On Reading, Presenting and Listening to Theory

Fall 2023

Brown University

ACTIVE

D Ellis Hershkowitz (Ellis)

Doing Theory

How Theory is (Often) Taught

How Theory is (Often) Taught

1. Here is **problem X**.
2. Here is **method A**.
3. Therefore **solution**.

(fast, bad for new ideas, **passive**)

How to Solve Theory Problems (?)

1. Write down the **problem X**.
2. Think *real* hard.
3. Write down the **solution**.

≈Murray Gell-Mann

How Theory is Done

How to Present (Research-Level) Theory

1. Listen to the rest of this talk.

(slow, good for new ideas, **active**)

How Theory Problems are Solved

1. Isolate a toy **model case x** of major **problem X**.
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4. This does not succeed but **method A** can be extended to **model cases x' and x''**.
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10. Realize that **counterexample y** is related to a **problem Z** in another field.

•••

22. **Method Z** is rapidly developed and extended to get the **solution** to **problem X**.

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Reading Theory Papers

Reading Theory Papers

Top-Level Goal

Simulate this for yourself

How Theory Problems are Solved

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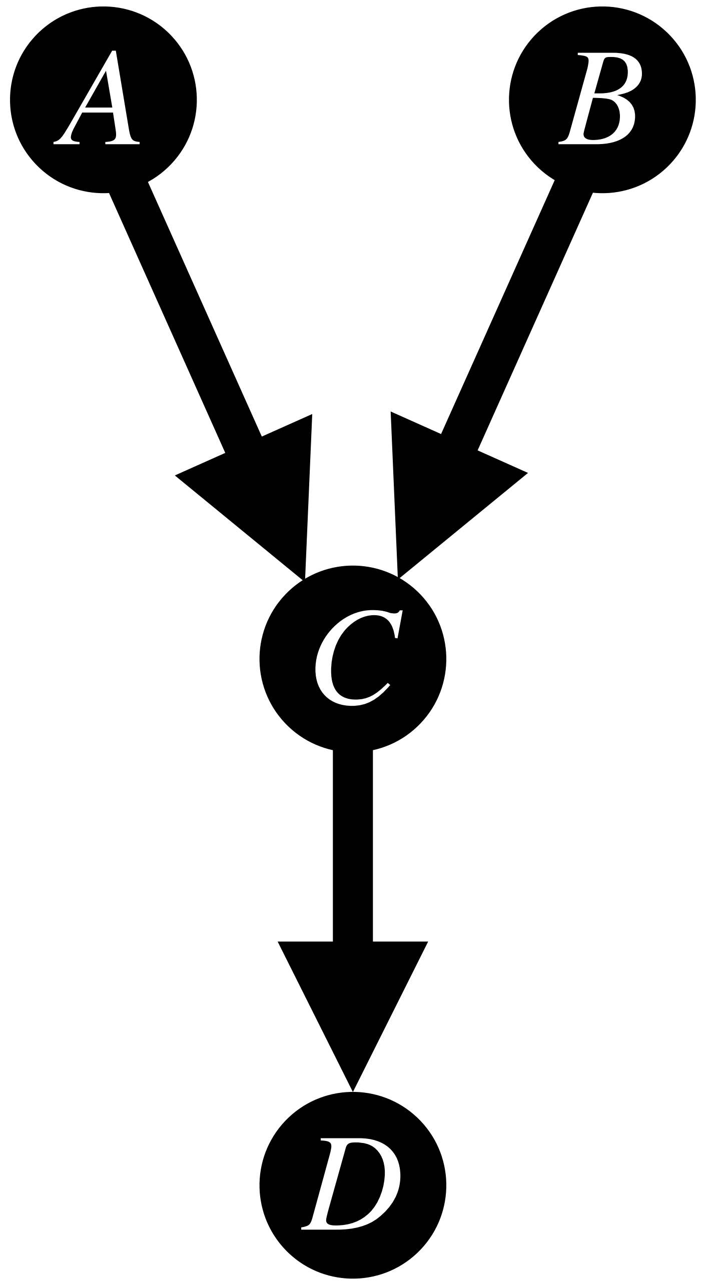
Reading Theory Papers

First Pass: Establish Roadmap

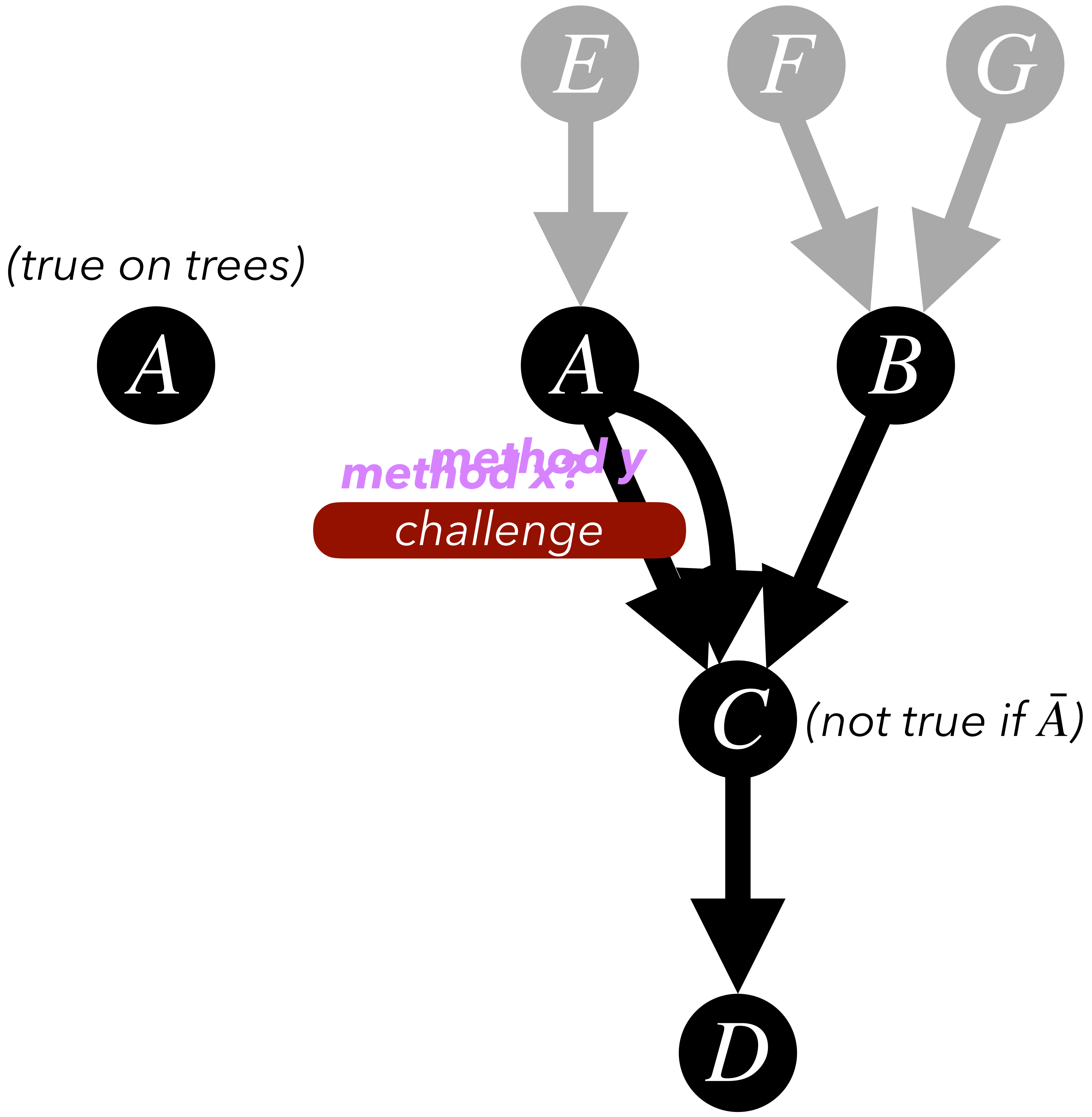
- Read title, abstract, intro, conclusion
- Should be able to answer
  - **Why:** is this problem studied?
  - **What:** is the formal result?
  - **How:** is the result shown (make a very rough **roadmap** for yourself)?



Reading Theory Papers

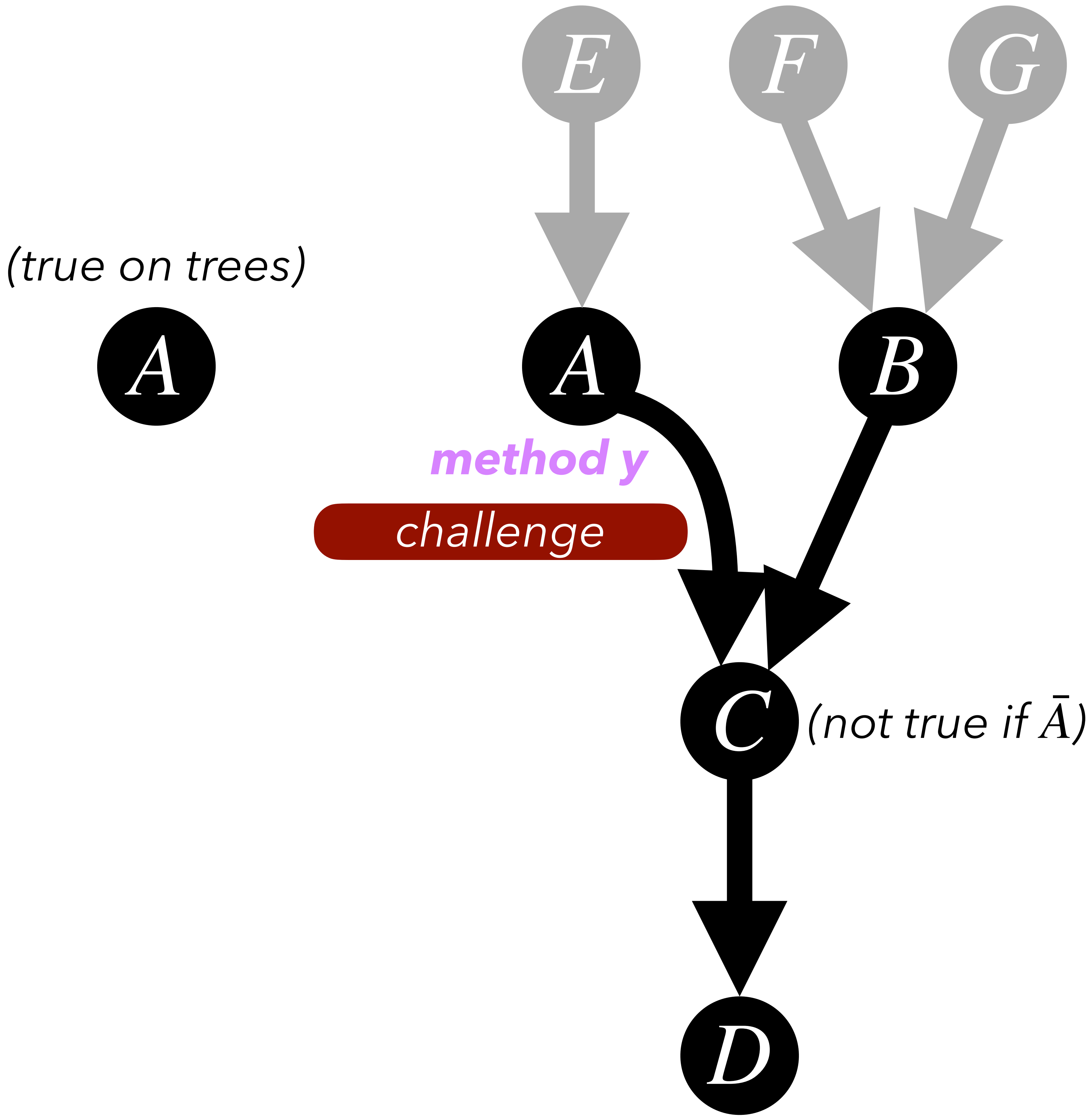
Second Pass: Expand Roadmap

- **Look things up** (often not the target audience)
- Try to **guess** what's coming next
- **Verify** that claim assumptions needed
- **Prove** main result on special cases
- See **where stuck** (with general case)



