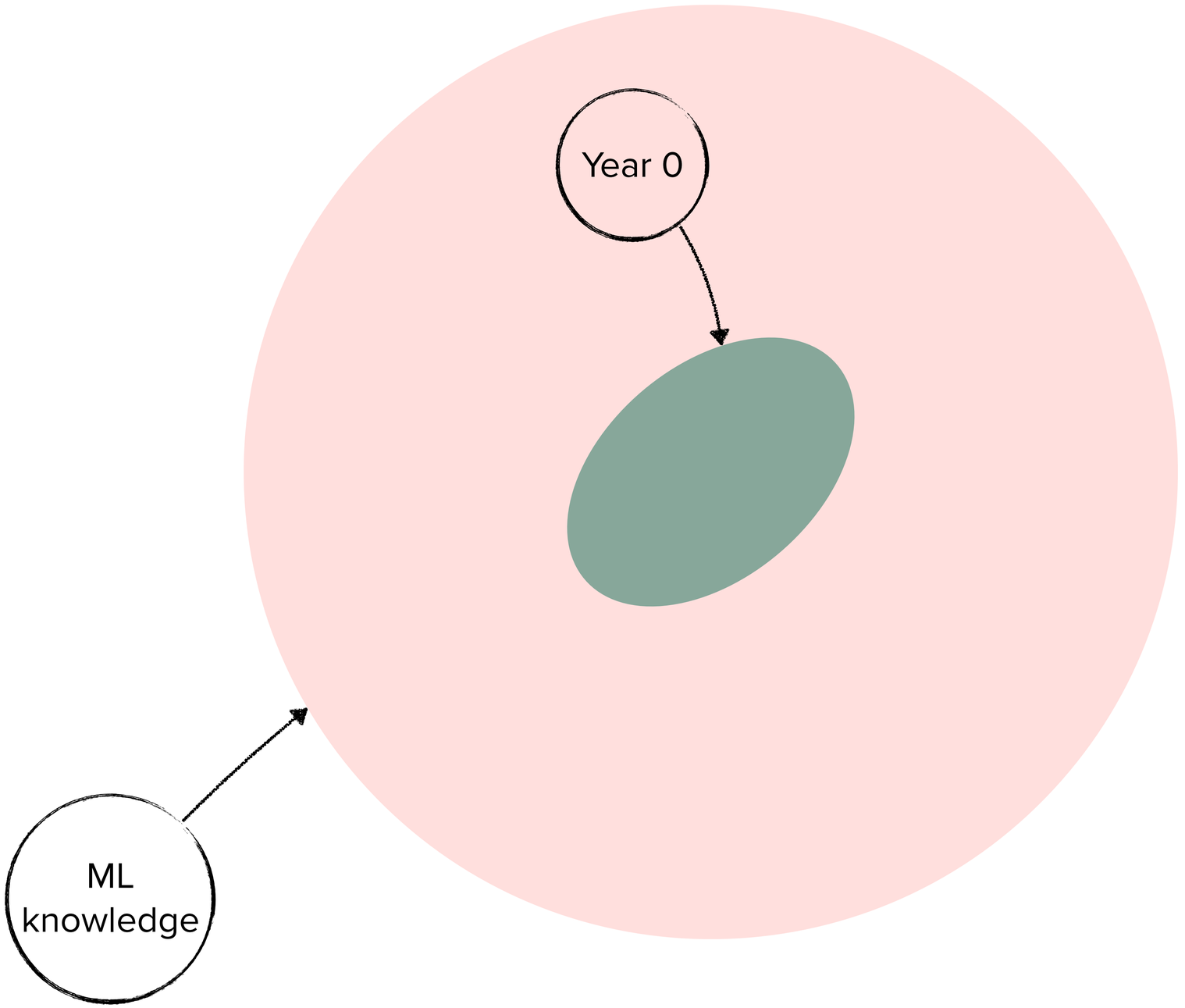


No trajectory is better than others

Non-markovian random process

Outcome is important, but path too: human path

