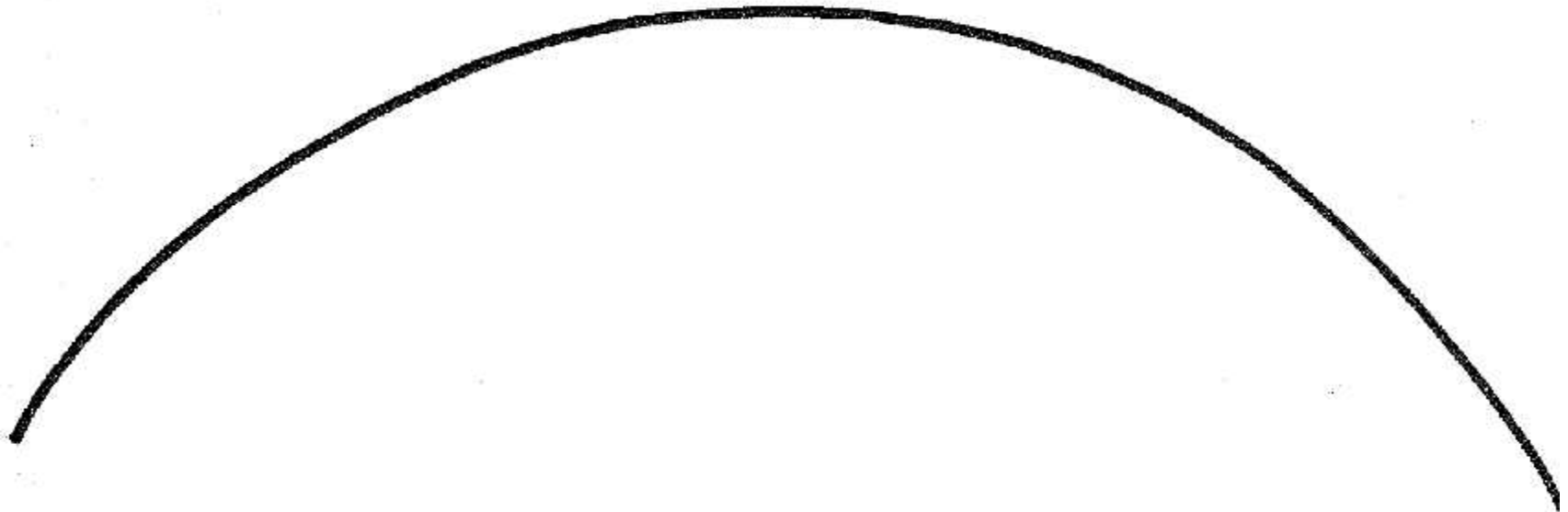


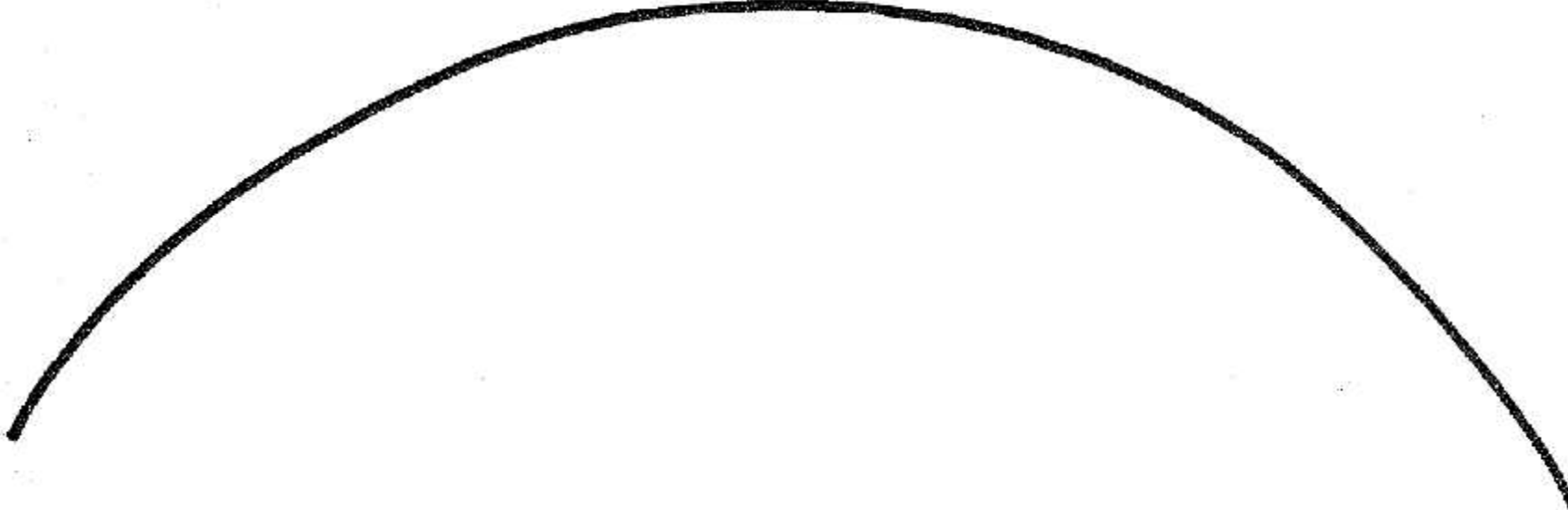
# How to be a successful PhD student

**By Cin-Ty Lee**  
**5 Jan, 2012**



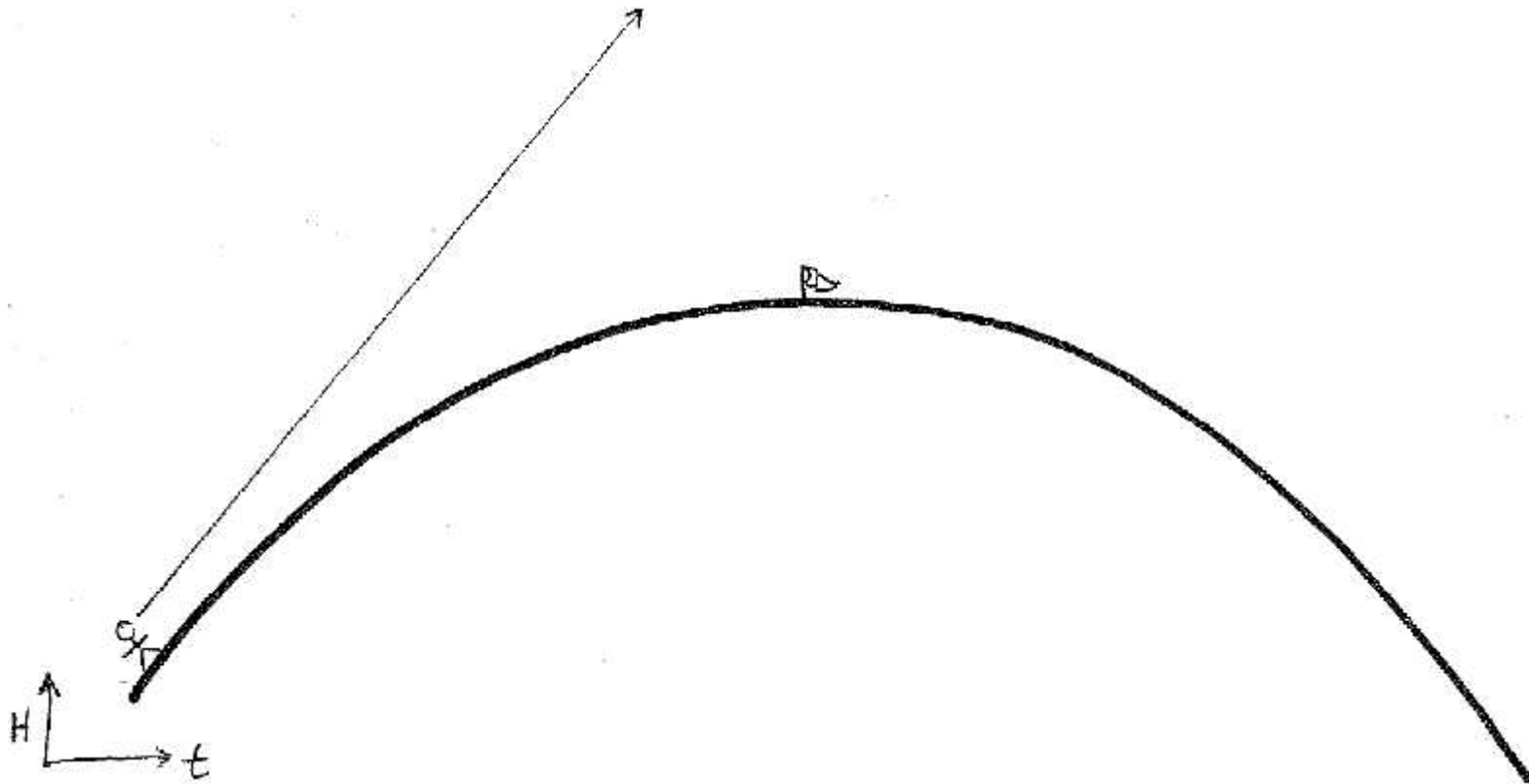
**Ph. D. = philosophiae doctor**

**Knowledge,  
understanding &  
societal contribution**



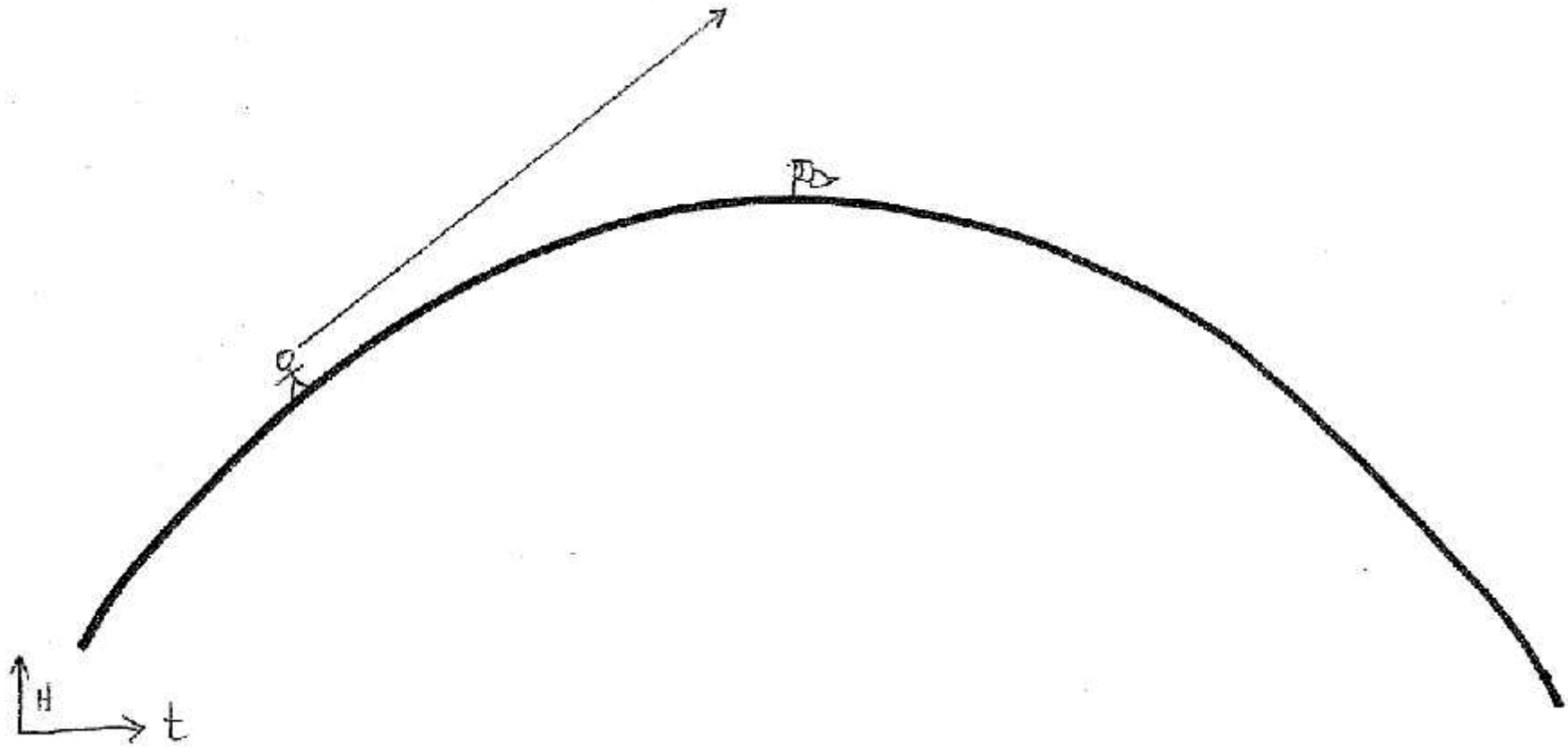
# Year 1 of graduate school

- You know nothing