Reading Theory Papers

During+Afterwards: Simplify Roadmap



(true on trees)

method y

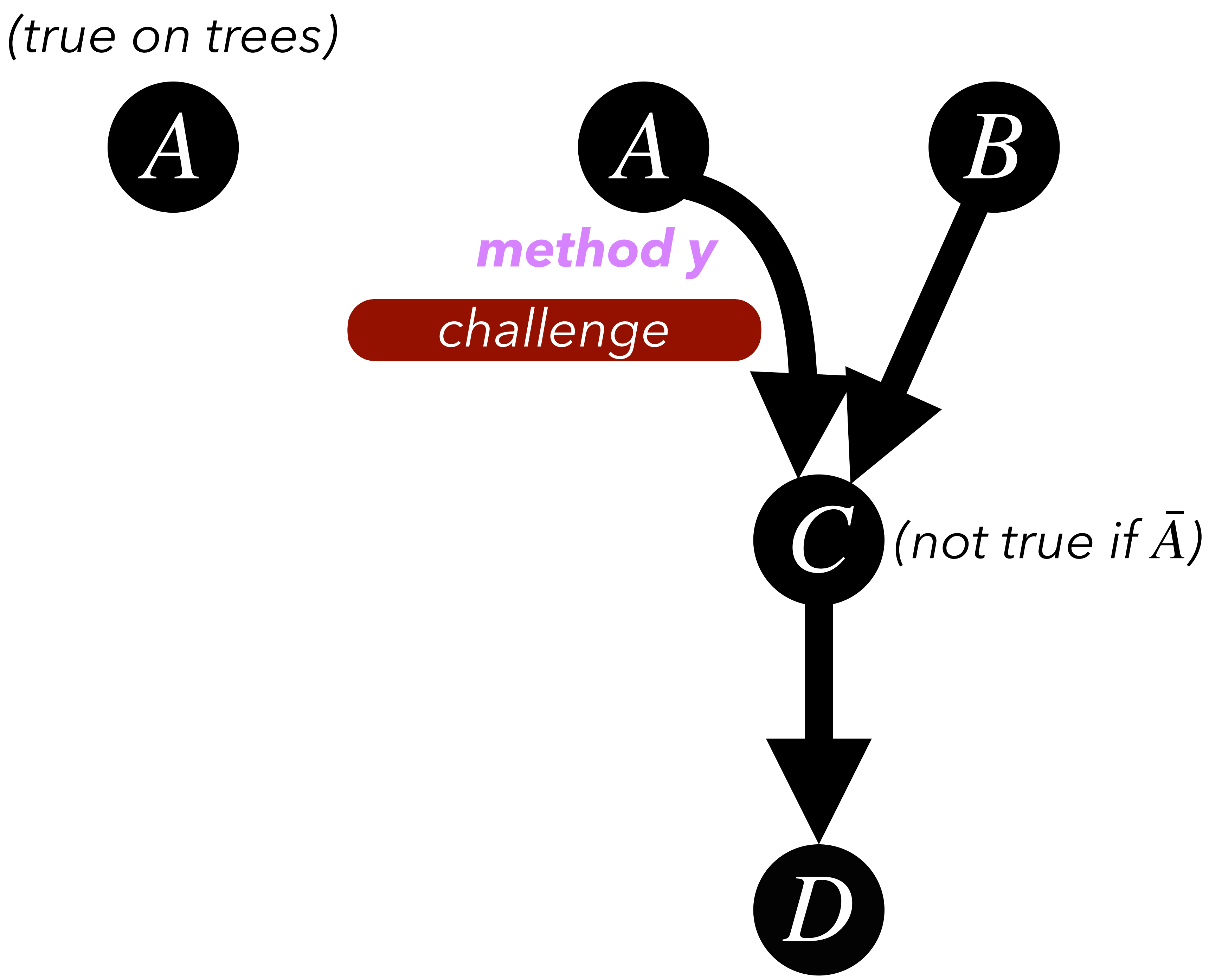
challenge

(not true if $\bar{A}$)

Reading Theory Papers

During+Afterwards: Simplify Roadmap

- **Prioritize:** skip standard or plausible details



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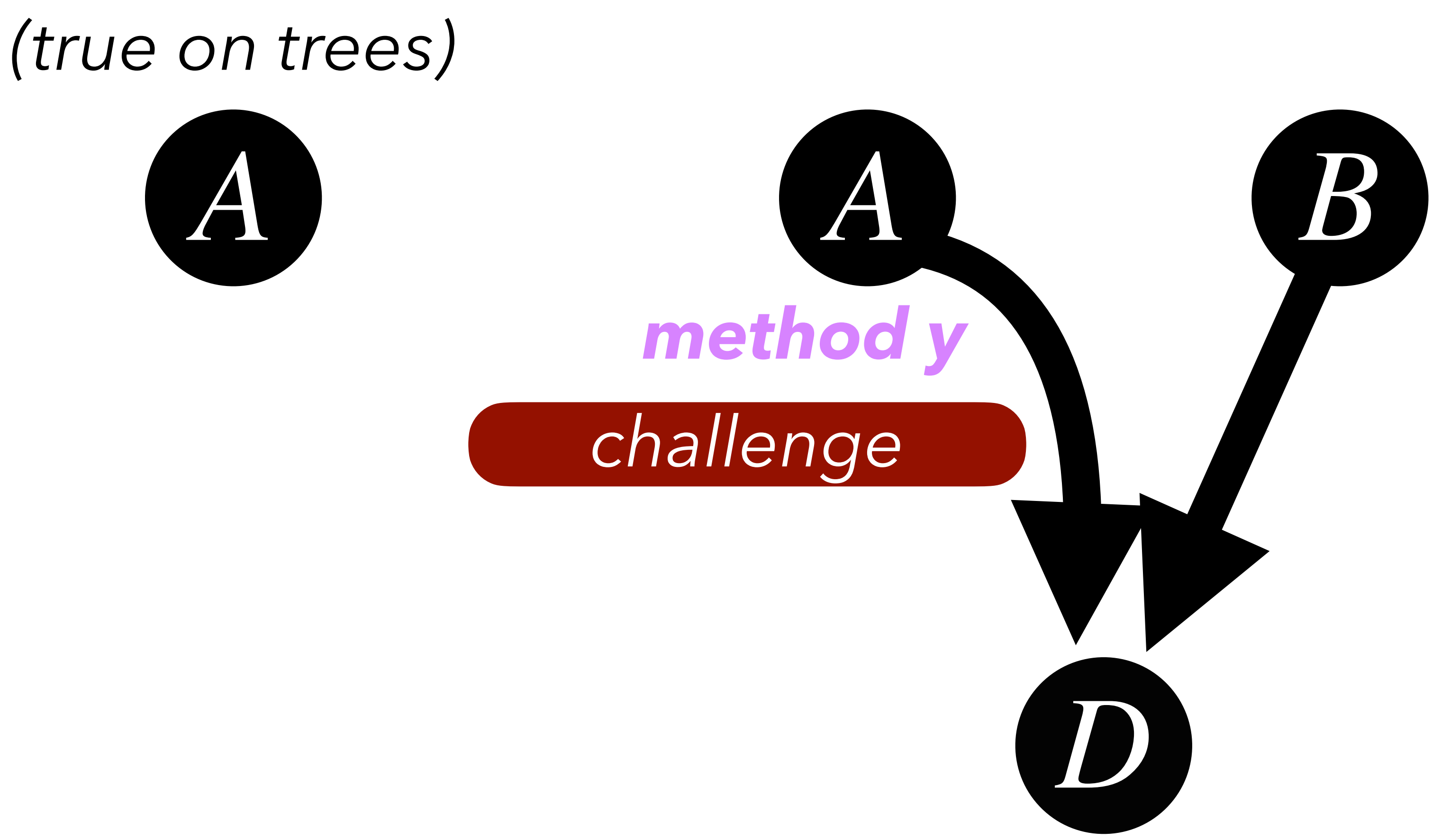
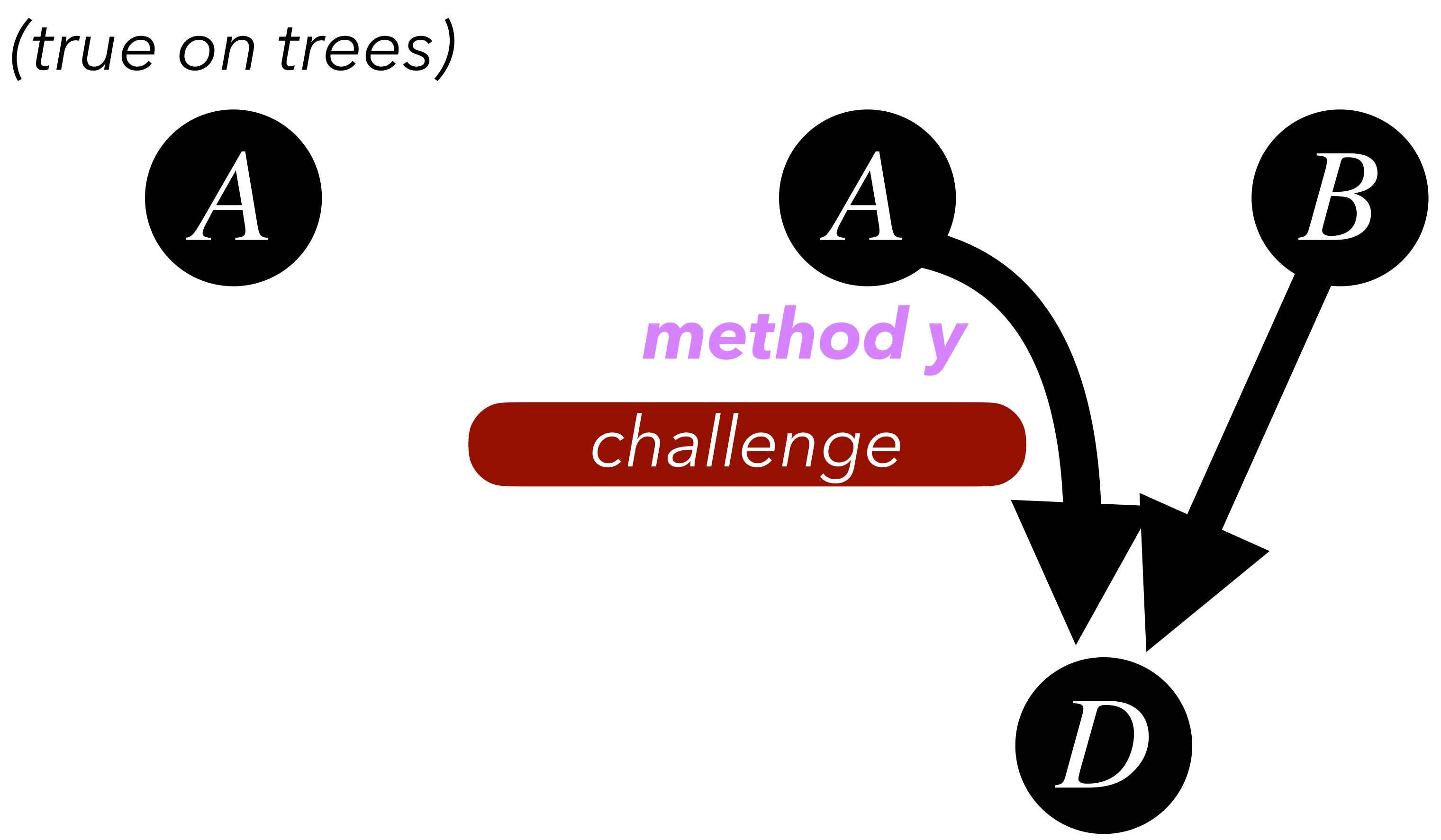


Reading Theory Papers

During+Afterwards: Simplify Roadmap

- **Prioritize:** skip standard or plausible details
- **Simplify theorems / proofs** for yourself



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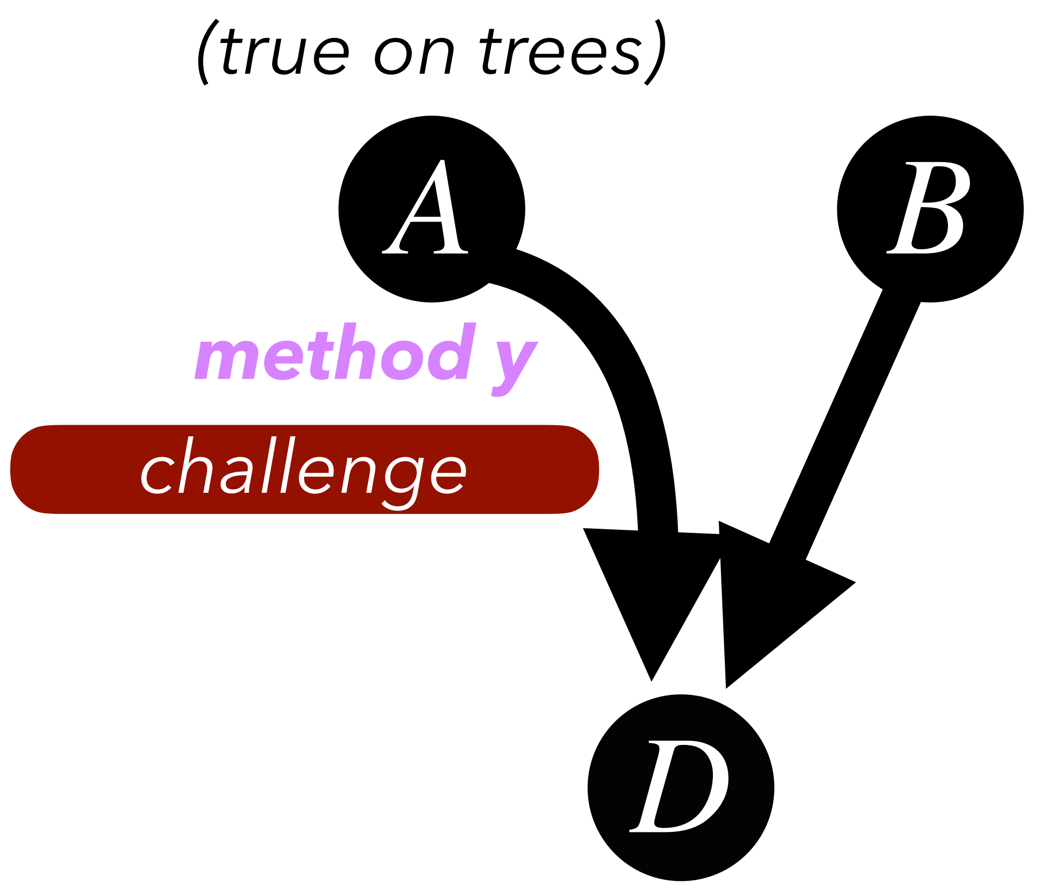