The ML PhD Journey



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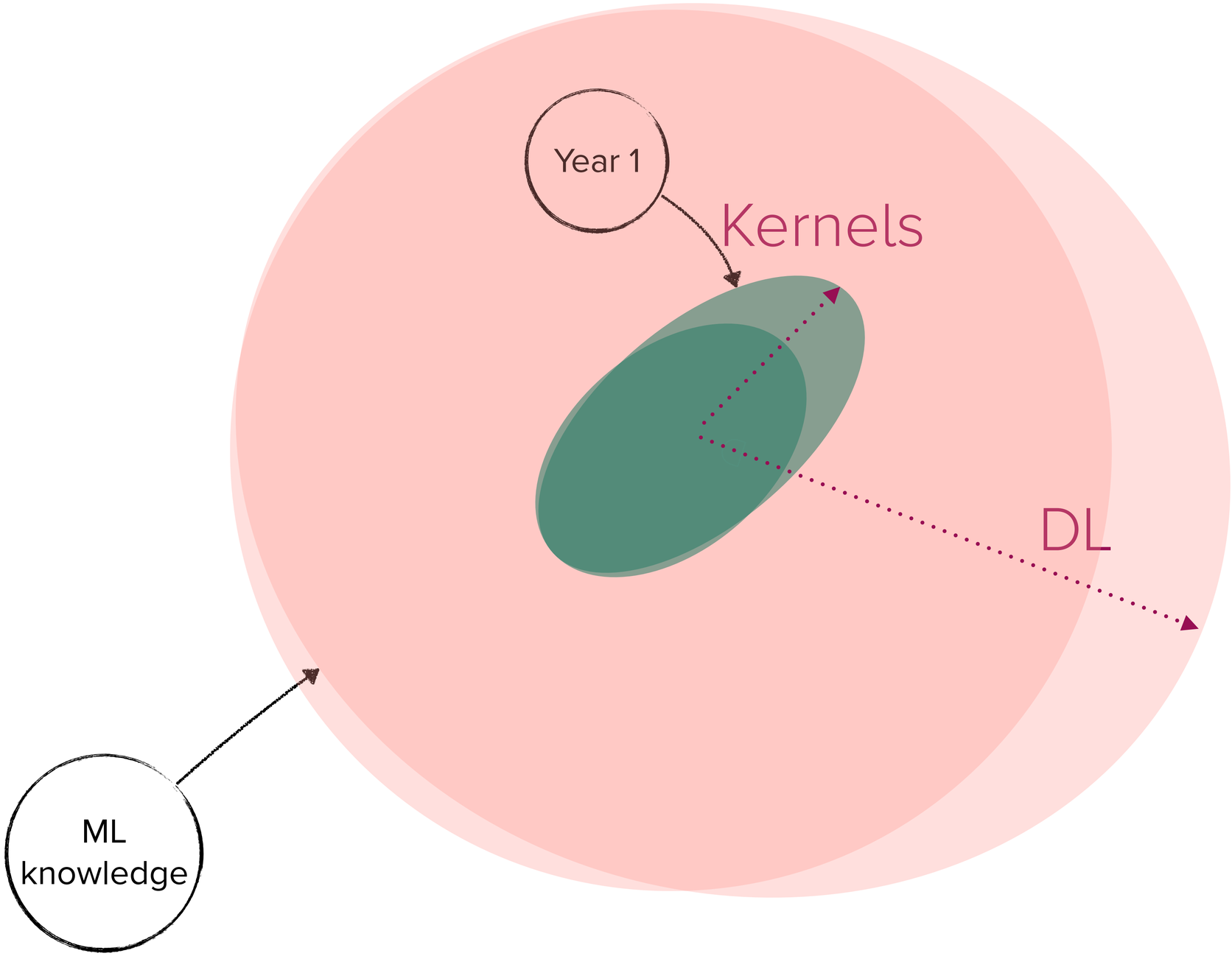