- You don't even know where you are going
- And the journey is steep



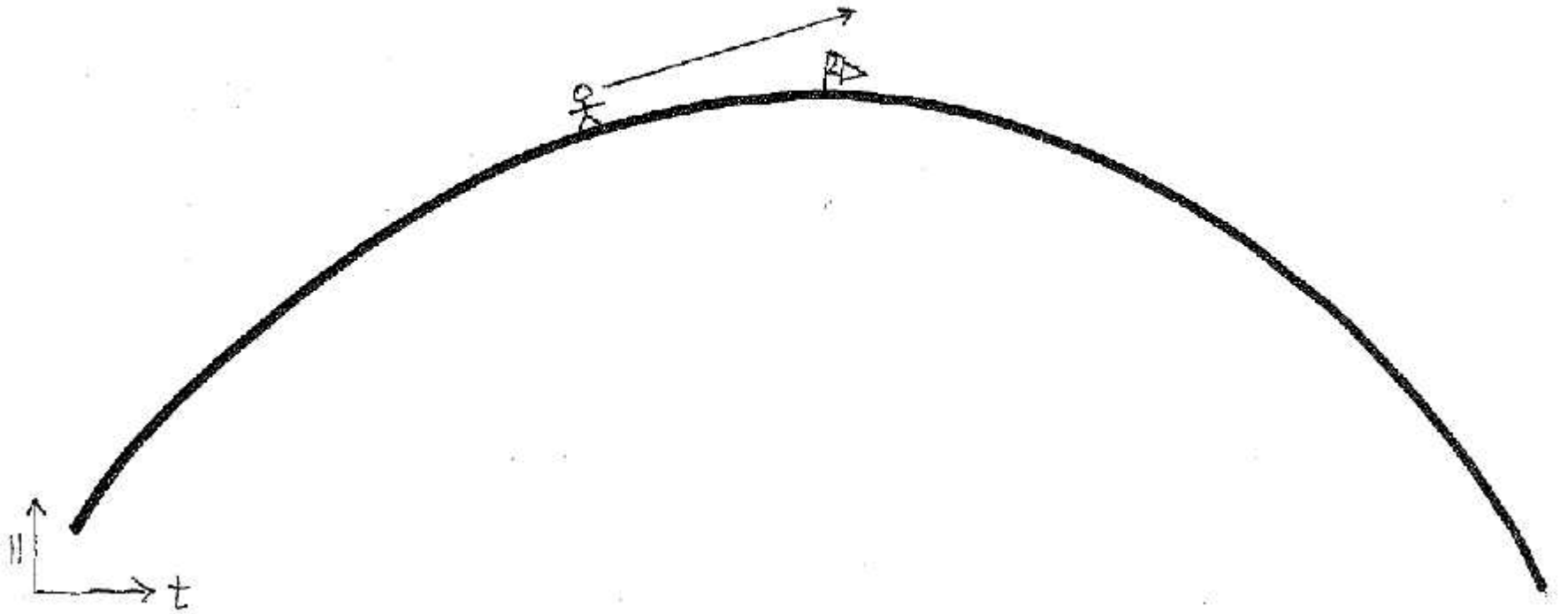
# Post-oral exams

- You know something
- You have identified a problem you are working on
- Still, no end in sight



# After your experiments are done

- You know a lot and you're wiser
- You can see the finish line
- You know what you have to write to finish