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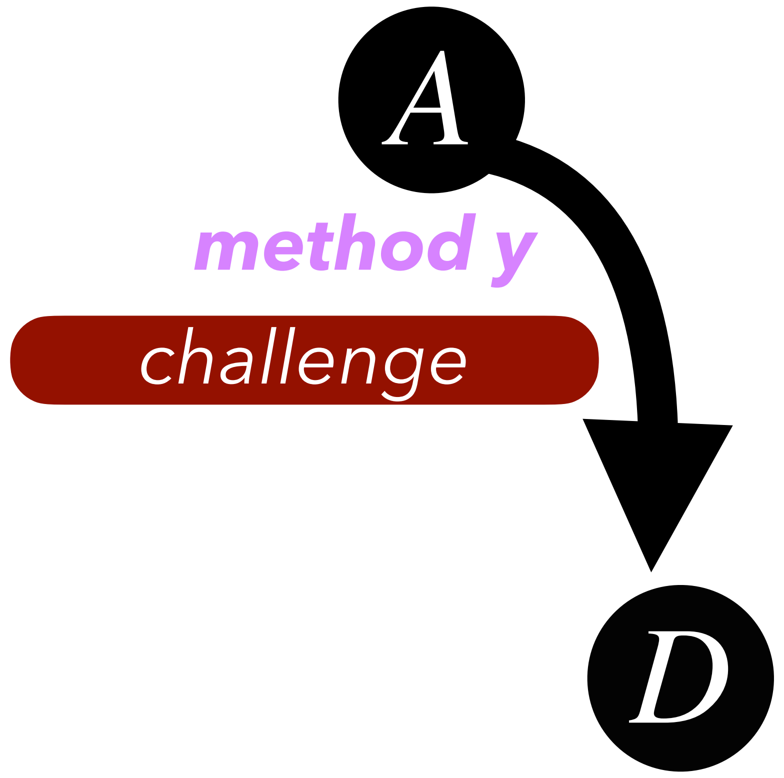
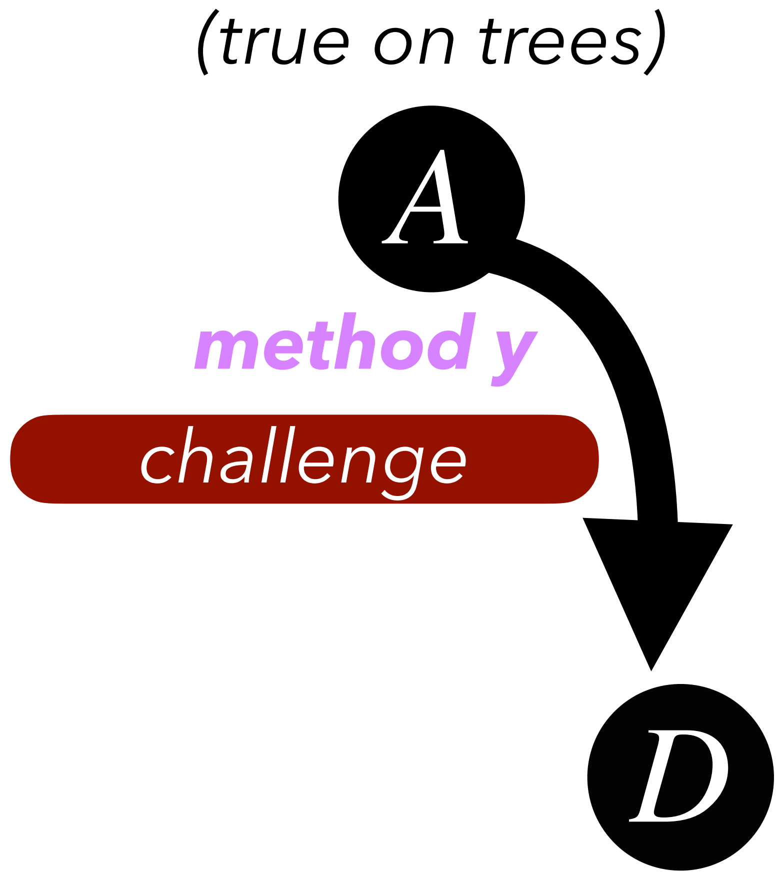
(true on trees)



Reading Theory Papers

During+Afterwards: Simplify Roadmap

- **Prioritize:** skip standard or plausible details
- **Simplify theorems / proofs** for yourself
- **Note tricks** and **invent stories** that you like
  + are easy-to-remember



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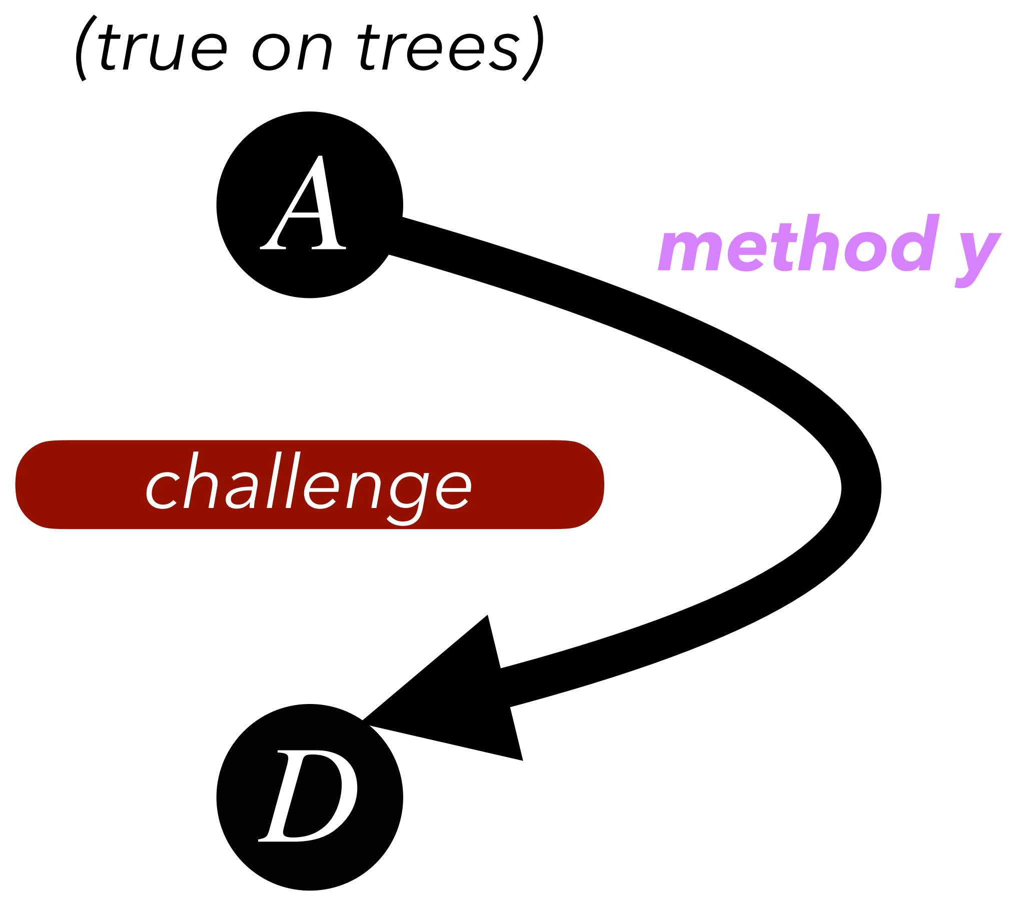

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During+Afterwards: Simplify Roadmap

- **Prioritize:** skip standard or plausible details
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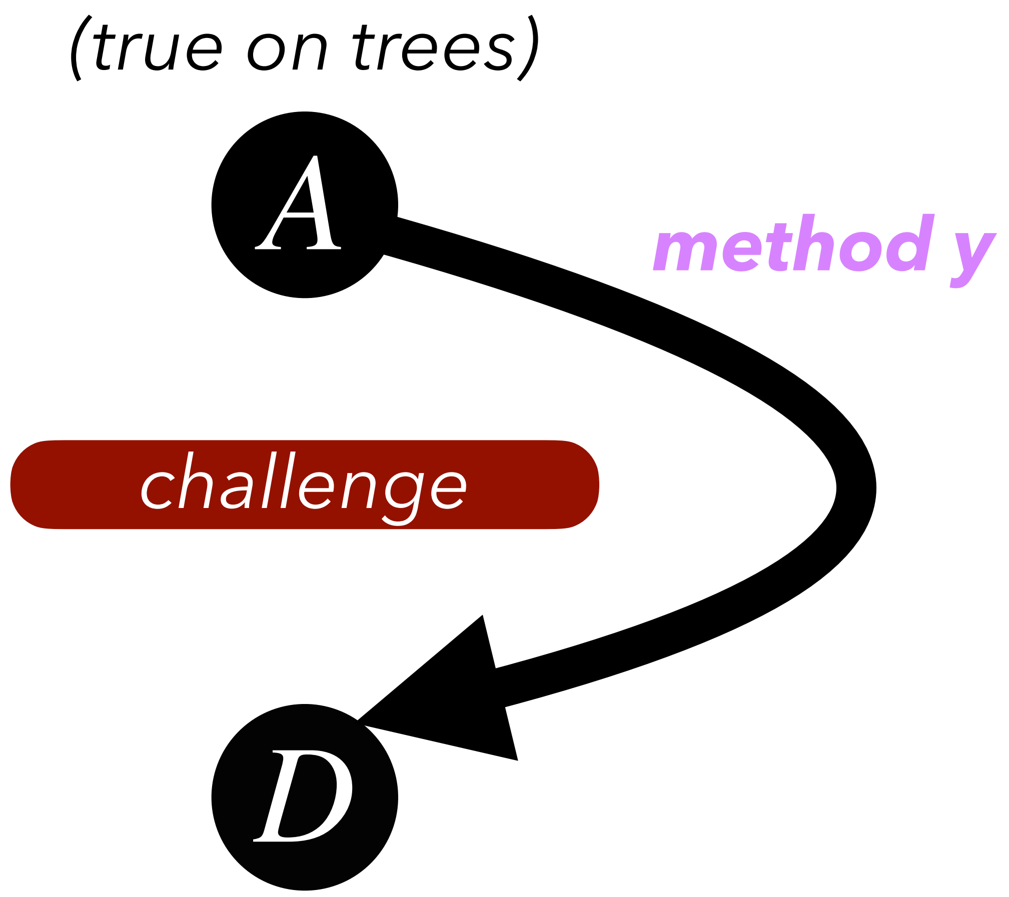
- **Backtrack** to Techniques / Intuition Section



Reading Theory Papers

During+Afterwards: Simplify Roadmap

- **Prioritize:** skip standard or plausible details
- **Simplify theorems / proofs** for yourself
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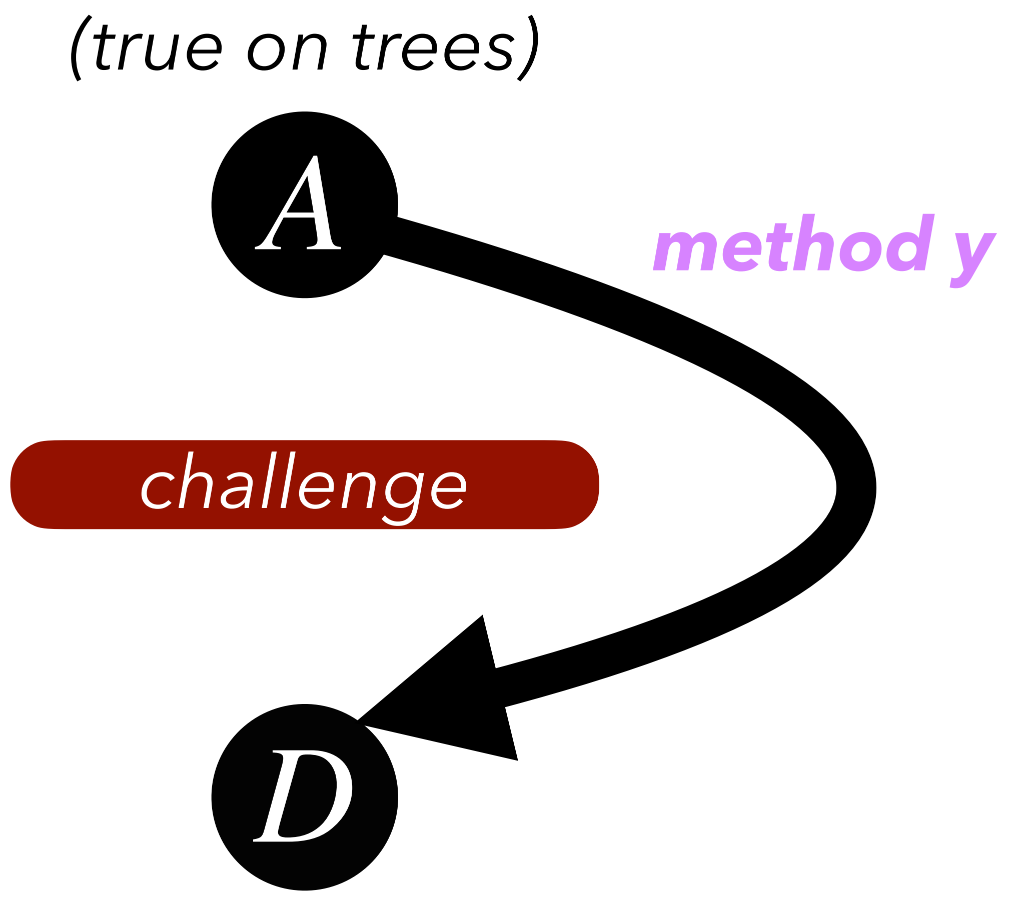
  + are easy-to-remember
- **Backtrack** to Techniques / Intuition Section
- **Recreate proofs** afterwards (pref. written)