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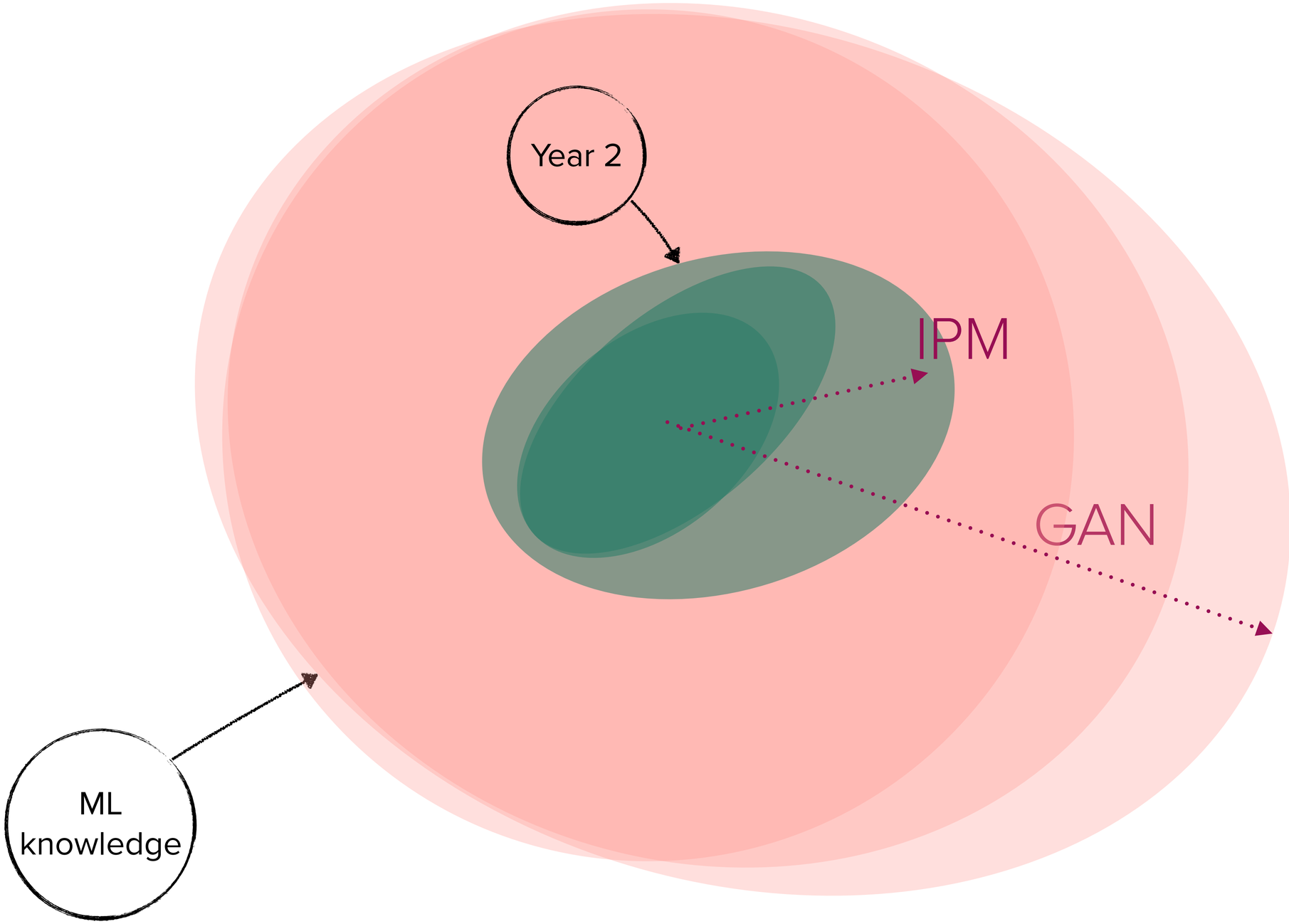