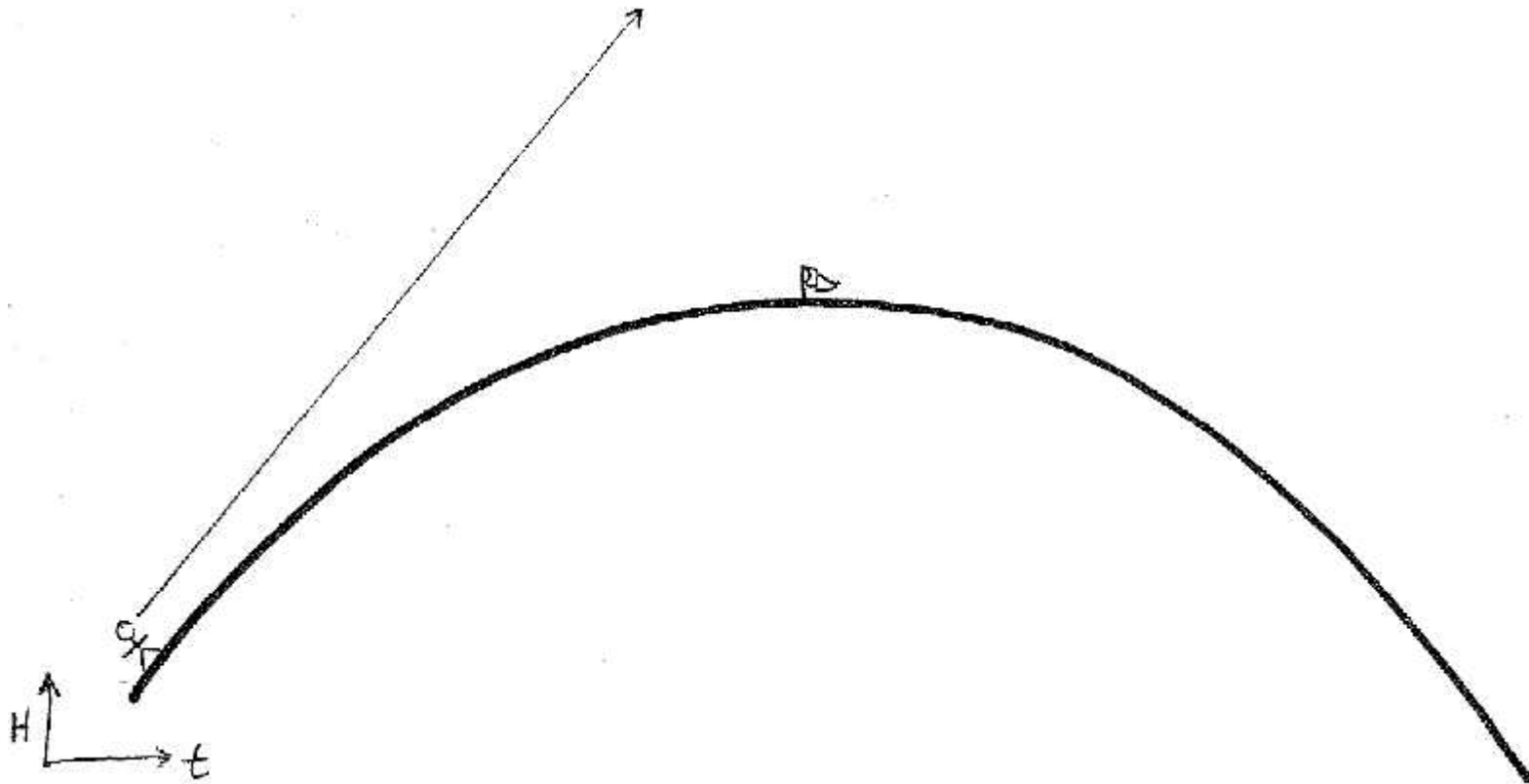
# Searching for questions

**Bottle  
of topics**



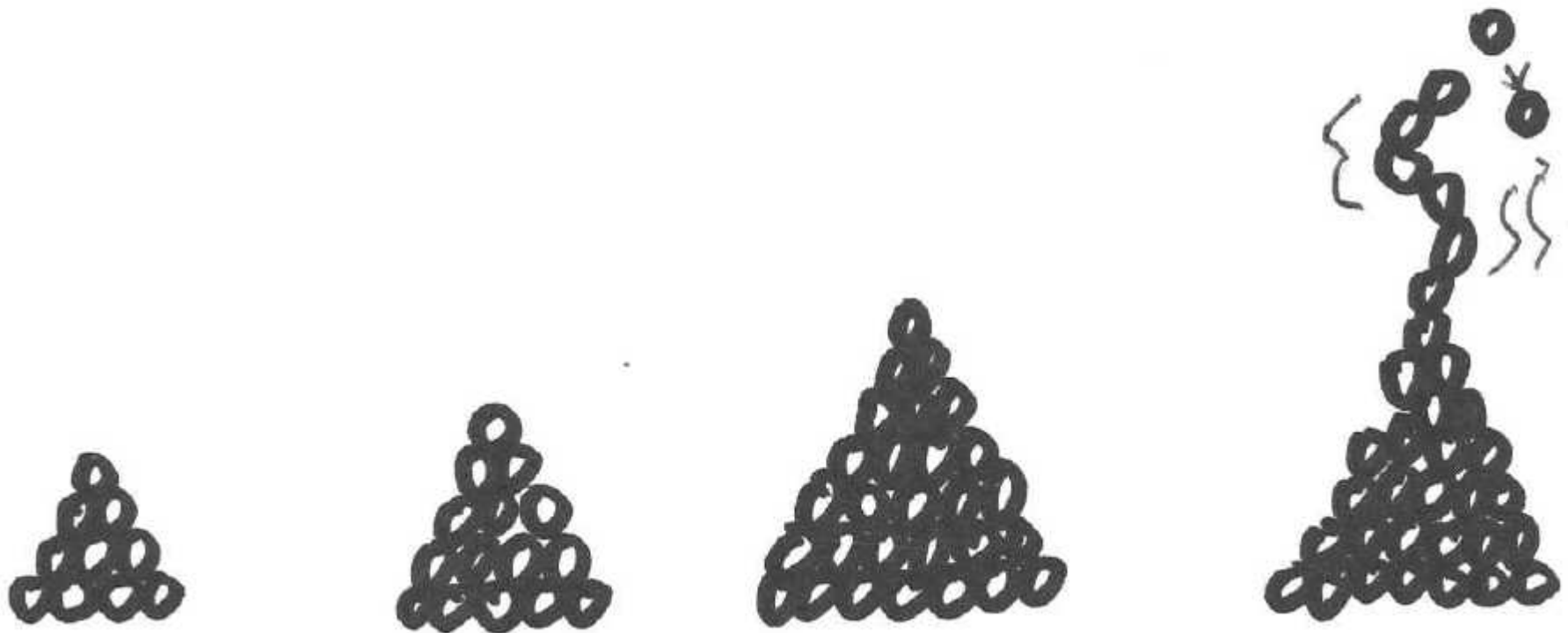
# Year 1 of graduate school

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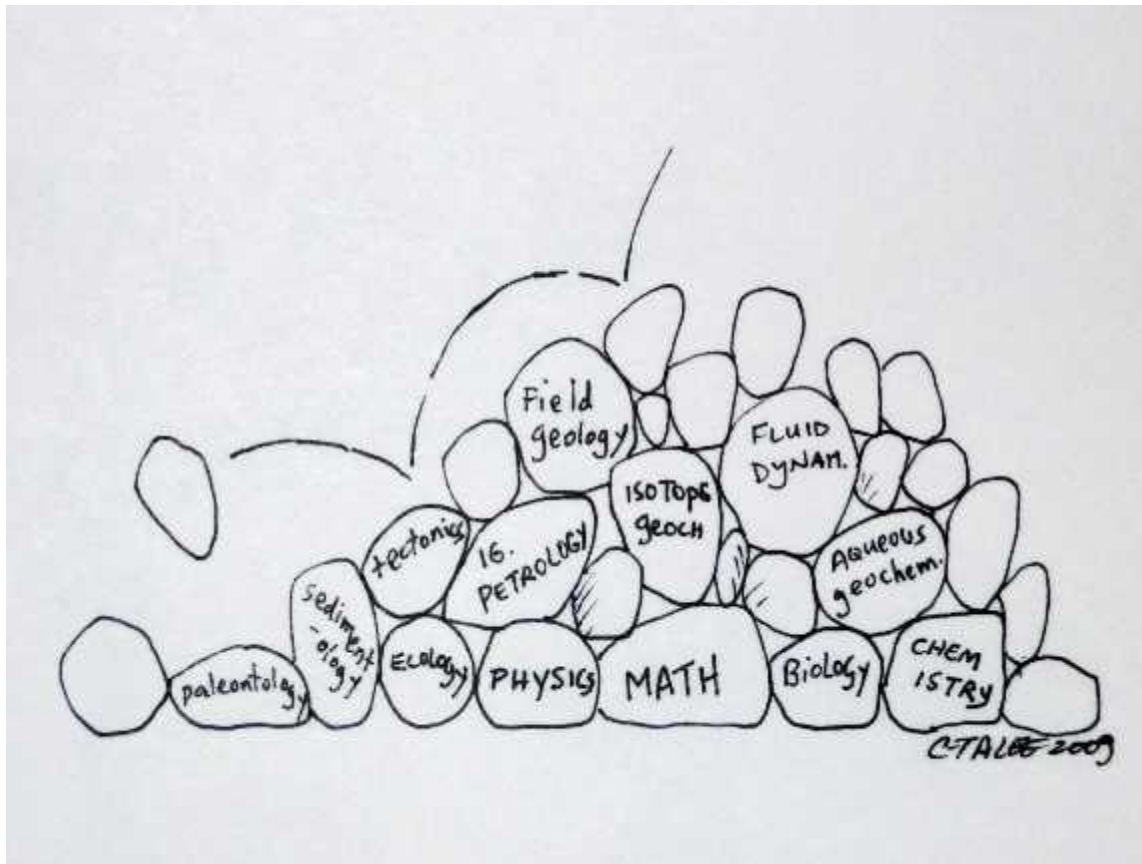
# Build your arsenal of knowledge

-build foundation first





# Arsenal grows sand grain by sand grain



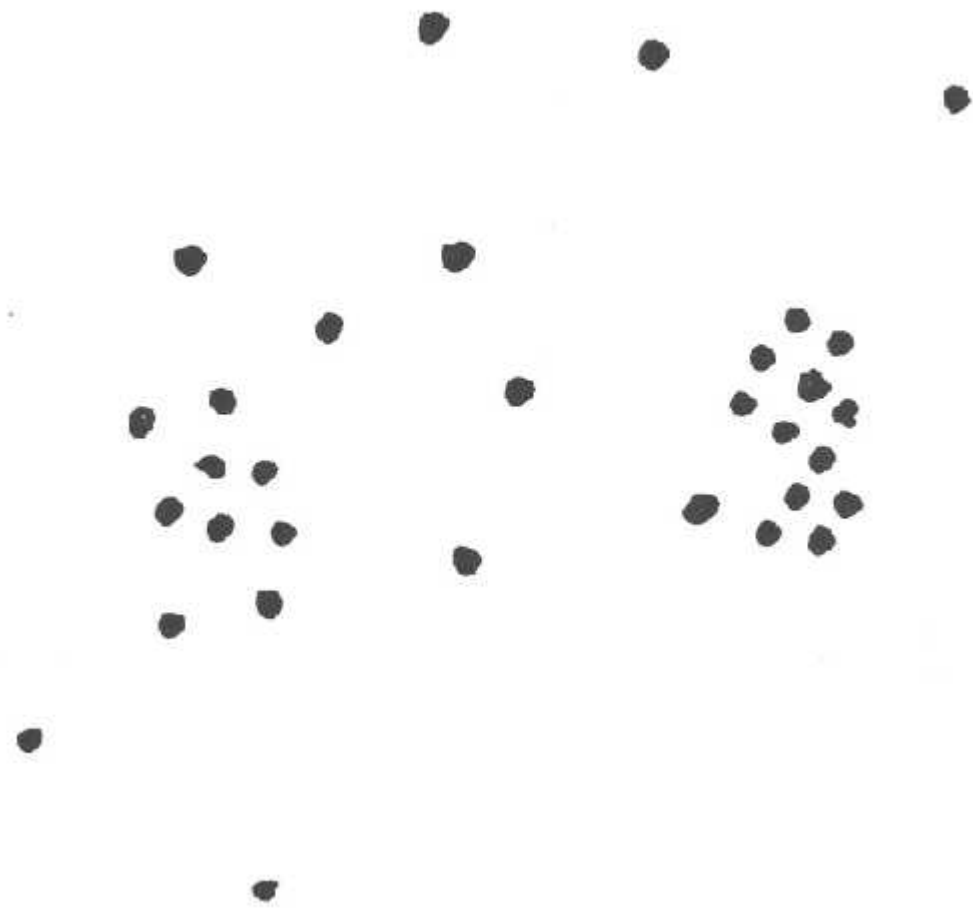
- Read
- Take classes
- Talk to colleagues