Reading Theory Papers

Goals at End

- A general **roadmap** of the paper

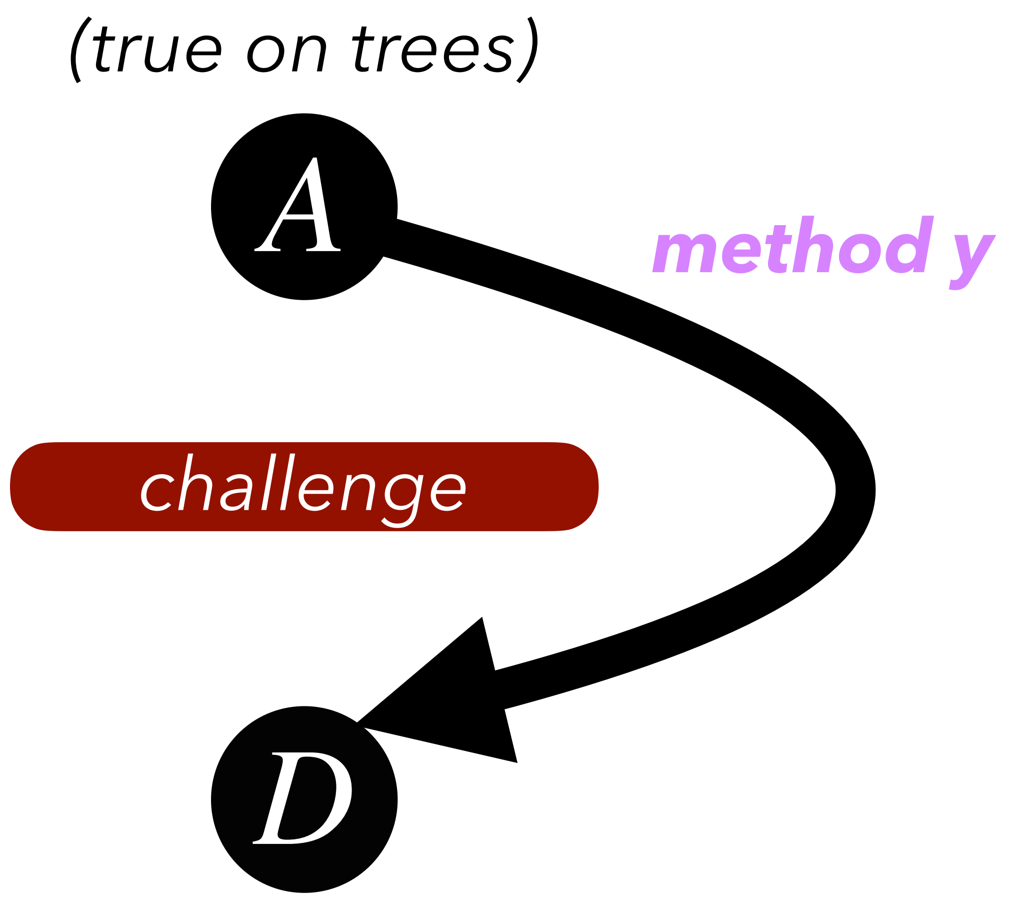
  authors not thinking in line-by-line calculations

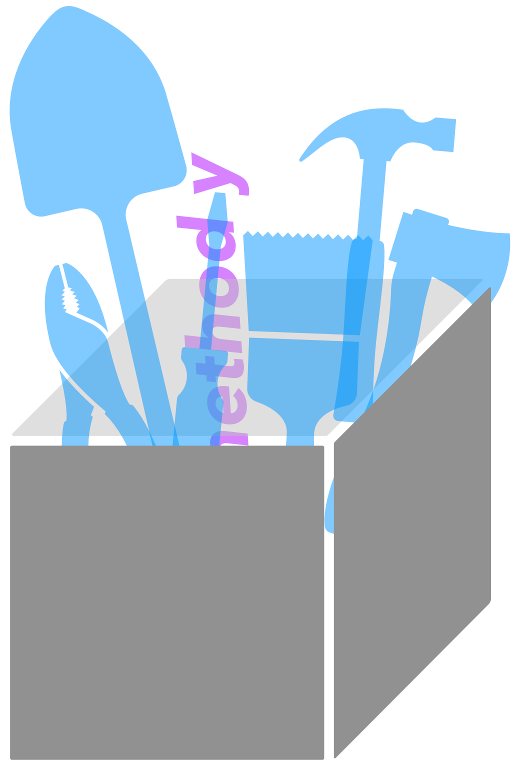
- Easy-to-remember **tools**, special-case proofs

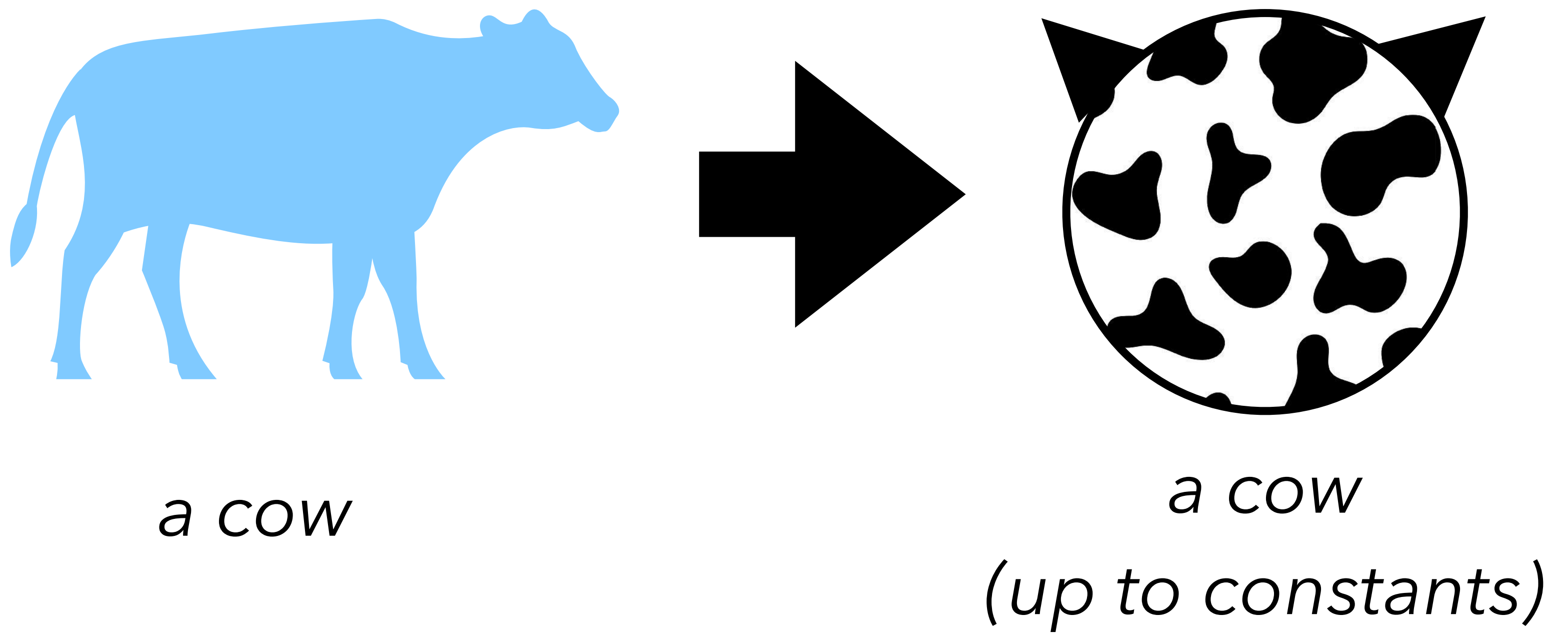
  usually only a few crucial insights / paper

- **Intuition**

  of how to think about complexity simply







Reading Theory Papers

General Thoughts

- Reading theory papers is **hard**

  a paper represents (probably) hundreds of hours of several people thinking hard 🤔

- A lot of papers are **not well-written**

  hundreds of hours of thinking, 1 week of panicked writing before deadline 😰

- **Pace yourself**

  internalizing papers takes time, sleep on new ideas, go for a walk, rubber ducky, ask for help 😪

Presenting Theory Research

Presenting Theory Research

Top-Level Goal

Simulate this for audience

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…

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Presenting Theory Research

Talks are Different from Papers

- **Different format**

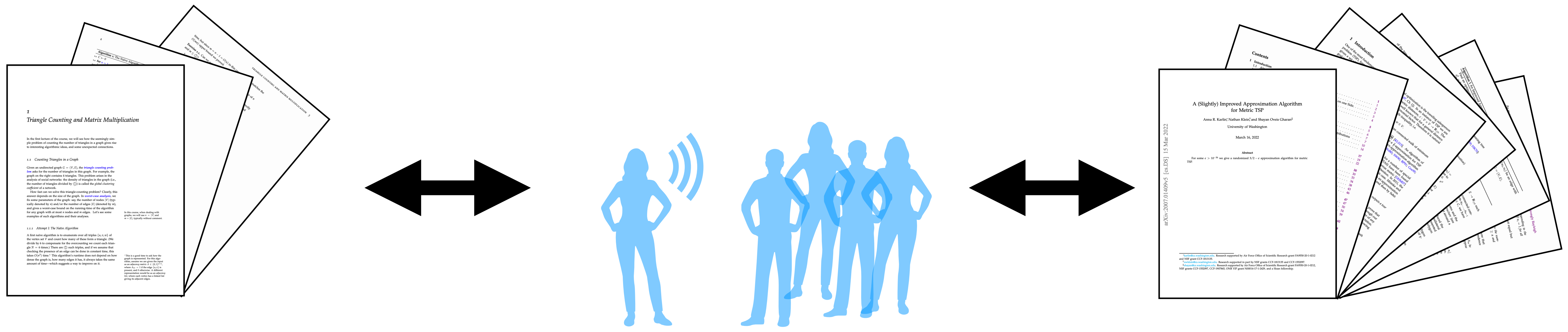
  capitalize on **human element, interactivity, figures**

- Talk audience has **less background / attention** for paper

  more **hand-holding**

- Way **less time**

  heavily **simplify/omit**



20 pages of lecture notes

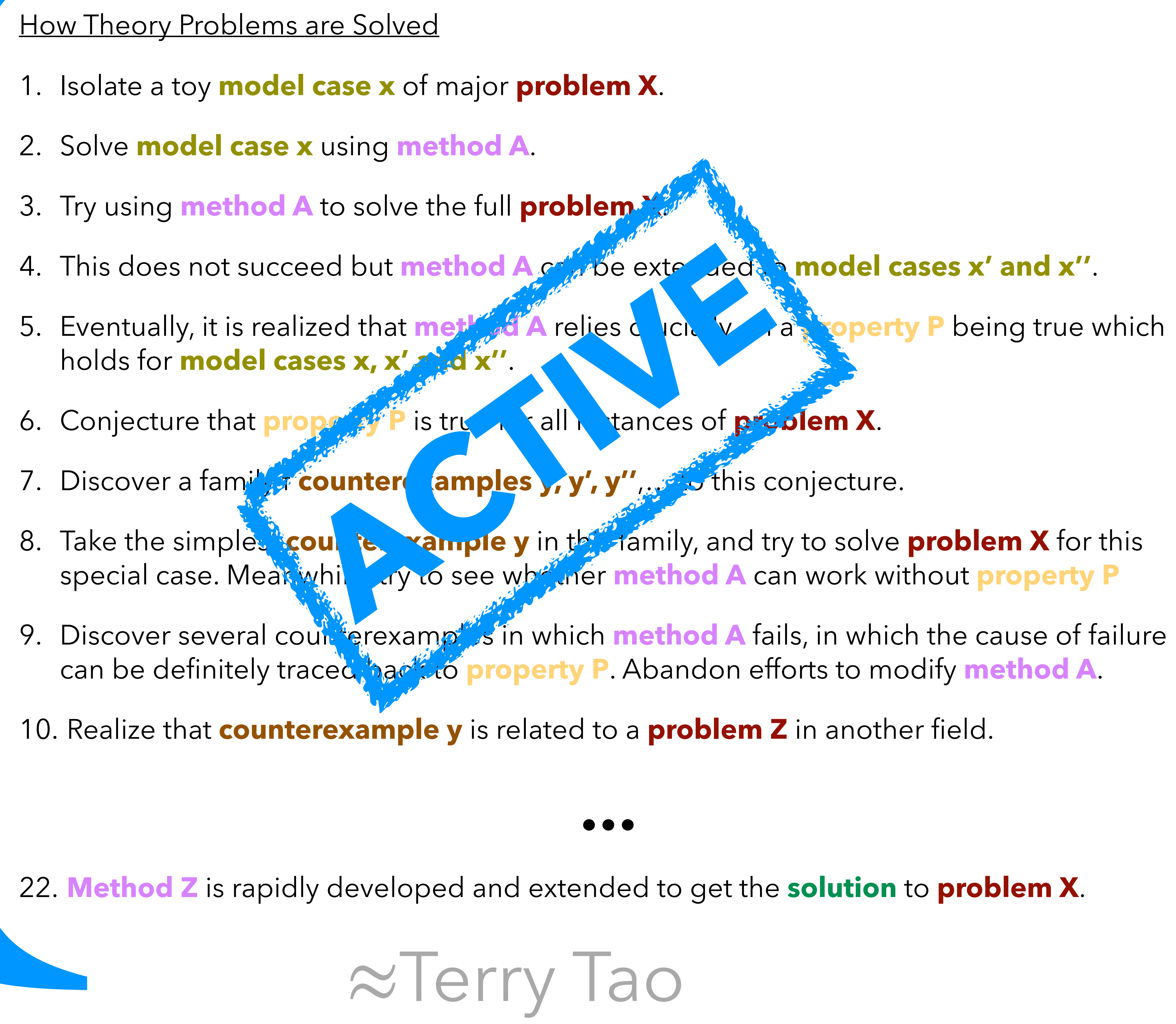
1 hour presentation

93 pages of paper

Presenting Theory Research

Returning to Top-Level Goal

Simulate this for audience



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Presenting Theory Research

Returning to Top-Level Goal

Simulate this for audience w/

- **human element, interactivity, figures**
- **hand-holding**
- **simplifications**