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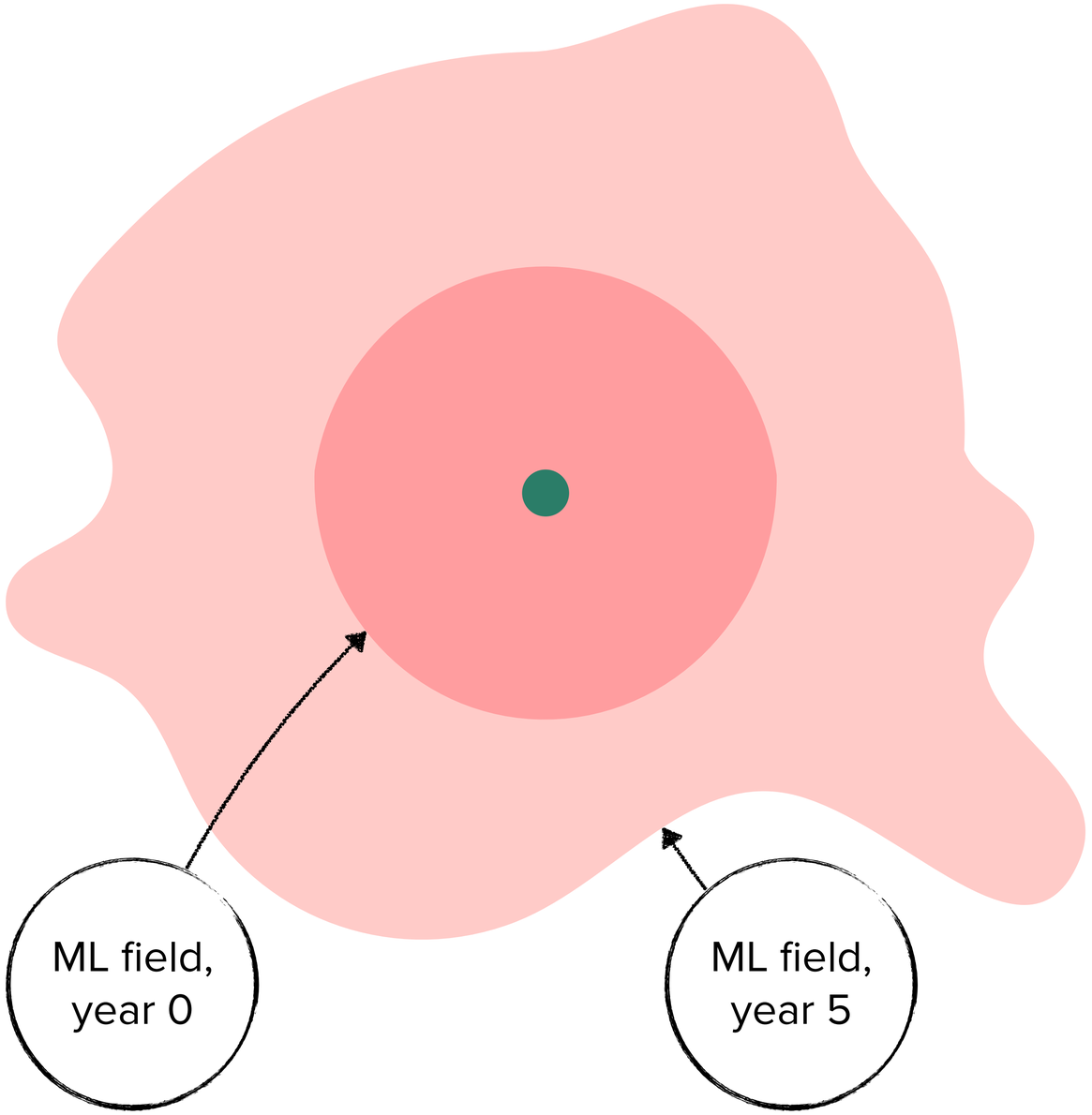
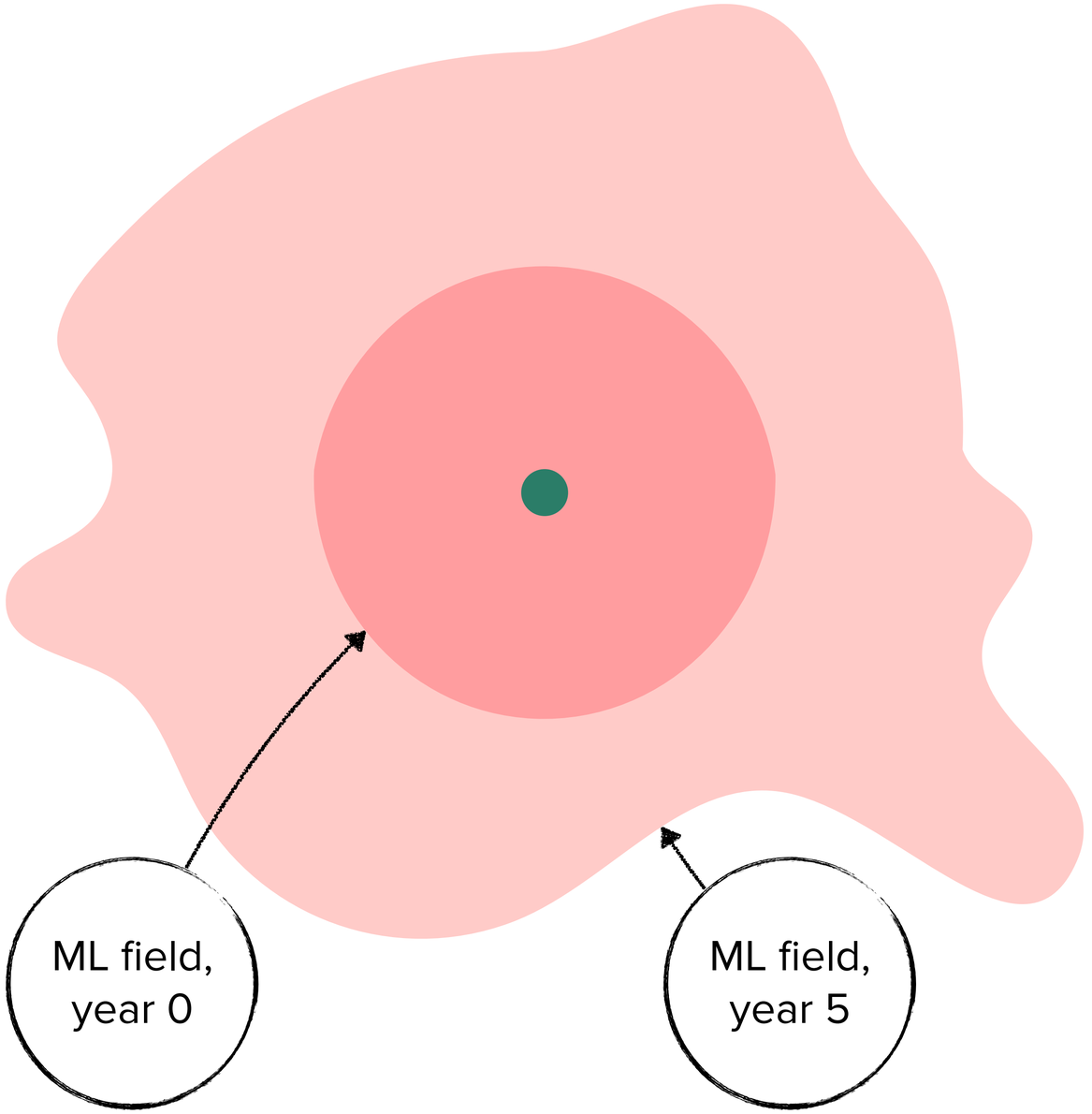