- Build a reference collection
- Make a scrapbook

# How do you identify a problem or ask a question?

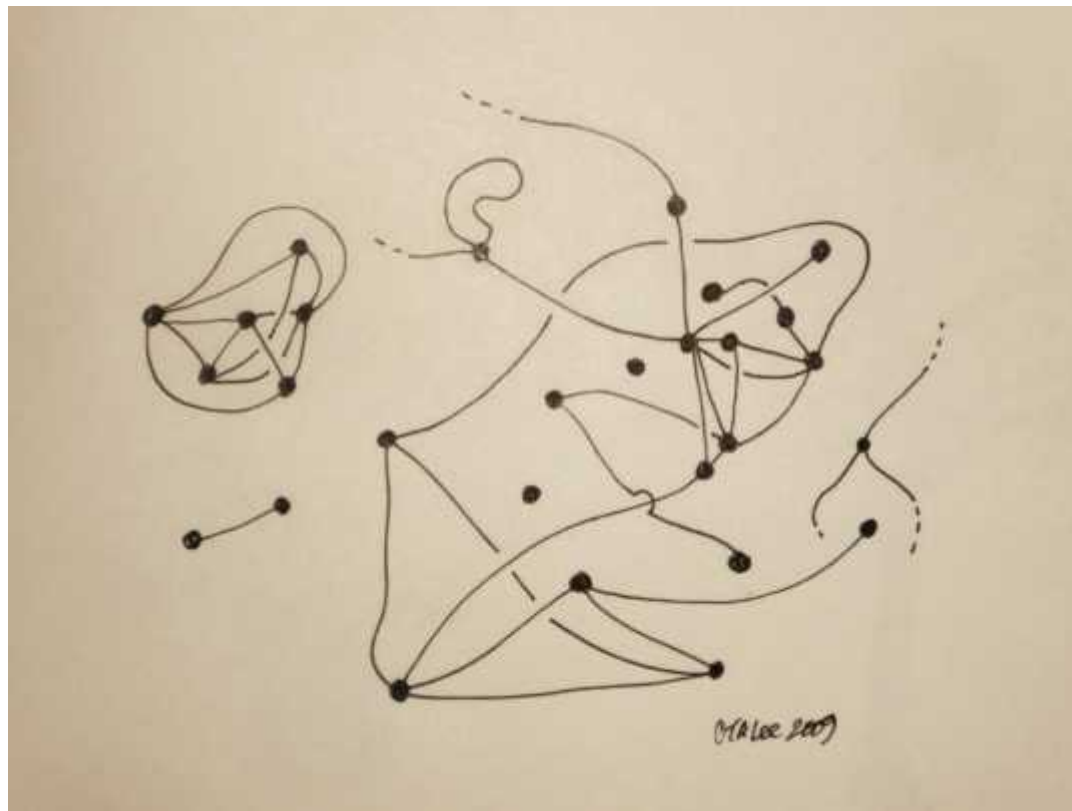
Aack! I know a lot but all my knowledge is fragmentary!



# Understand Landscape of Knowledge

-make connections

Connections = hypothesis = question/problem



**Luck favors the prepared mind**

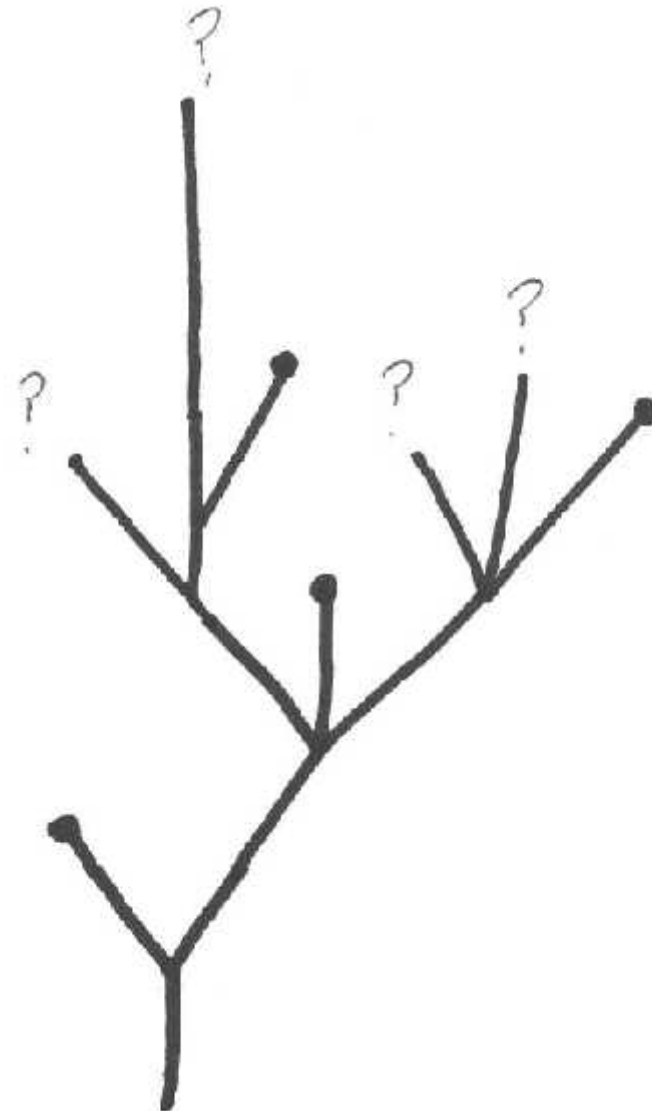
**-Louis Pasteur**

Begin with a connection

--connections lead to other connections

--ideas begin to flourish and branch out

--pick some research directions and follow them

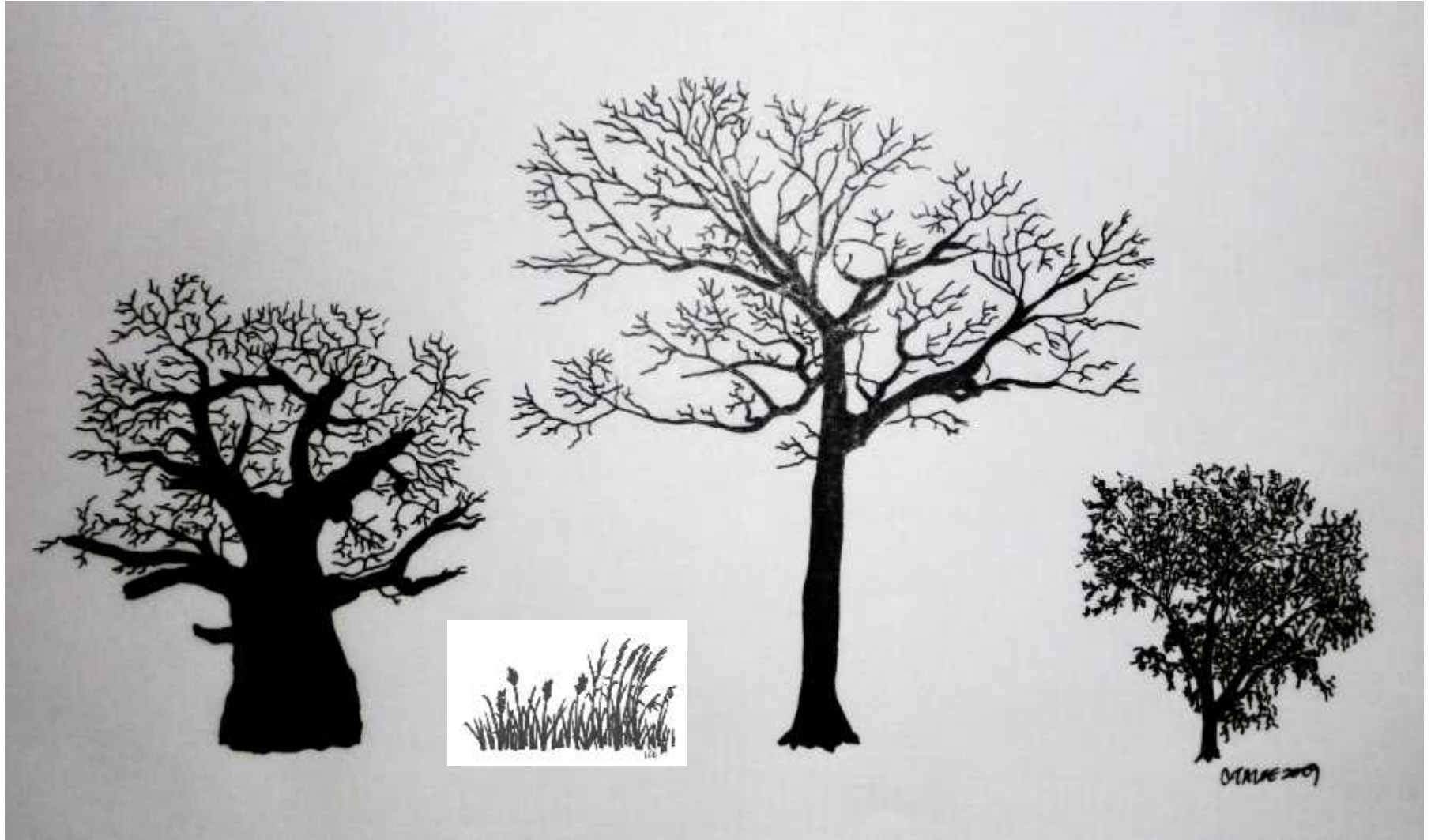


But you don't want to pick too many problems/questions

- You will get lots of grass, but in the winter, they will all die back down



# Build up your knowledge tree



What type of tree are you?

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# **The good and the bad of questions**

**-bad question**

**ill-defined, no answer, too difficult**

**-good question**

**well-posed**

**leads to testable hypotheses**

**difficulty is within reason**

# Bad questions/problems for a PhD thesis

What is the origin of life?

I want to solve global warming

I want to end world hunger

What is gravity?

How do mountains form?

Why do animals sleep? Dream?

I want to cure cancer.

These are certainly worthy questions/goals, but they are unrealistic ways to begin as they are ill-posed, too ambitious, too vague, or simply have no answer for mortals like us. Start small.