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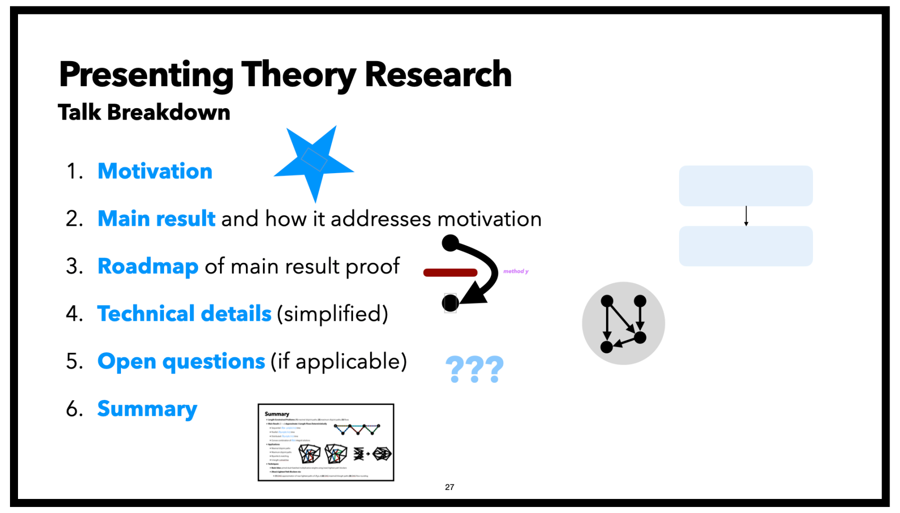
Presenting Theory Outline

1. **Talk Breakdown**



Presenting Theory Research

Talk Breakdown

1. **Motivation**
2. **Main result** and how it addresses motivation
3. **Roadmap** of main result proof
4. **Technical details** (simplified)
5. **Open questions** (if applicable)
6. **Summary**

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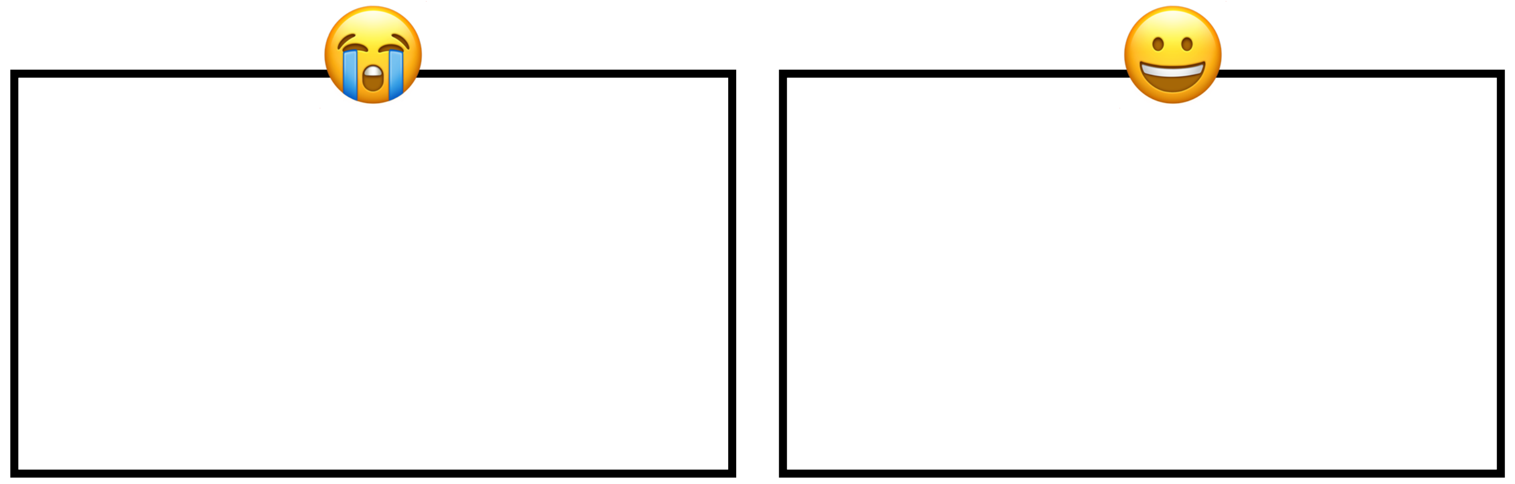
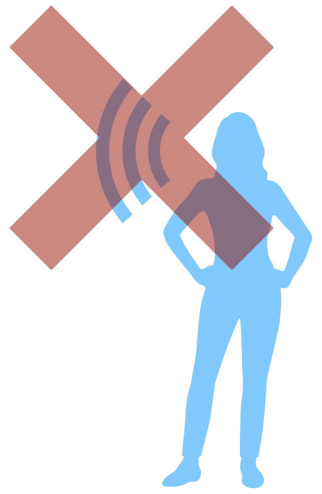
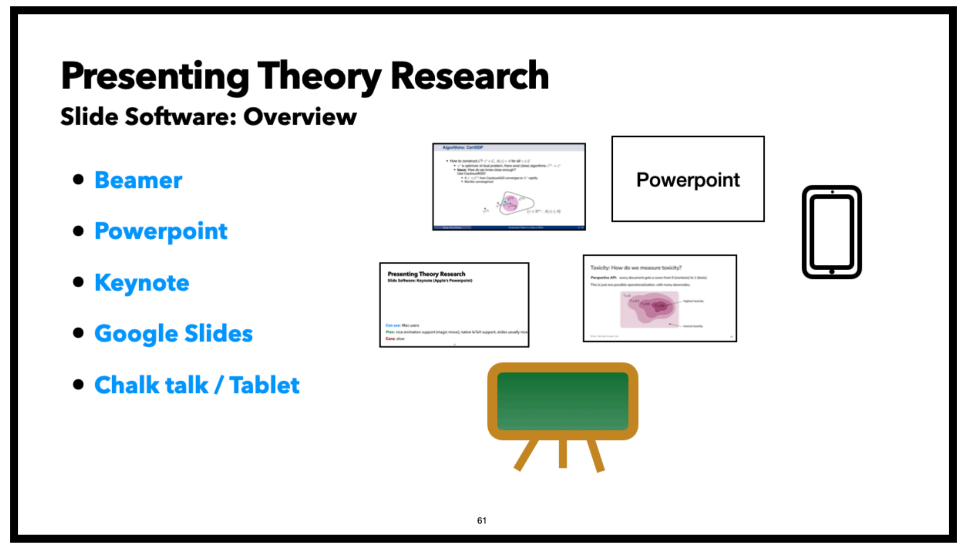
2. **Slide Best Practices**



3. **Speaking Best Practices**



4. **Presenting Software**



Presenting Theory Research

Slide Software: Overview

- **Beamer**
- **Powerpoint**
- **Keynote**
- **Google Slides**
- **Chalk talk / Tablet**

Powerpoint
Algorithms: CertSDP
Presenting Theory Research
Toxicity: How do we measure toxicity?

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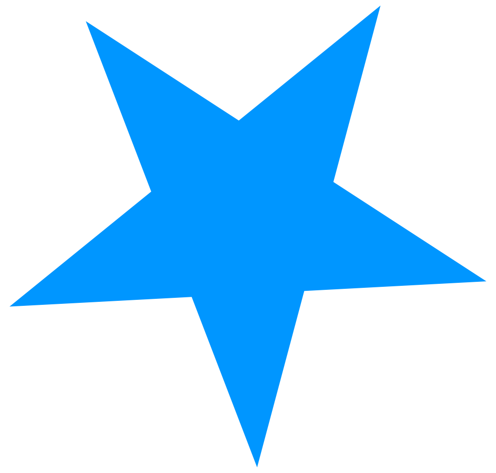
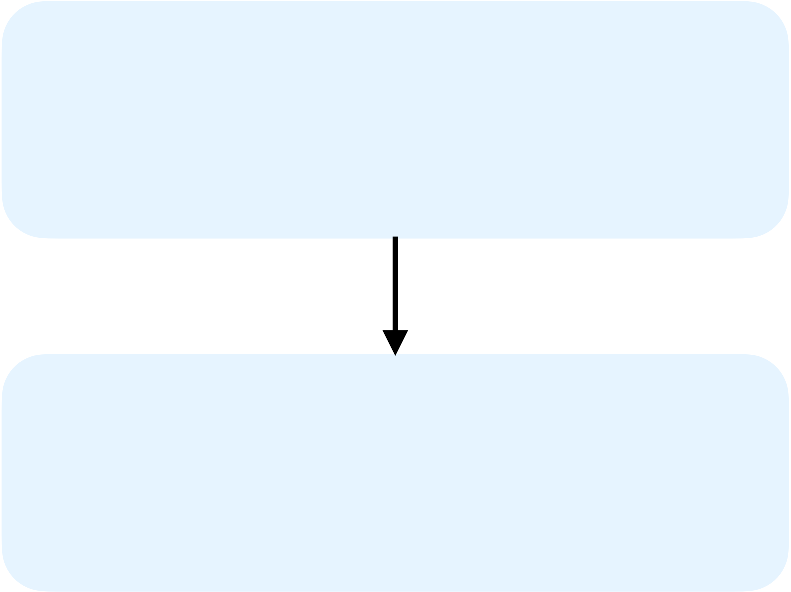
Presenting Theory Research

Talk Breakdown

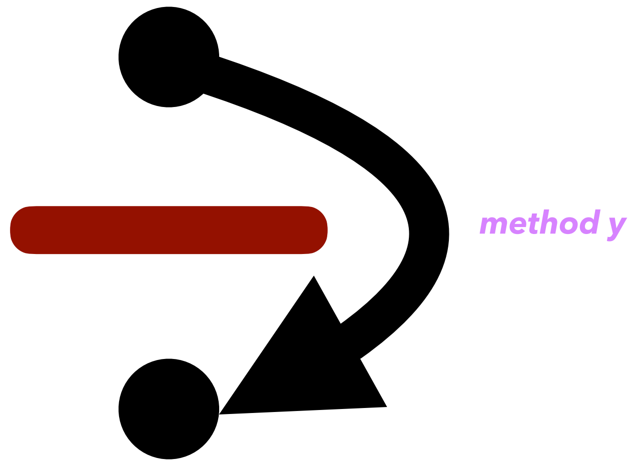
1. **Motivation**



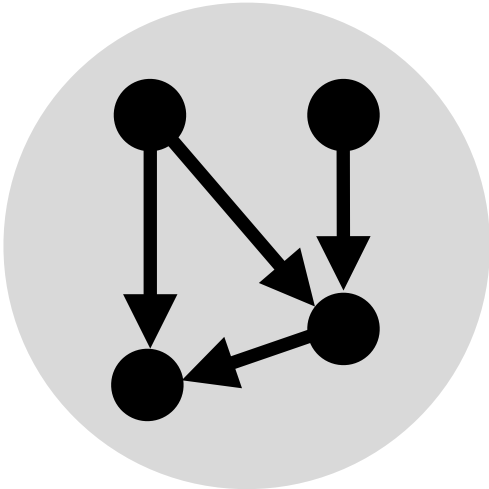
2. **Main result** and how it addresses motivation



3. **Roadmap** of main result proof



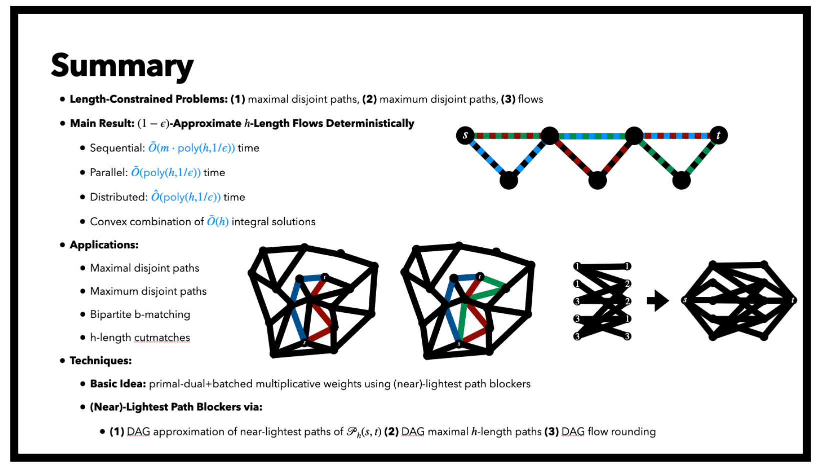
4. **Technical details** (simplified)



5. **Open questions** (if applicable)

???