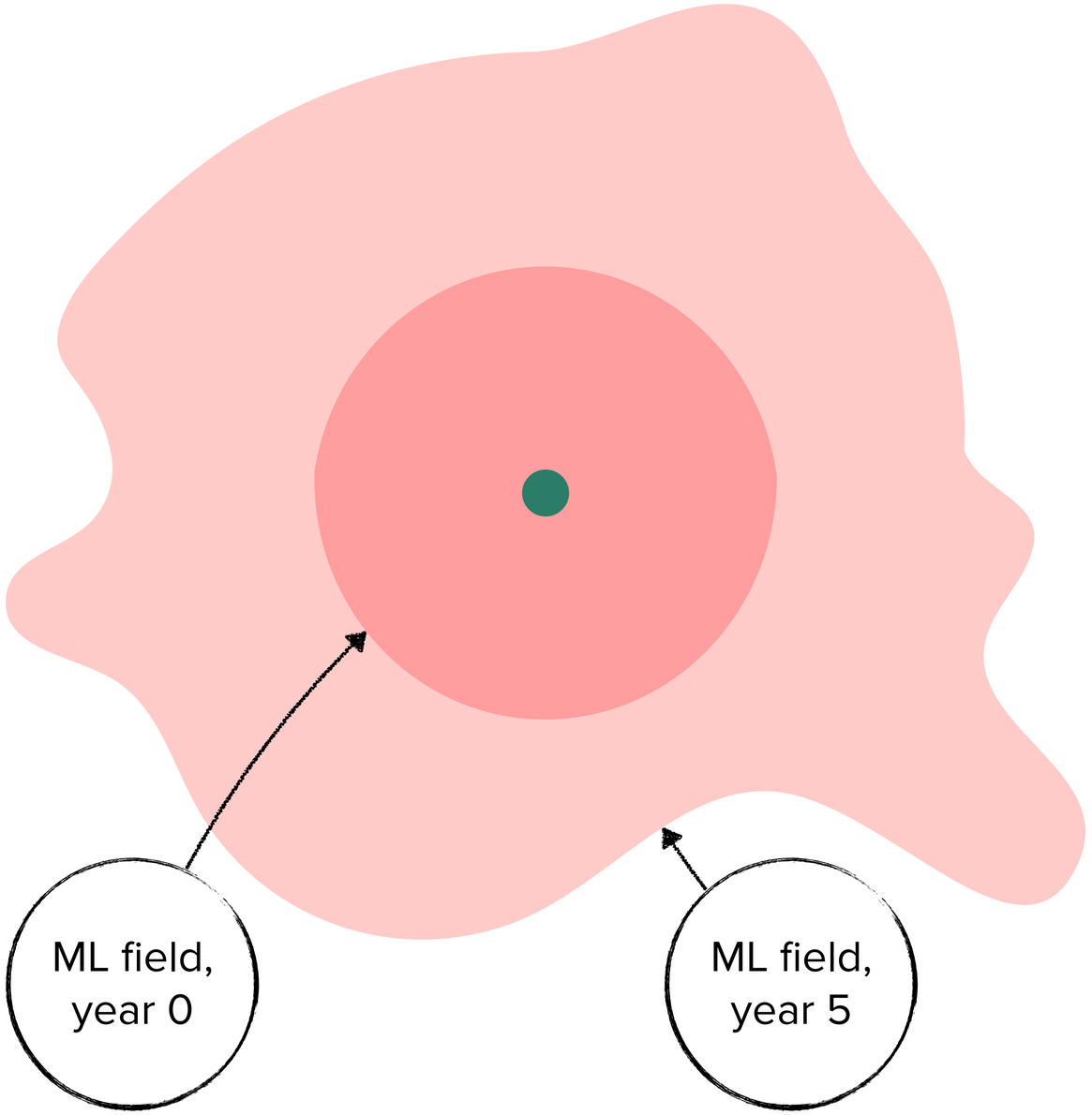