**Ill-posed question: Why do rivers meander?**

**Why shouldn't rivers meander?**



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## Better posed question

**What are the physical parameters that define whether a river meanders or flows straight?**



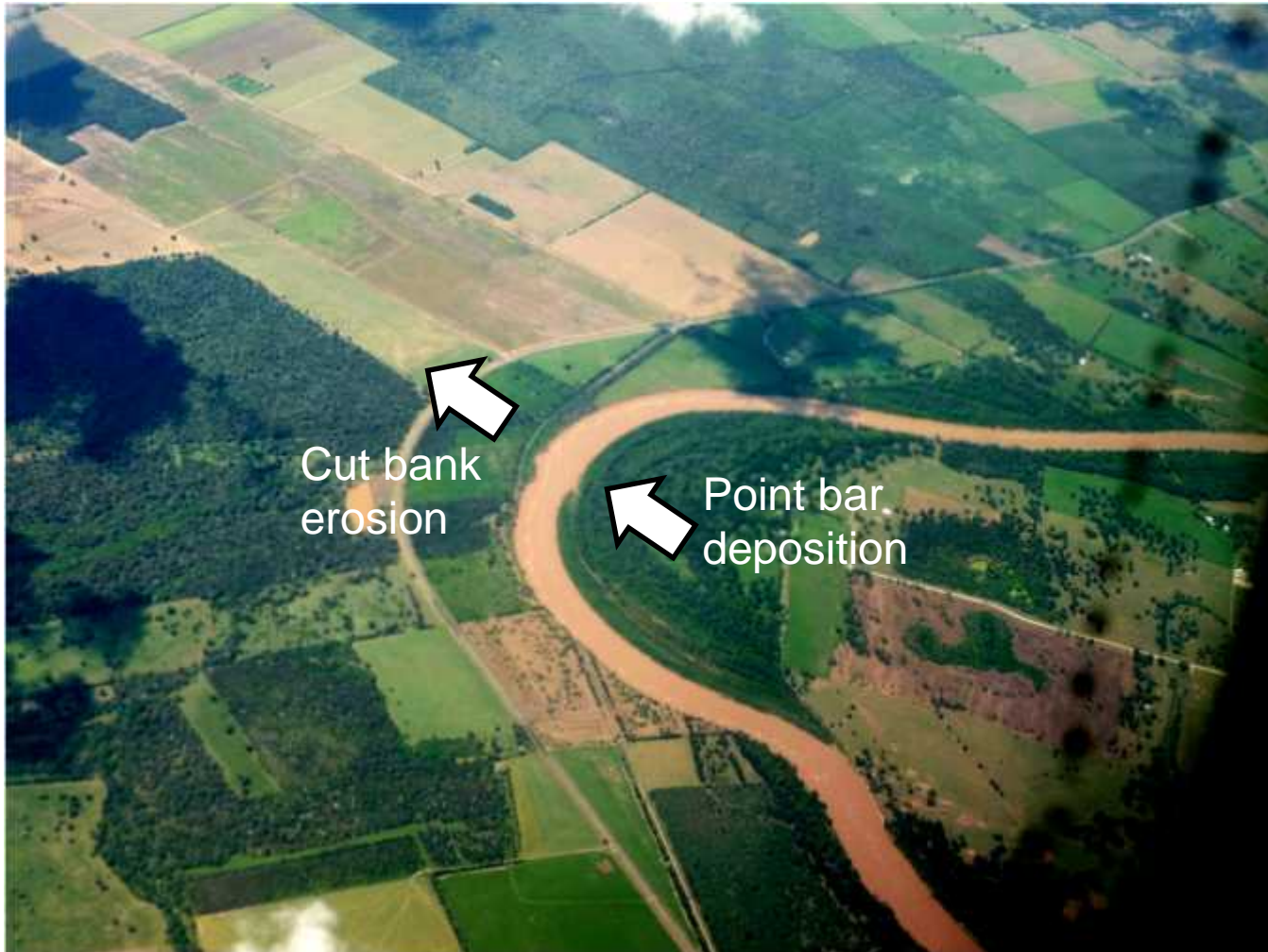
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# Who cares about this question?

## Implications

- Where should I build my house, bridge, farm?
- How do I control flooding?
- How do I preserve river eco-systems?
- Taps our fundamental curiosity

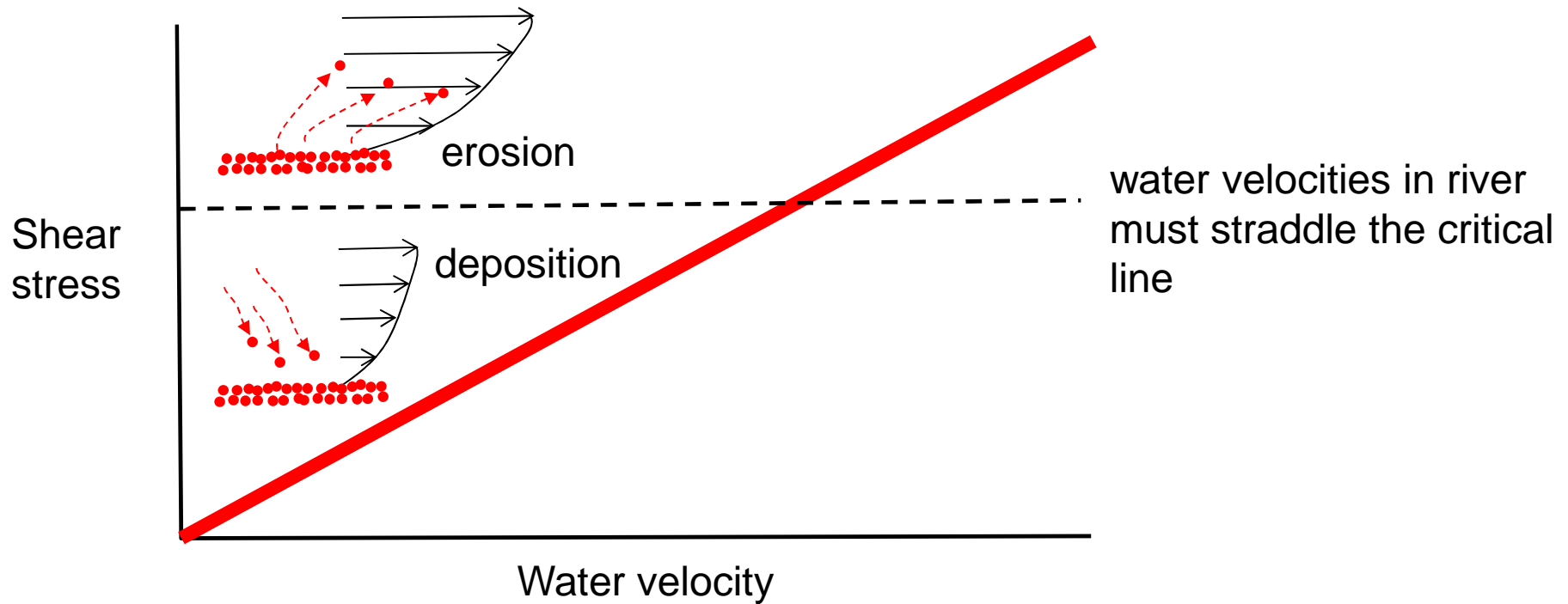
# A good question should lead to a good hypothesis



In outer bend, the river is erosive. On inner bend, the river deposits sand.

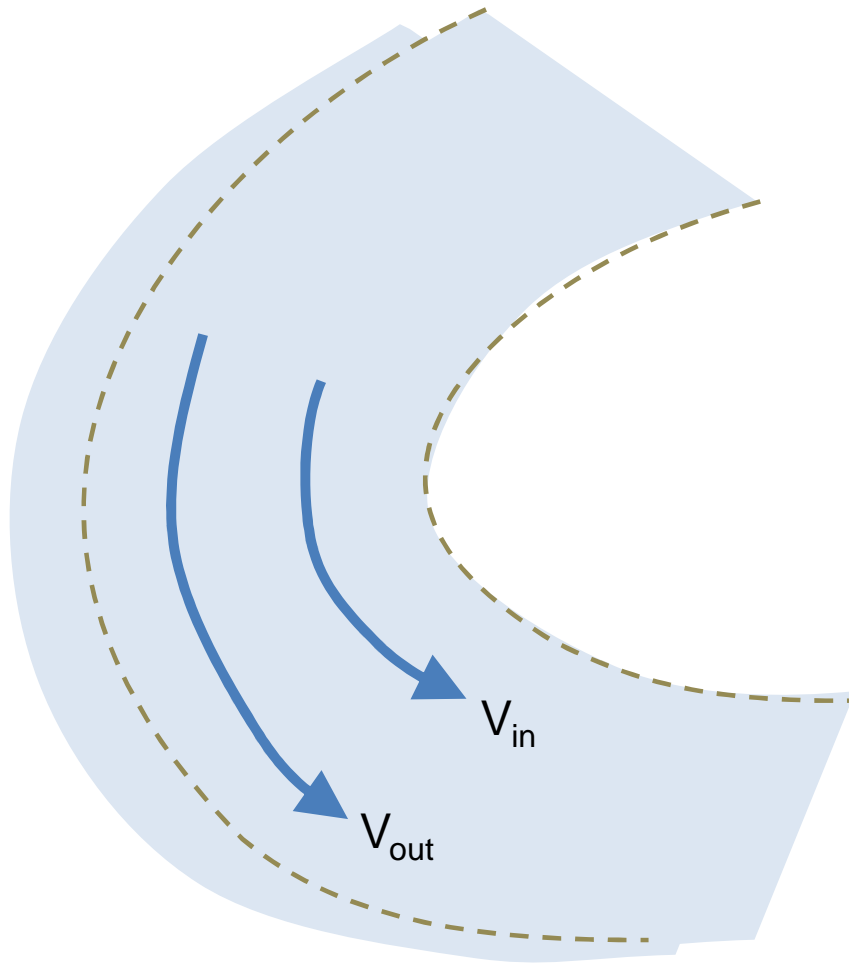
Hypothesis:

In outer bend, the river is erosive. On inner bend, the river deposits sand.



Hypothesis:

In outer bend, the river is erosive. On inner bend, the river deposits sand.