6. **Summary**

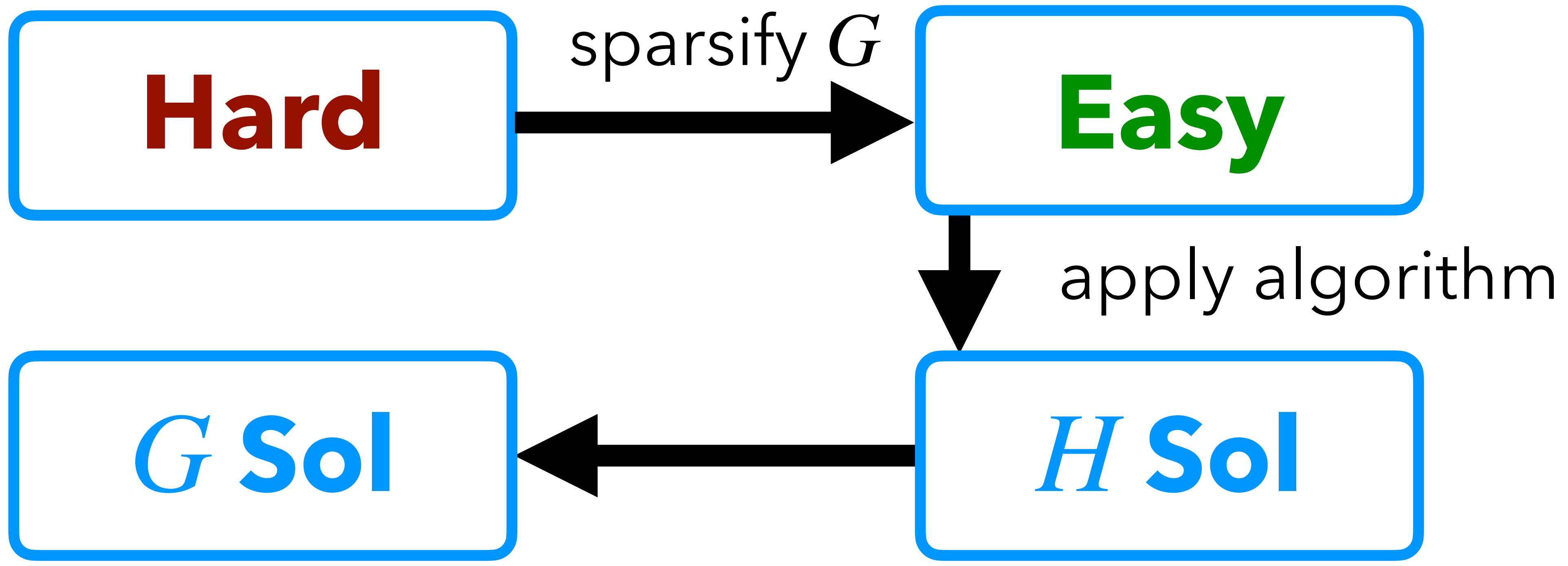


Summary

- **Length-Constrained Problems: (1)** maximal disjoint paths, **(2)** maximum disjoint paths, **(3)** flows
- **Main Result:** $(1-\epsilon)$**-Approximate** h**-Length Flows Deterministically**
  - Sequential: $\tilde{O}(m \cdot \mathrm{poly}(h, 1/\epsilon))$ time
  - Parallel: $\tilde{O}(\mathrm{poly}(h, 1/\epsilon))$ time
  - Distributed: $\hat{O}(\mathrm{poly}(h, 1/\epsilon))$ time
  - Convex combination of $\tilde{O}(h)$ integral solutions
- **Applications:**
  - Maximal disjoint paths
  - Maximum disjoint paths
  - Bipartite b-matching
  - h-length cutmatches
- **Techniques:**
  - **Basic Idea:** primal-dual+batched multiplicative weights using (near)-lightest path blockers
  - **(Near)-Lightest Path Blockers via:**
    - **(1)** DAG approximation of near-lightest paths of $\mathscr{P}_h(s,t)$ **(2)** DAG maximal h-length paths **(3)** DAG flow rounding

Presenting: Motivation

- Give **motivation** for both
  - **General area** (often canned story)



Hard

sparsify G

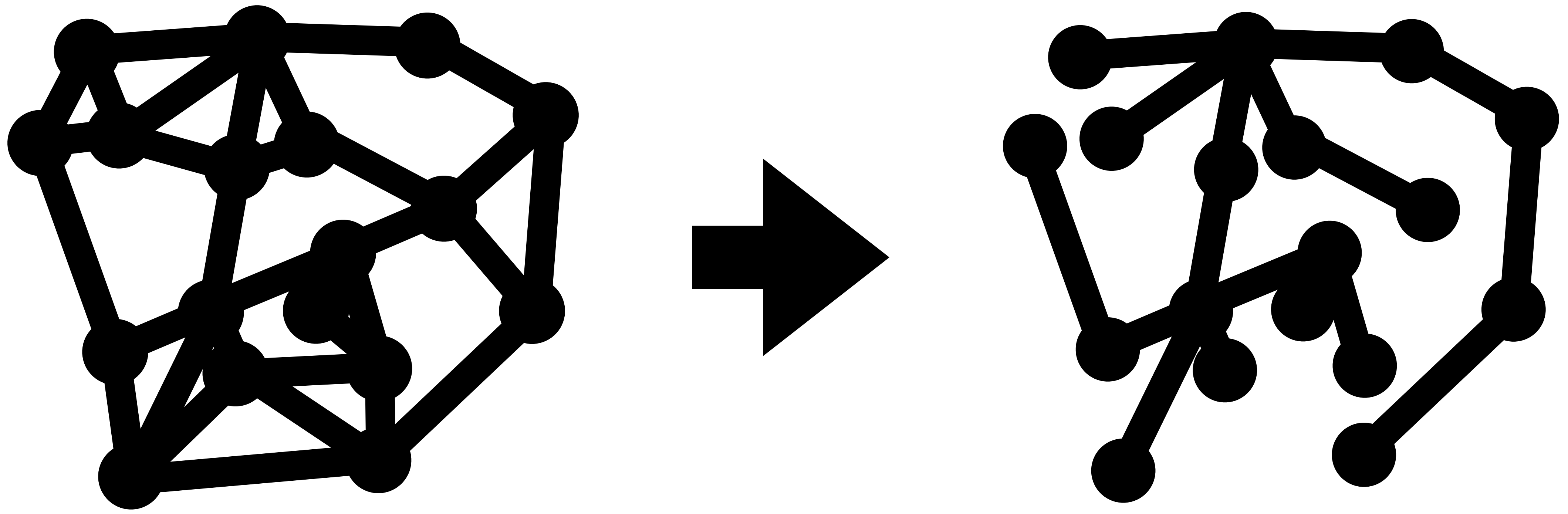
Easy

apply algorithm

H **Sol**

G **Sol**

  - **Specific result** of this paper



Presenting: Motivation

Ways Theory Papers are Motivated

WOW!

- **Practical** motivation

  people use (or should use) this in practice

- **Connections** to other areas (of theory)

  this implies things for other areas

- **Surprising**

  we had reasons to believe this shouldn't be true

- **Aesthetics**

  math pretty

- **Open Problem**

  a lot of smart people were unsuccessful

Presenting: Motivation

Ways Theory Papers are Motivated

cool!

A sampling of motivation given by best papers at top theory venues.

Presenting: Motivation

Ways Theory Papers are Motivated: Practical

gee!

…gradient descent… reigns ***supreme in machine learning****.*

The Complexity of Gradient Descent

best paper, STOC23

Presenting: Motivation

Ways Theory Papers are Motivated: Connections

neat!

…this problem and its extension has ***contributed foundational advances*** *and concepts to the theory of computing, including [a bunch of examples].*

Dynamic Matching with Better-than-2 Approximation…
best paper, SODA23

Presenting: Motivation

Ways Theory Papers are Motivated: Surprise

nifty!

Surprisingly*, we are able to argue that a solving sequence of* $\tilde{O}(m)$ ℓ_1 *minimizing subproblems…*

Maximum Flow and Minimum-Cost Flow in Almost-Linear Time
best paper, STOC23

Presenting: Motivation

Ways Theory Papers are Motivated: Aesthetics

swell!

*…our algorithm is **simple**…*

Negative-Weight Single-Source Shortest Paths in Near-linear Time
best paper, FOCS22

Presenting: Motivation

Ways Theory Papers are Motivated: Open Problem

great!

For some $\epsilon > 10^{-36}$ we give a $3/2 - \epsilon$ approximation algorithm for ***metric TSP****.*

(The entire abstract)

A (Slightly) Improved Deterministic Approximation Algorithm for Metric TSP

best paper, STOC21

Presenting: Motivation

Ways Theory Papers are Motivated

great!

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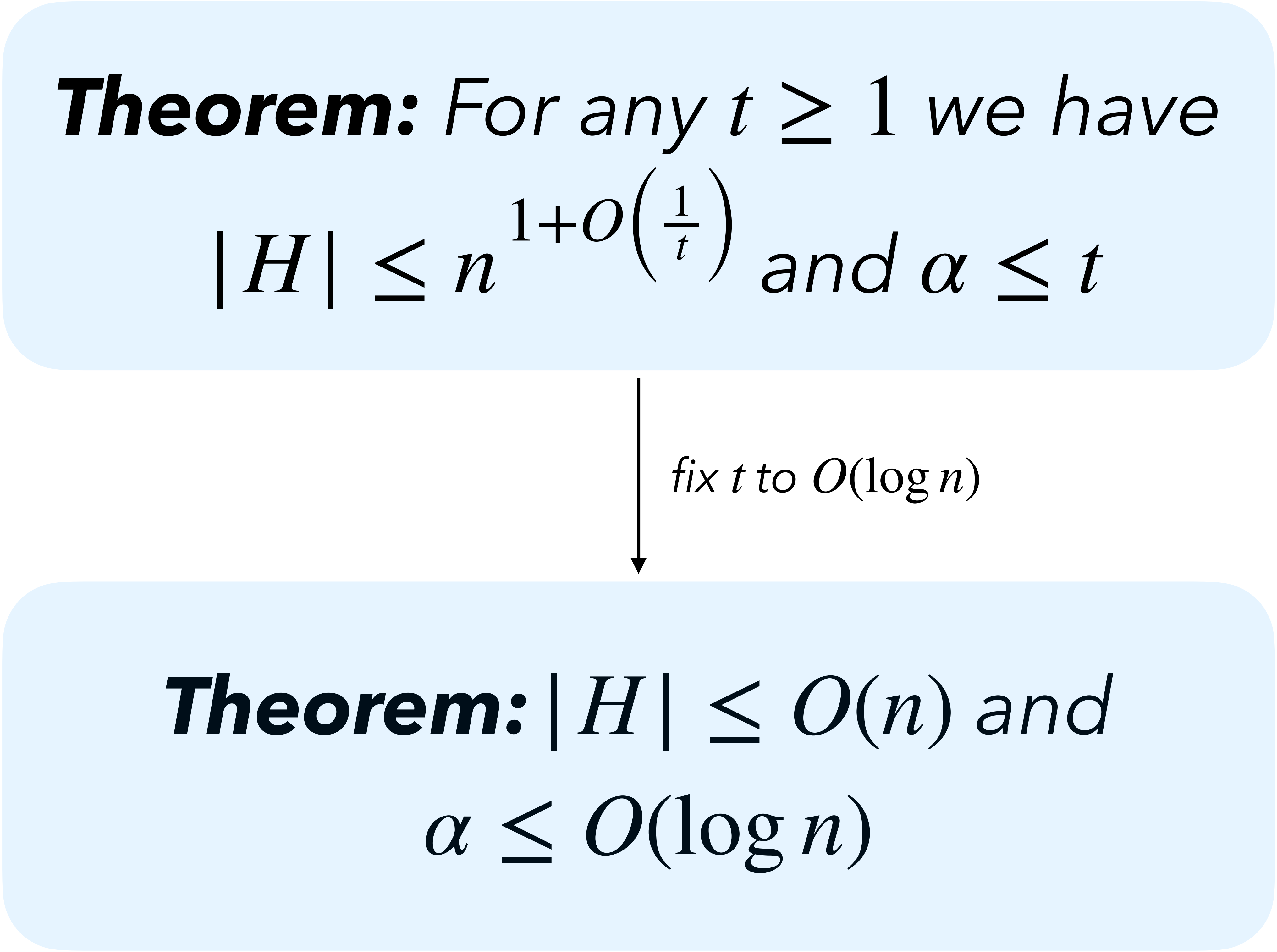
Presenting: Main Result

- Explicitly **connect to motivation** section
- Focus on **main main result**
- Present **simplified** version
- **Engage audience** with
    - Why intuitively makes sense
    - Why conditions are necessary
    - Theorem on specific examples
    - Comparison to trivial solutions