The ML PhD Journey



Trends are often unpredictable

The ML PhD Journey



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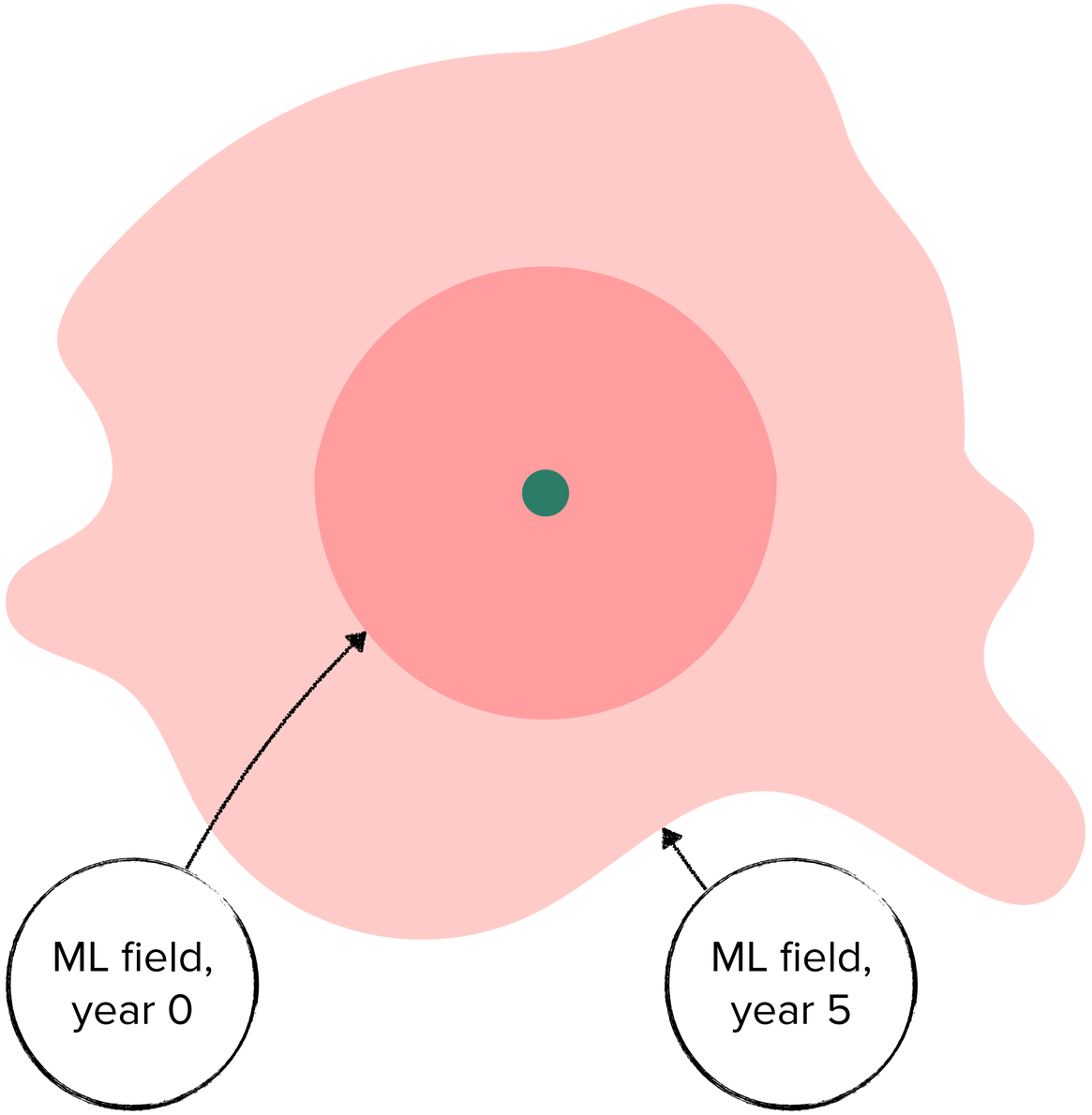

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ML is remarkably broad: profit from it!