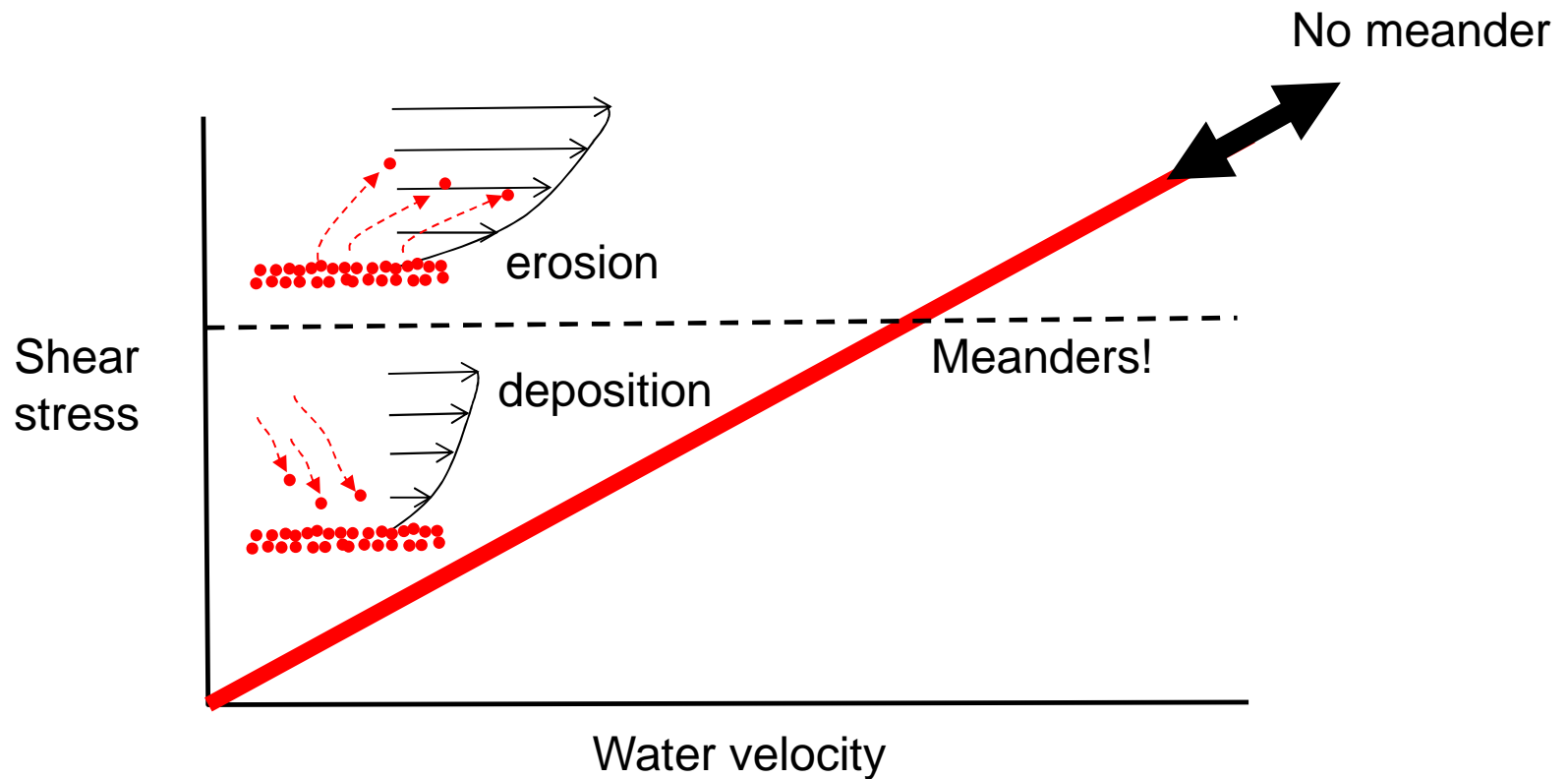
$$V_{out} = \frac{R_{out}}{R_{in}} V_{in}$$

$$V_{out} > V_{in}$$



Hypothesis:

In outer bend, the river is erosive. On inner bend, the river deposits sand.



# What have we done?

- Followed our curiosity with a question
- Made observations from nature
- Developed a testable hypothesis

What's next?

- Testing the hypotheses by constructing an experiment

# What if our hypothesis is wrong?

Well, you won't know until you try to test it.

If you're wrong, you still learned something.

Better to have learned something than to have done nothing at all.

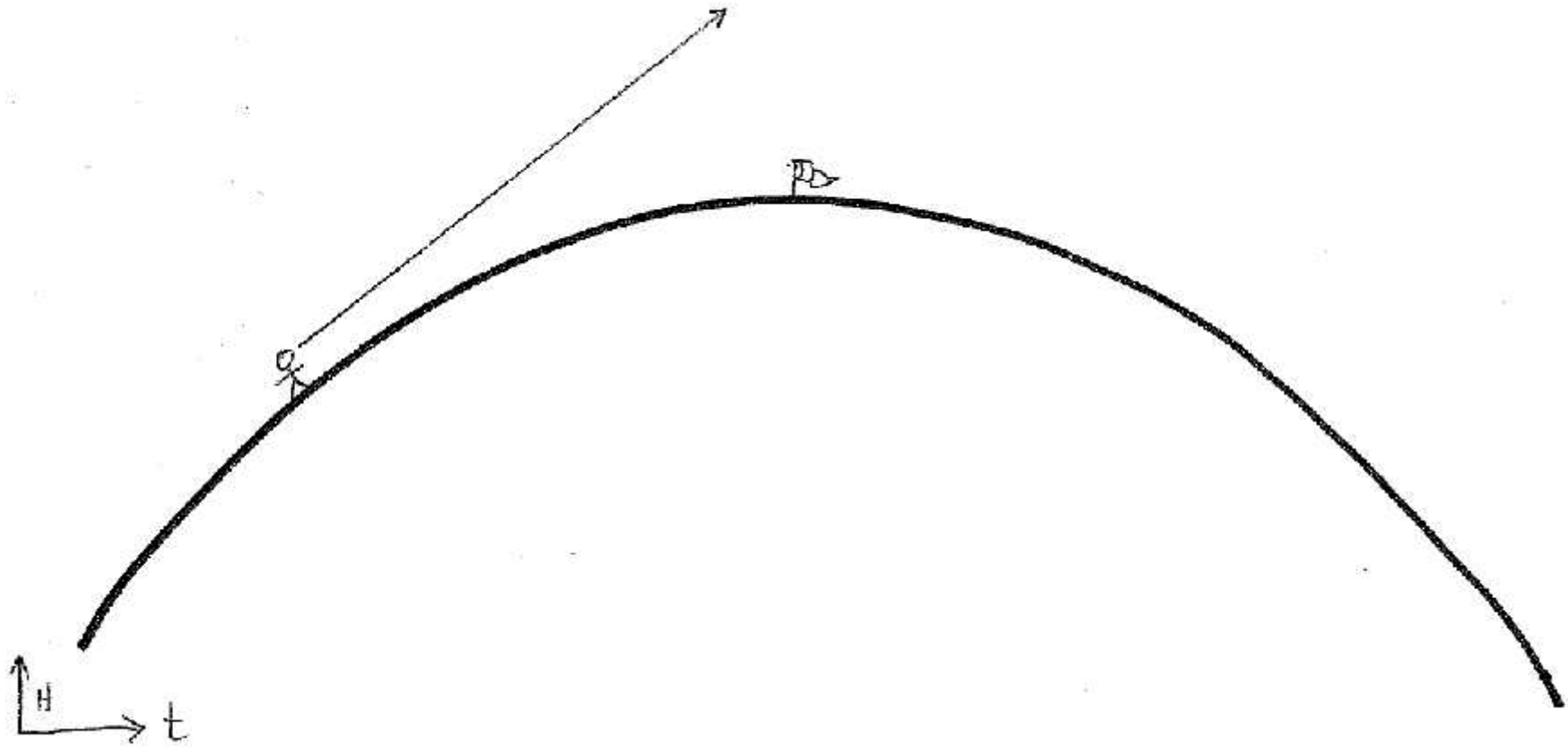
Don't be afraid to try things.

Don't be afraid to make mistakes.

Learn from your mistakes.

# Post-oral exams

- You know something
- You have identified a problem you are working on
- Still, no end in sight



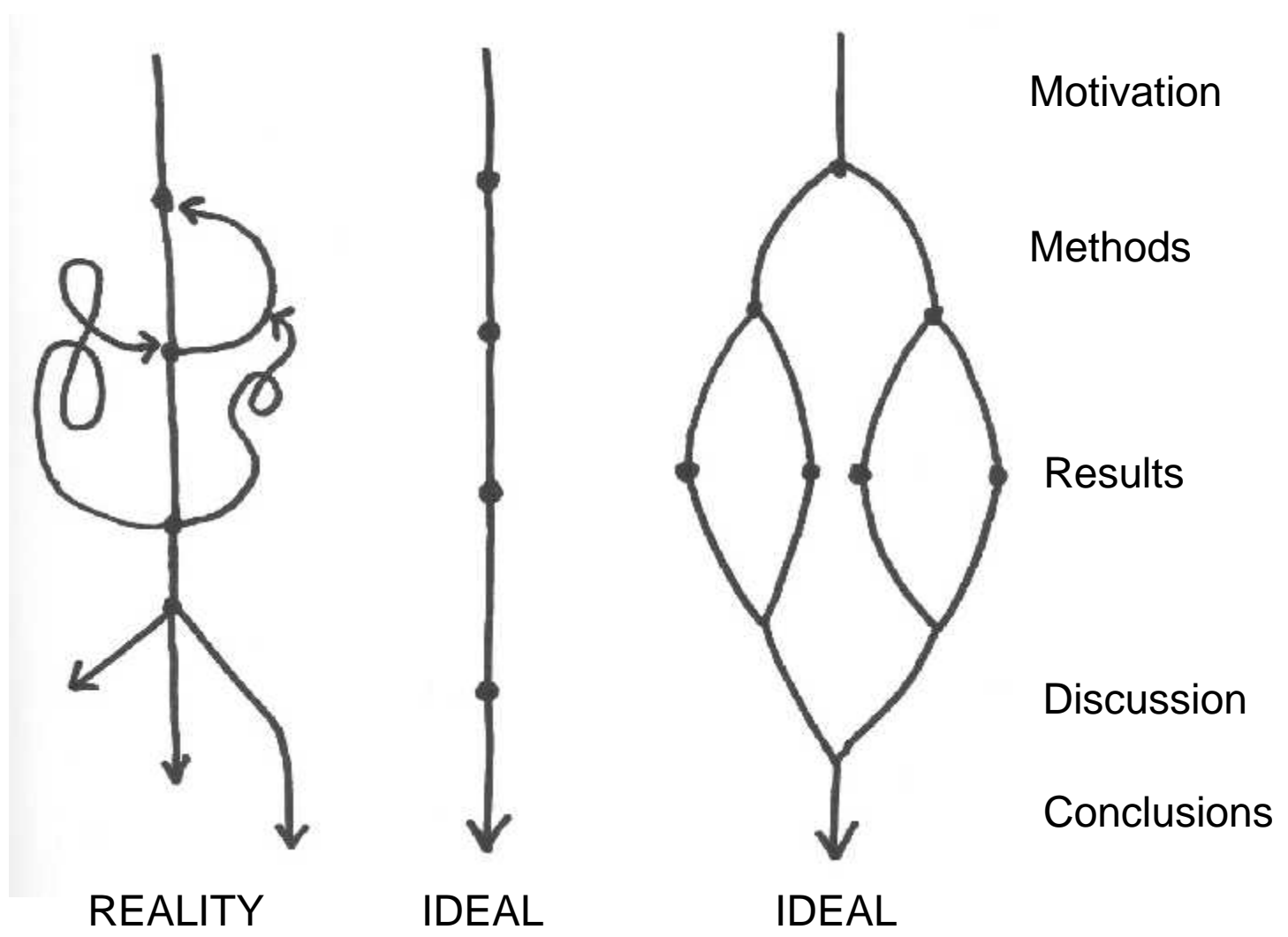
# Thinking and executing your proposed study

- Motivation – why is the problem interesting?
- What is the hypothesis?
- How will you solve the problem?
- What did you find?
- What do your results mean?
- What is the next step?