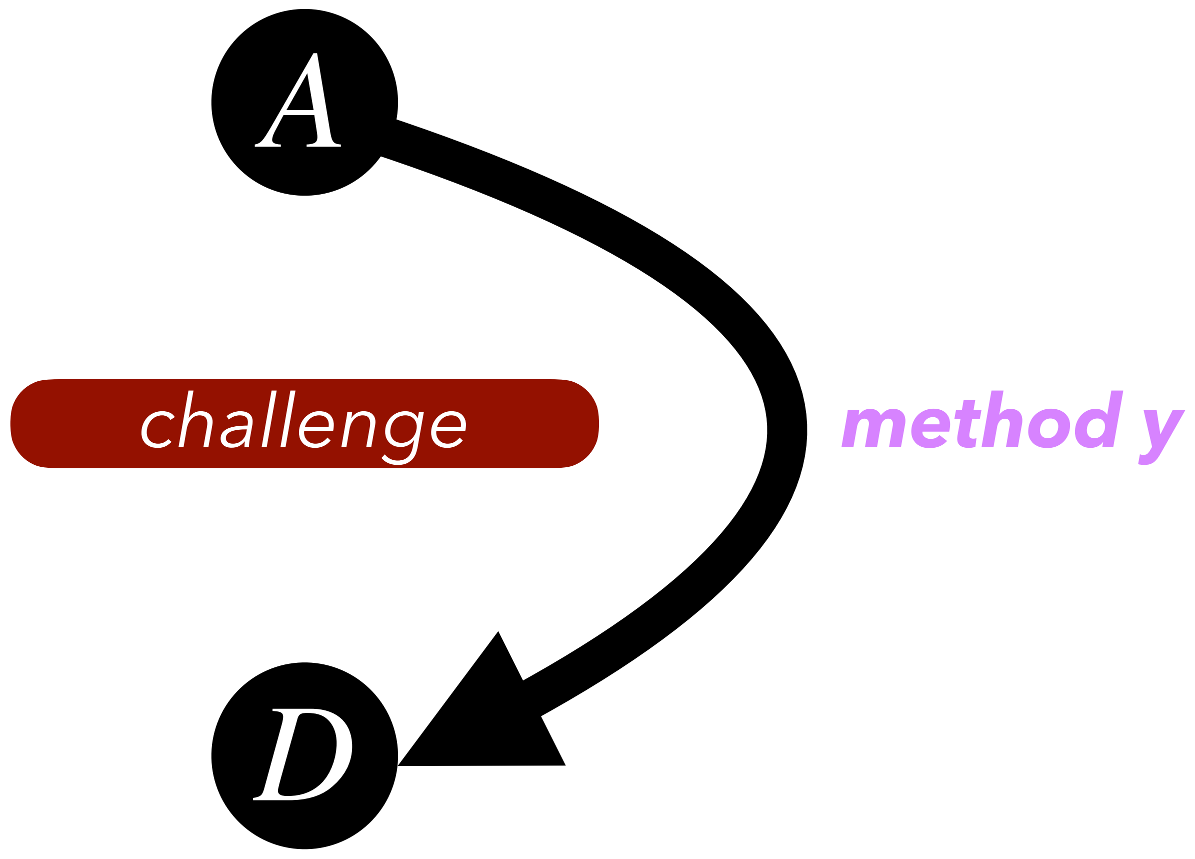
Theorem: *For any* $t \geq 1$ *we have* $|H| \leq n^{1+O\left(\frac{1}{t}\right)}$ *and* $\alpha \leq t$

fix t *to* $O(\log n)$

Theorem: $|H| \leq O(n)$ *and* $\alpha \leq O(\log n)$

Presenting: Roadmap

- Give (simplified) **roadmap** of proof of main result

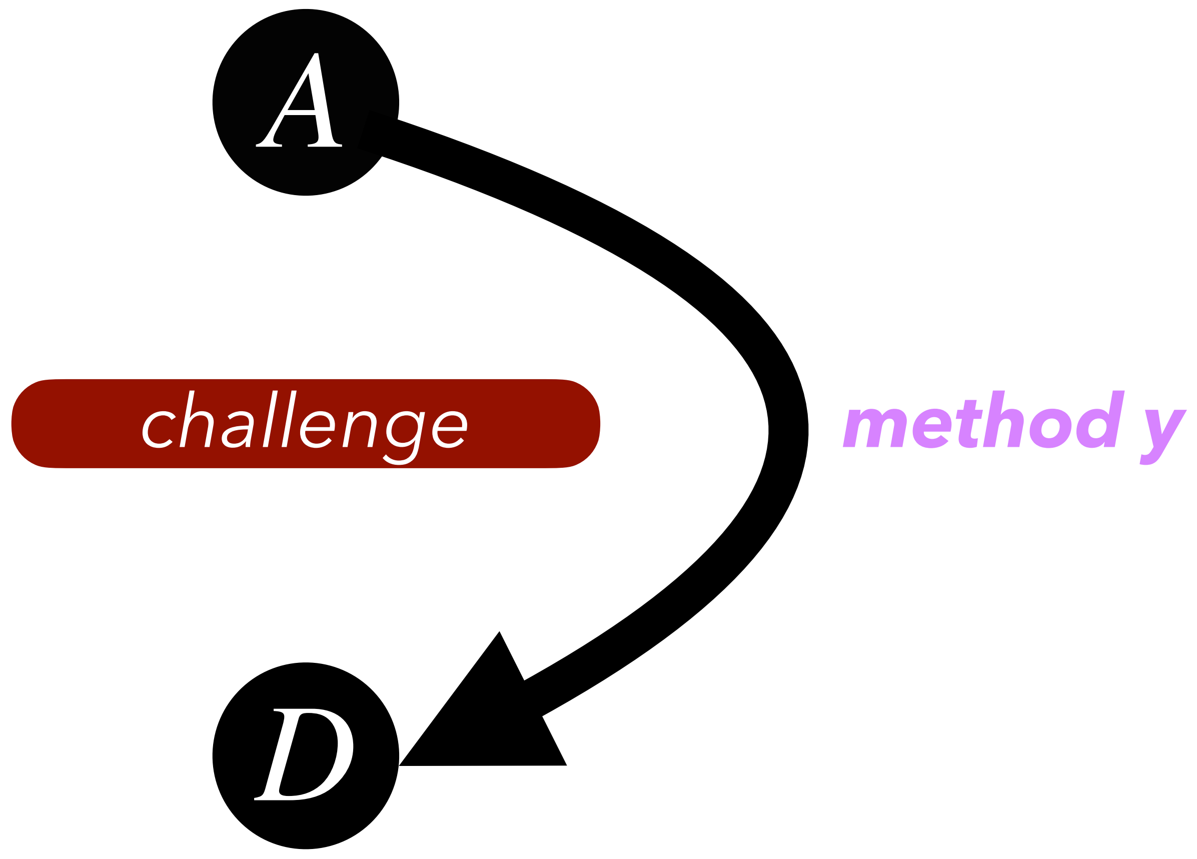


- **Return to roadmap** and remind audience (often) where we were/are/will be

Presenting: Technical Details

- **Advice re main** result also holds for lemmas

  roadmap, present simple versions, engage audience



Presentation: Technical Details

- **Advice re main** result also holds for lemmas

  roadmap, present simple versions, engage audience

Presenting: Technical Details

- **Advice re main** result also holds for lemmas

  roadmap, present simple versions, engage audience

- Prove **simpler versions** of results

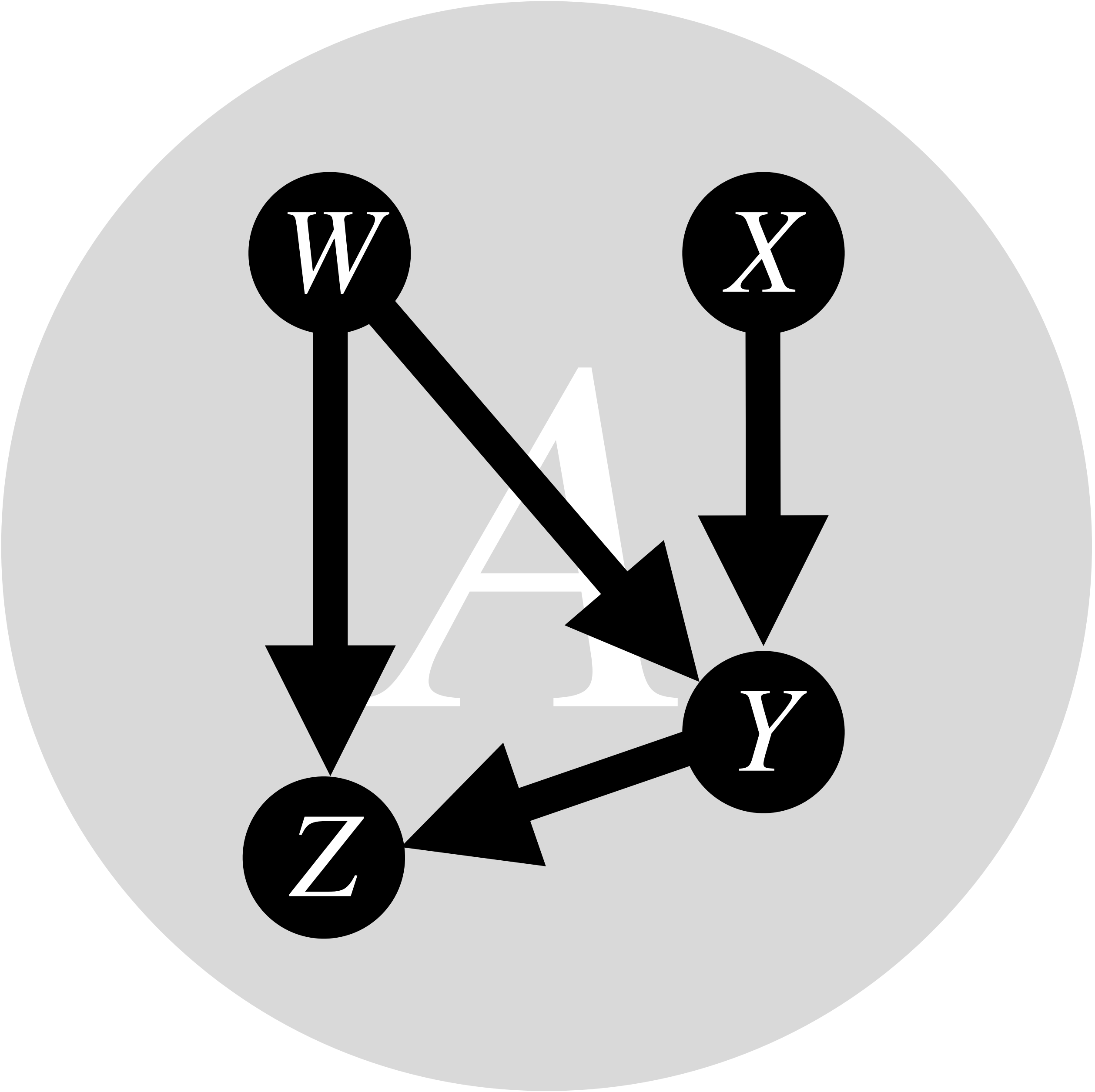
  even if stated in full complexity

- **Proof sketches** are fine

  and often preferred

- Focus on **new techniques** in the paper

  skip standard arguments and calculations



Presenting: Open Questions

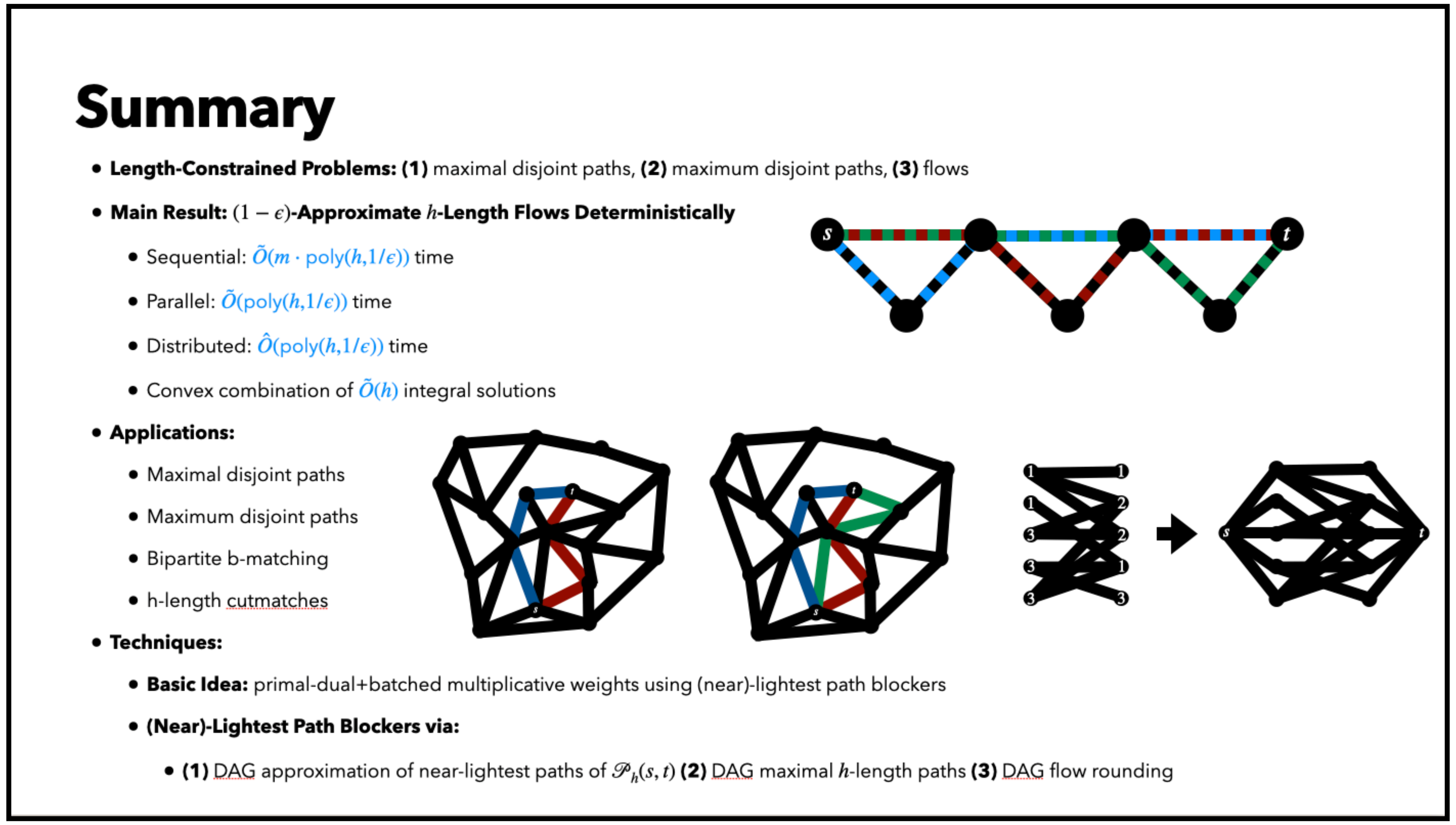
- Chance to **get others interested** in your research

???