ML Academic Ecosystem

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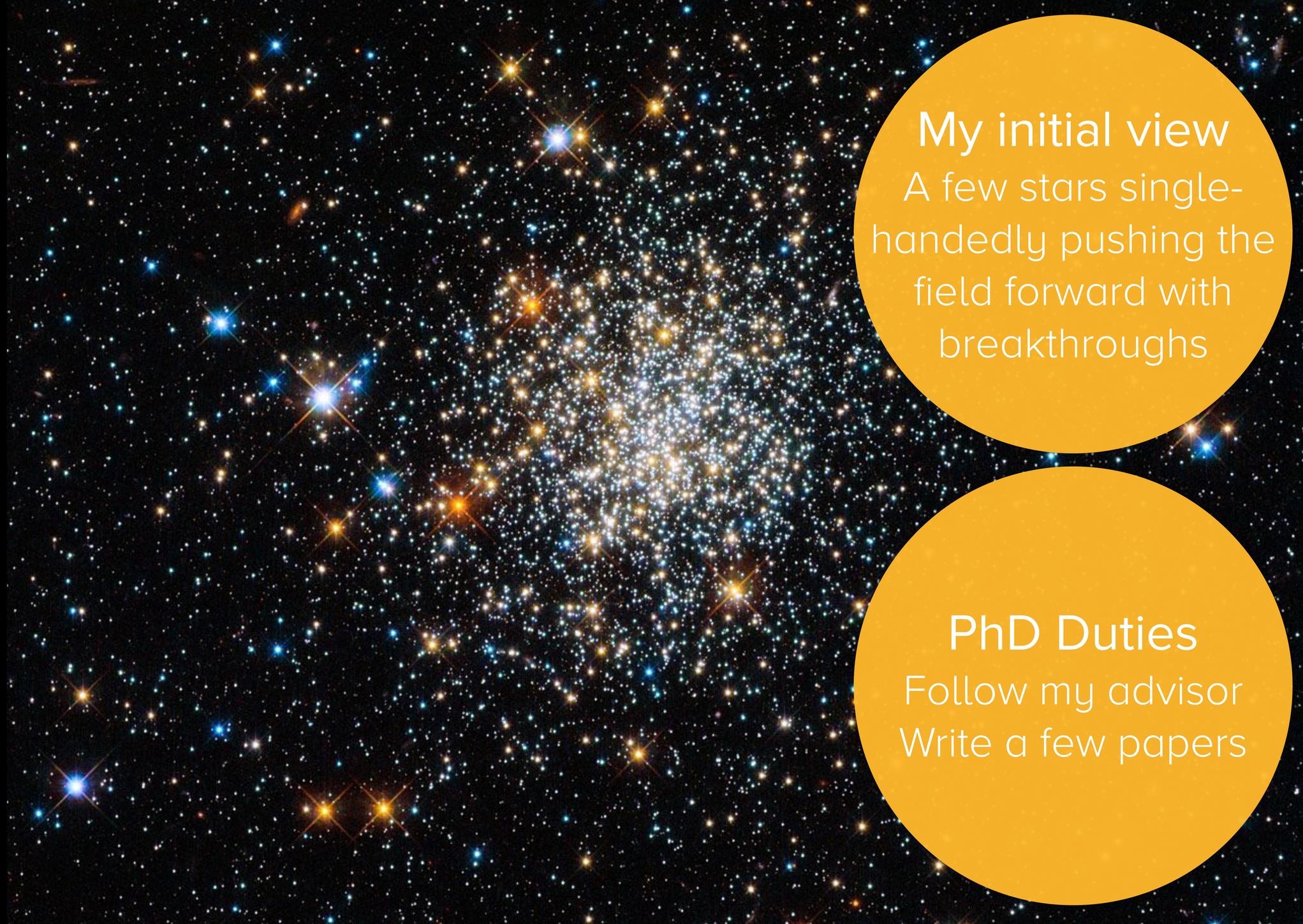

My initial view

A few stars single-handedly pushing the field forward with breakthroughs

PhD Duties

Follow my advisor

Write a few papers

ML Academic Ecosystem

ML Academic Ecosystem

My current view

ML research is primarily a team-effort.

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ML research is primarily a team-effort.

Team can be:

You & advisor
Your lab-mates
Github org
etc.

ML Academic Ecosystem

Progress *is* incremental

Good research should not discriminate.

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ML Academic Ecosystem

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Good research should not discriminate.

My current view

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Research is essentially sustained by students like **you**!

Team can be:

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Closing Personal Advice

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Less emphasis on **analyzing current methods** that work well in practice.

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Feel free to rebuke!

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Welcome to the field!