How to Choose a Research Topic

Hao Tang
What this session is not
What this session is not

• Togelius and Yannakakis, Choose your weapon: Survival strategies for depressed AI academics, 2023

• Ignat et al., A PhD student’s perspective on research in NLP in the era of very large language models, 2023

• Saphra et al., First tragedy, then parse: History repeats itself in the new era of large language models, 2023

• Li et al., Defining a new NLP playground, 2023
What is research?
What is research?

Building models
What is a model?

A **model** is an imaginary artifact that describes the inner working of something.
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- imaginary
A **model** is an imaginary artifact that describes the inner working of something.

- imaginary
- describes inner working
What is a model?

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- imaginary
- describes inner working
- of something
Examples
Examples
Examples

- Golgi apparatus
- Plasma membrane
- Lysosome
- Secretory vesicle
- Smooth endoplasmic reticulum
- Ribosomes
- Nuclear pore
- Nuclear envelope
- Nucleus
- Rough endoplasmic reticulum
Examples

The hypothesis class $\mathcal{H}$ is PAC learnable if for any distribution $\mathcal{D}$, $\epsilon > 0$, and $0 < \delta < 1$, there is a sample size $m$ such that for every $h \in \mathcal{H}$,

$$
\mathbb{P}_{S^m \sim \mathcal{D}^m} \left[ |L_D(h) - L_{S^m}(h)| > \epsilon \right] < \delta.
$$

(1)
Examples

• phoneme

• morpheme

• generative grammar

• mentalese
Examples

- perceptron
- multi-layer perceptron
- long short-term memory network
- Transformer
Examples
Examples

Transformers Learn Shortcuts to Automata

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Examples

Thinking Like Transformers

Gail Weiss 1  Yoav Goldberg 2,3  Eran Yahav 1

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Examples

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Tighter Bounds on the Expressivity of Transformer Encoders

David Chiang¹  Peter Cholak¹  Anand Pillay¹

Transformers Learn Shortcuts to AI

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Examples

Transformers as Recognizers of Formal Languages:
A Survey on Expressivity

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Thinking Like Transformers

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Transformers Learn Shortcuts to At

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Topics, questions, and problems

• A topic refers to a broad field.
• A question is something that can be answered.
• A problem is something that bothers people.
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How to choose a research topic?

• Intrinsic motivation
• Extrinsic motivation
• Constraints
Intrinsic motivation

• That sounds fun!
• I really want to learn that thing!
• I hope someday I can be like them!
• I cannot stand this anymore!
Intrinsic motivation

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Intrinsic motivation
Extrinsic motivation

• Everybody is working on that thing.
• It's easy to find a job if I work on this thing.
• My supervisor works on this thing.
• Everybody is bothered by that same problem.
• I have a tool and I'd better use it somewhere.
• There is a low-hanging fruit.
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What research is about
What research is about
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Constraints
Constraints

• What you already know
Constraints

- What you already know
- Where you are now
Constraints

• What you already know

• Where you are now

• What you have worked on
Constraints

• What you already know
• Where you are now
• What you have worked on
• Whether you have an approach to a problem
Constraints

• What you already know
• Where you are now
• What you have worked on
• Whether you have an approach to a problem
• Whether you have the resources
Constraints

• What you already know
• Where you are now
• What you have worked on
• Whether you have an approach to a problem
• Whether you have the resources
• Whether people care
Hamming’s approach

"Luck favors the prepared mind." – Louis Pasteur

Collect problems and tools.

"It’s not the consequence that makes a problem important; it is that you have a reasonable attack."

"The great scientists, when an opportunity opens up, get after it and they pursue it. They drop all other things."

"Knowledge and productivity are like compound interest." – Hendrik Bode
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• “Knowledge and productivity are like compound interest.” – Hendrik Bode
Should I work on this topic?

- Am I interested? Is there something I can learn from?
- Is that something people care about?
- Do I have an attack?
- Is somebody else working on it?
Further reading

• Hamming, You and your research, 1986

• Lazebnik, Can a biologist fix a radio?—or, what I learned while studying apoptosis, 2002

• Jonas and Kording, Could a neuroscientist understand a microprocessor?, 2017

• Shmueli, To explain or to predict, 2010

• Breiman, Statistical modeling: The two cultures, 2010

• Mullaney and Rea, Where research begins, 2022

• Booth et al., The craft of research, 2016
Summary

• Fuel your interests with success.

• Engage with the moving collective experience.

• Compound your knowledge and productivity.

• How likely is your work going to be rediscovered?