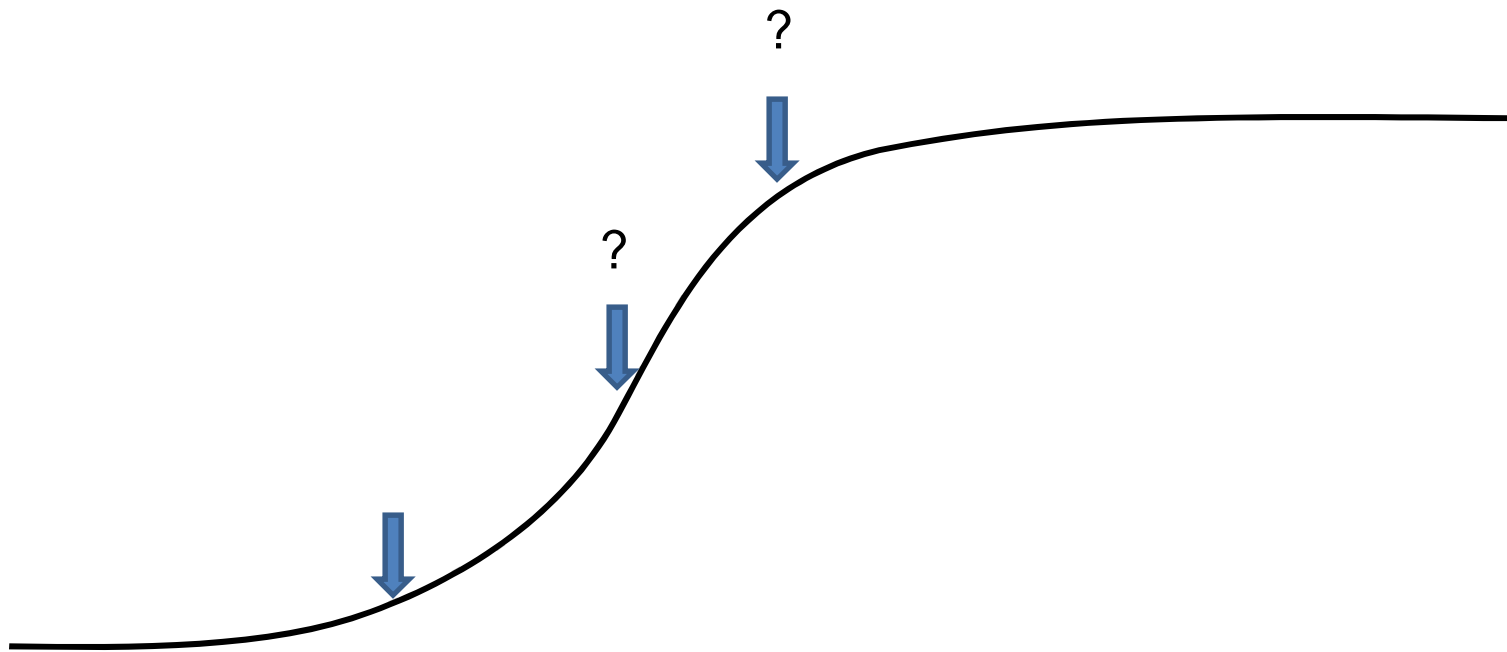
# Progression of your science is nonlinear

--be prepared to make mistakes

--be prepared to reconsider your hypotheses, methods



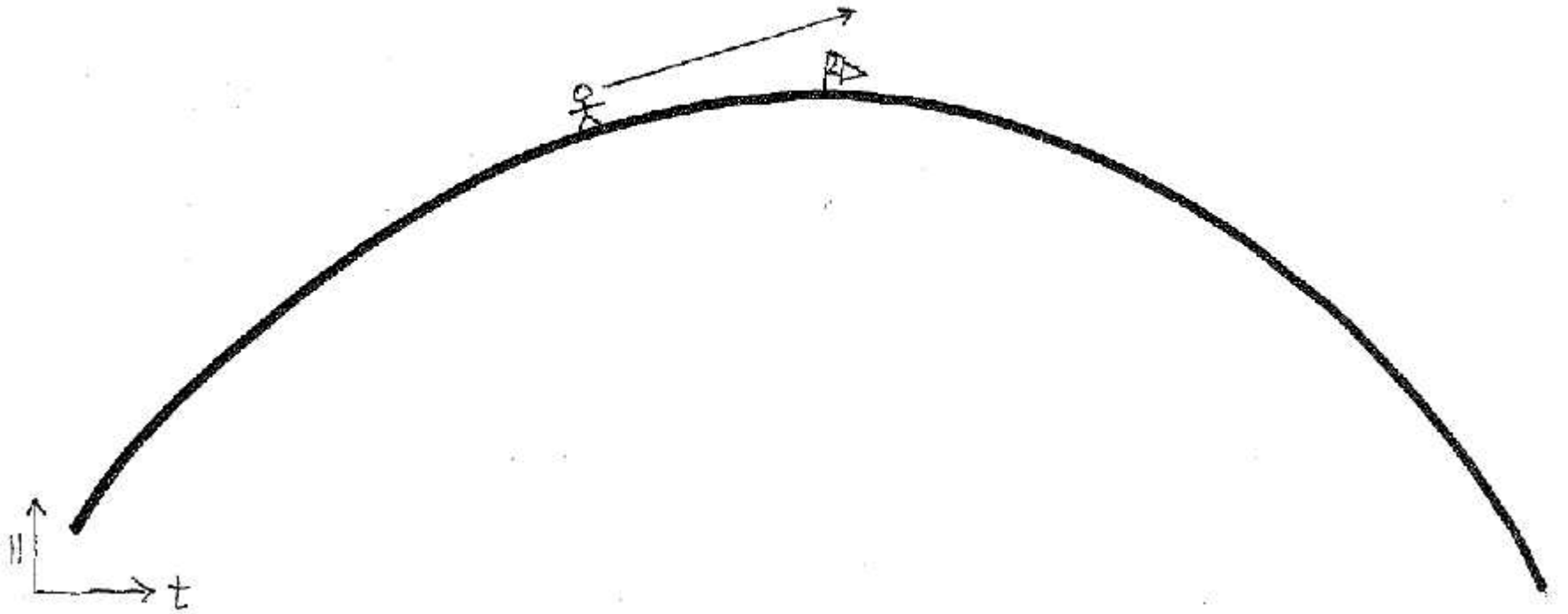
**When is too much data enough?  
When do you stop?**





# After your experiments are done

- You know a lot and you're wiser
- You can see the finish line
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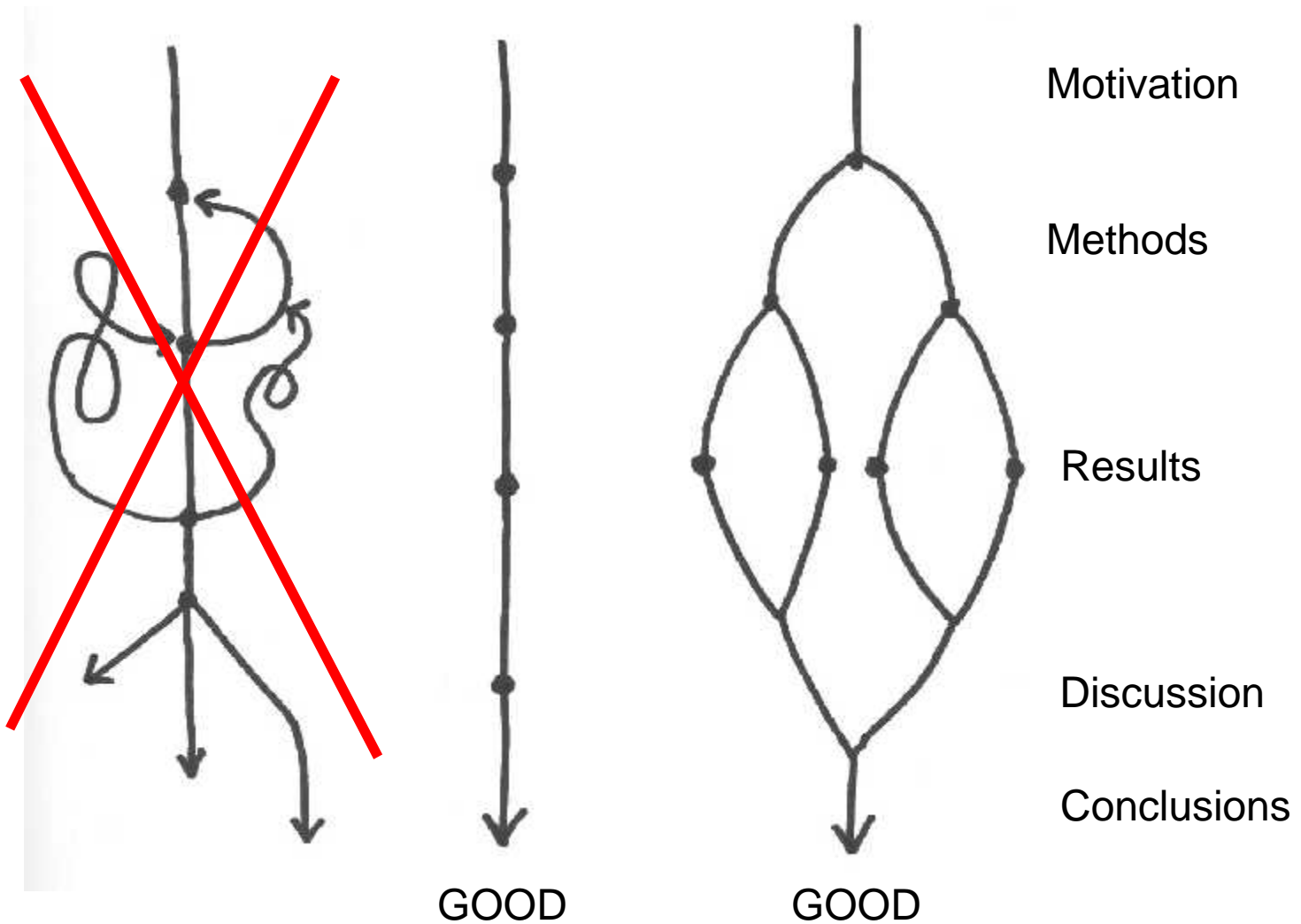


# Outline of a paper

1. Introduction
  - Motivation, context, background
  - Hypotheses
2. Methods
  - Experimental setup
  - Analytical techniques
  - Numerical techniques
3. Results
  - Data and observations
4. Discussion
  - Comparison to other work
  - Meaning of your observations
5. Conclusions/Summary
  - Brief overview
  - Outlook for future work

# Outline structures

- Flow should be unidirectional (like a river)
- there should not be flashbacks!





Some more words of wisdom

Sometimes, if you're excited,  
if you think it's beautiful, then  
that's all that matters.

Pursue your love.

Don't forget about the big picture



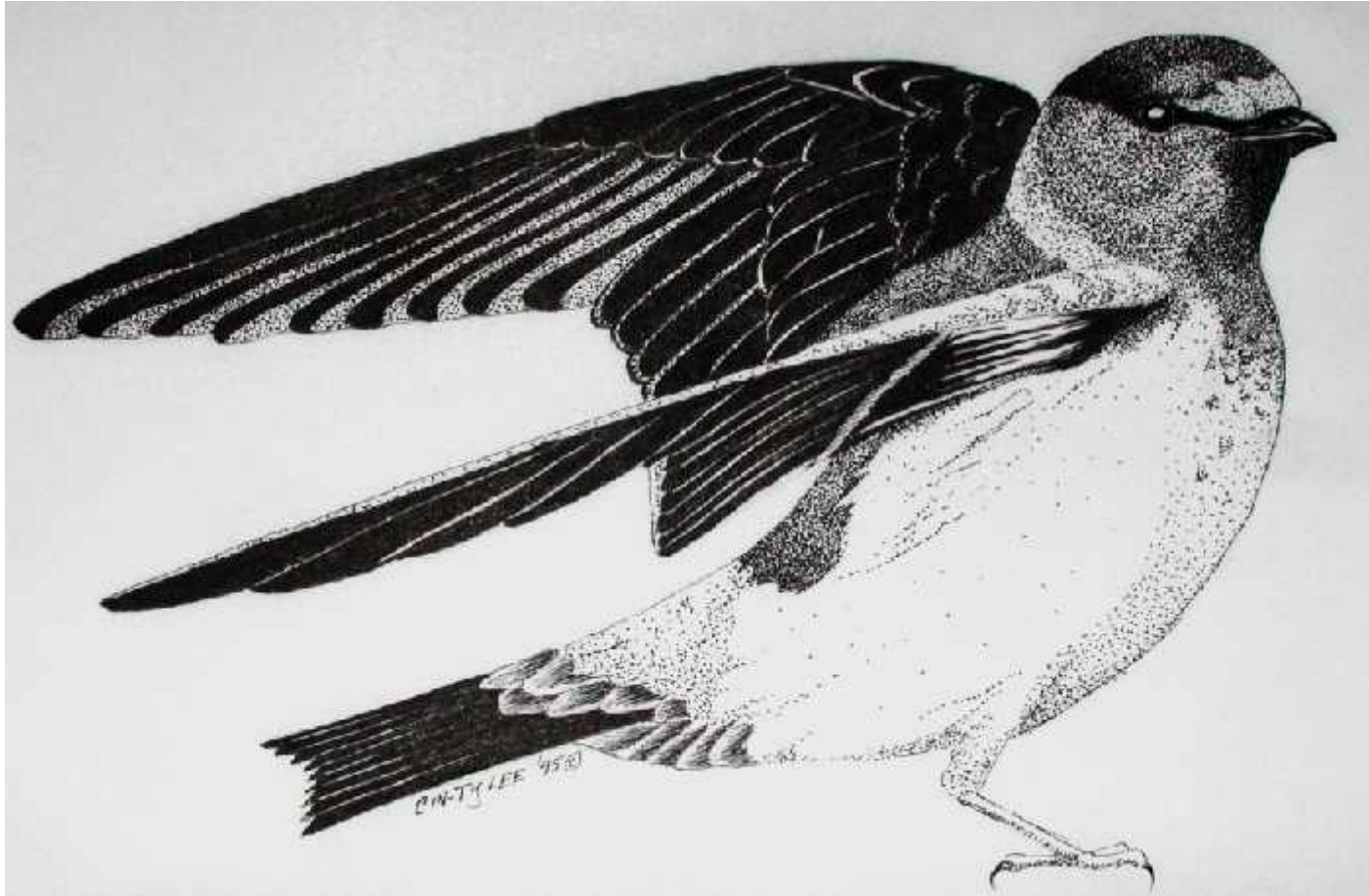
Van Gogh painting

Don't forget about the big picture



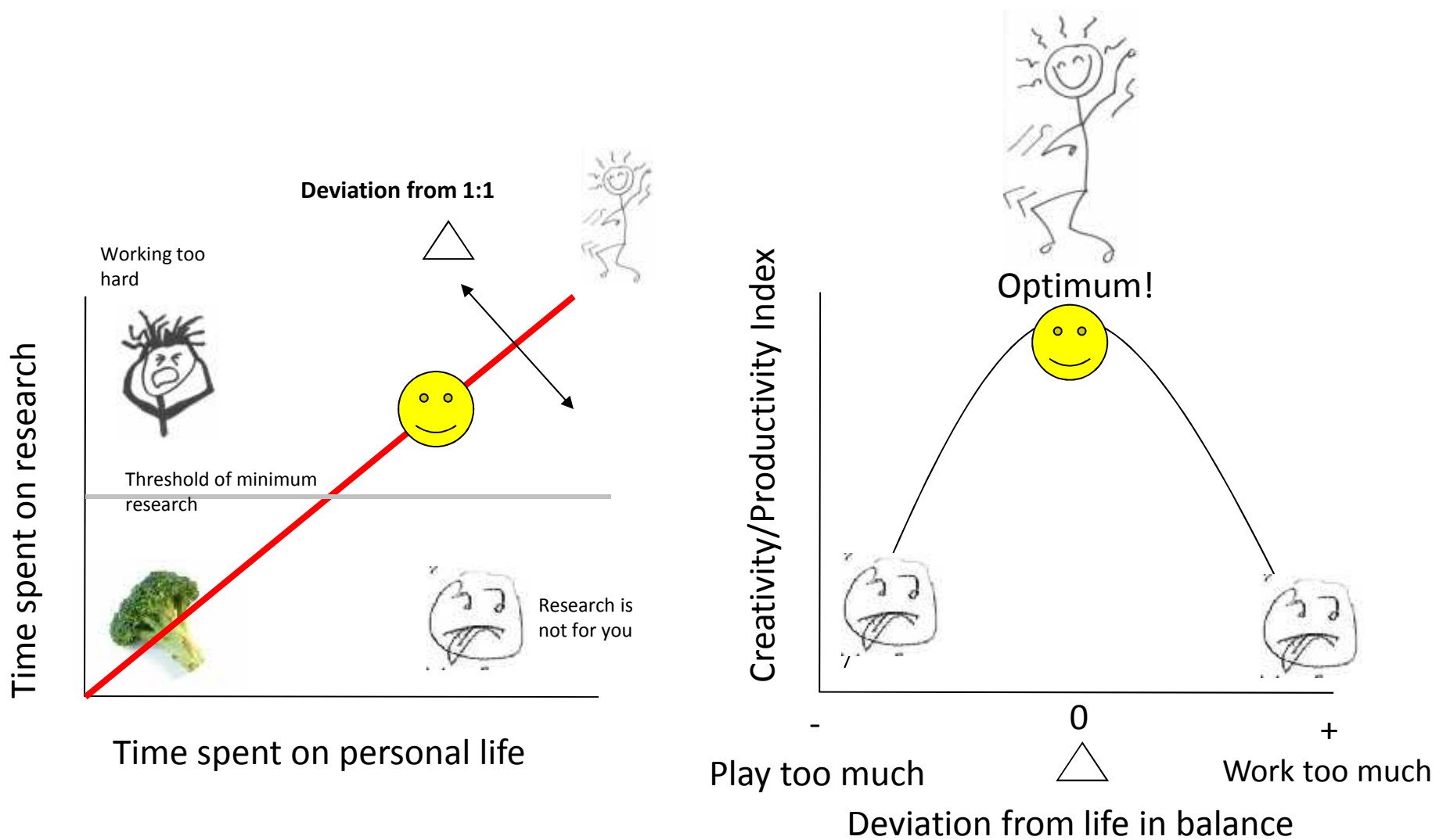
Van Gogh painting

Pay attention to details & get the holistic experience



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# Balance work and play to be creative





The going will be rough





But it's worth it!  
-you made it  
-you can do anything now!

# You now have your PhD.

## But it's only the first of many more hills!

What is the origin of life?  
I want to solve global warming  
I want to end world hunger  
What is gravity?  
How do mountains form?  
Why do animals sleep? Dream?  
I want to cure cancer.



One last word...

Pay back by teaching others and bringing everyone up with you.

Share your knowledge and your enthusiasm.



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