- **May be none** in your paper

Presenting: Summary

- **Repetition** is important
- Chance to **re-onboard people**
- **Don't skip!**



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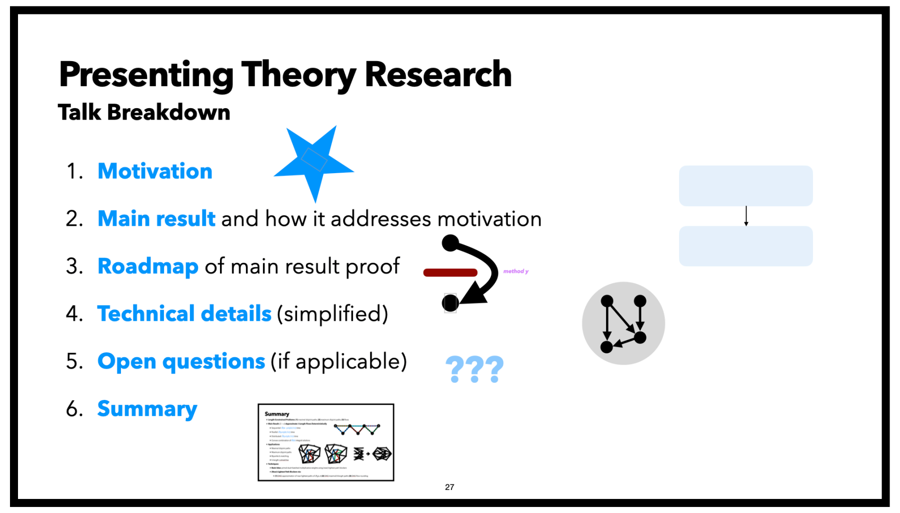
  - Parallel: $\tilde{O}(\mathrm{poly}(h, 1/\epsilon))$ time
  - Distributed: $\hat{O}(\mathrm{poly}(h, 1/\epsilon))$ time
  - Convex combination of $\tilde{O}(h)$ integral solutions
- **Applications:**
  - Maximal disjoint paths
  - Maximum disjoint paths
  - Bipartite b-matching
  - h-length cutmatches
- **Techniques:**
  - **Basic Idea:** primal-dual+batched multiplicative weights using (near)-lightest path blockers
  - **(Near)-Lightest Path Blockers via:**
    - **(1)** DAG approximation of near-lightest paths of $\mathscr{P}_h(s,t)$ **(2)** DAG maximal h-length paths **(3)** DAG flow rounding

Presenting Theory Outline

1. **Talk Breakdown**



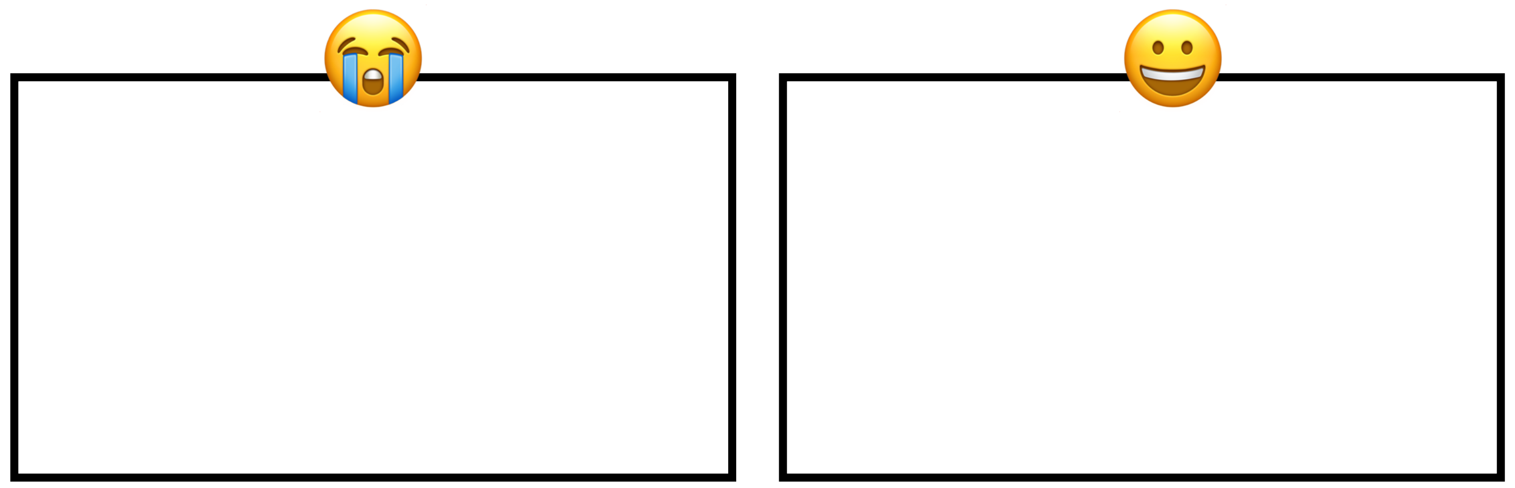
Presenting Theory Research

Talk Breakdown

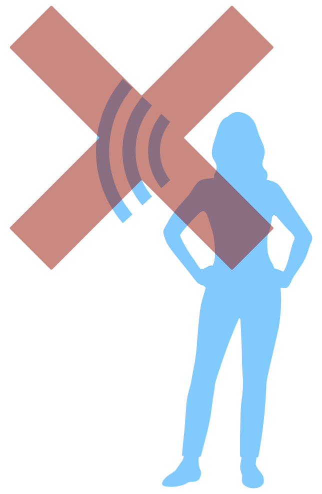
1. **Motivation**
2. **Main result** and how it addresses motivation
3. **Roadmap** of main result proof
4. **Technical details** (simplified)
5. **Open questions** (if applicable)
6. **Summary**

27

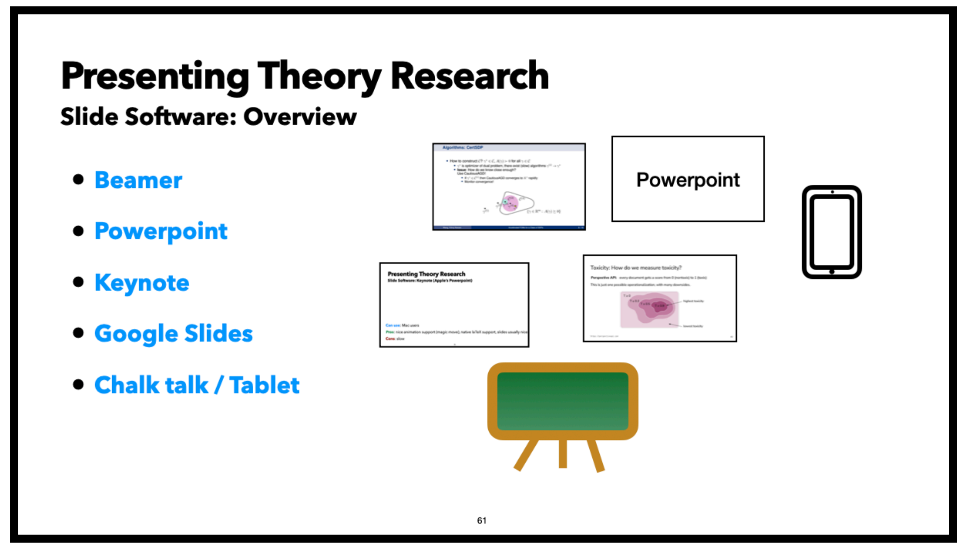
2. **Slide Best Practices**



3. **Speaking Best Practices**



4. **Presenting Software**



Presenting Theory Research

Slide Software: Overview

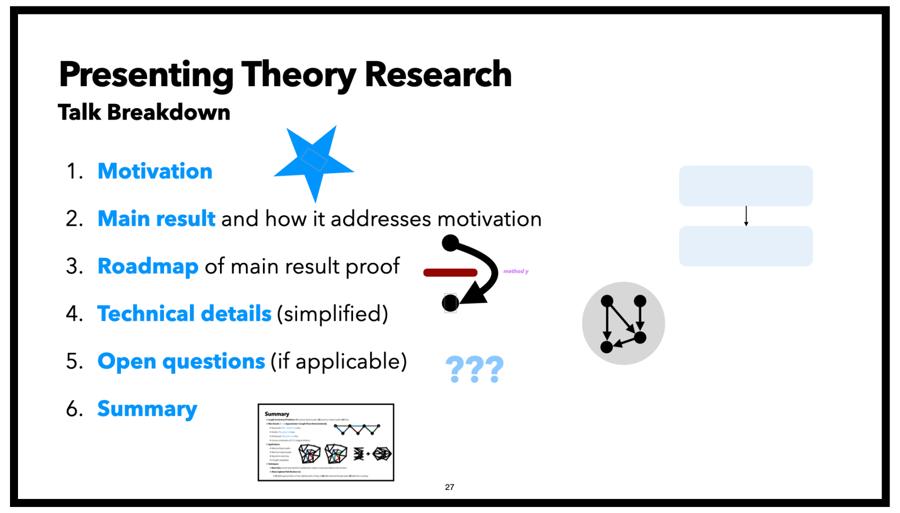
- **Beamer**
- **Powerpoint**
- **Keynote**
- **Google Slides**
- **Chalk talk / Tablet**

Powerpoint
Presenting Theory Research
Toxicity: How do we measure toxicity?

61

Presenting Theory Outline

✓ 1. **Talk Breakdown**



Presenting Theory Research
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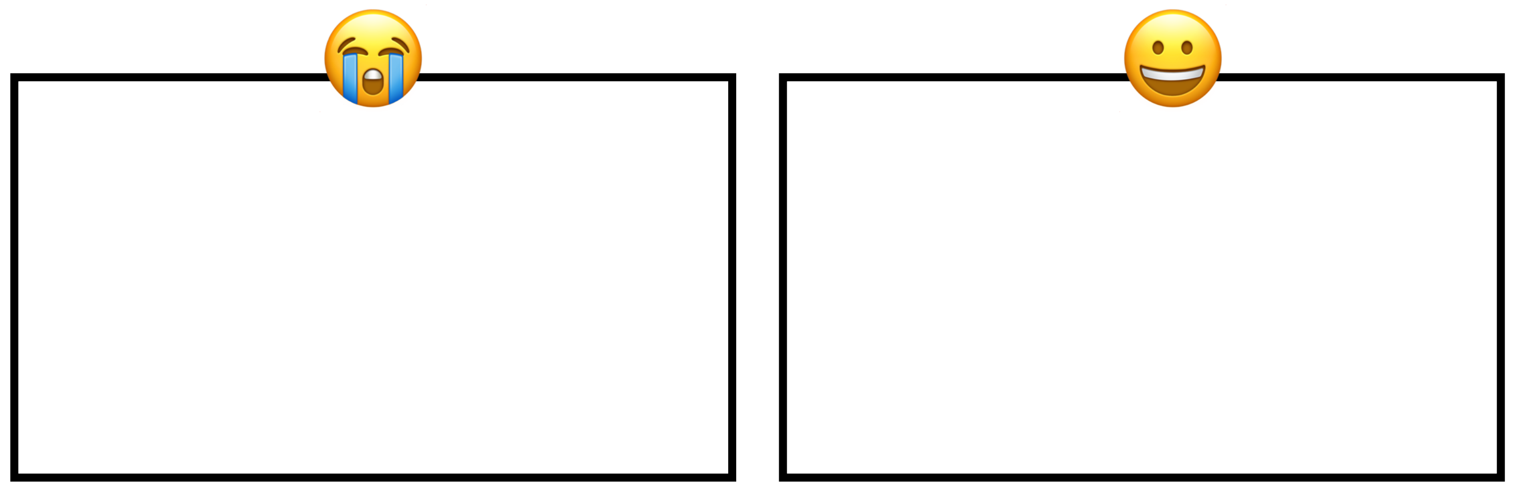

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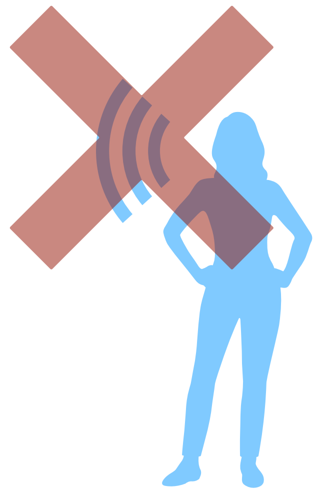

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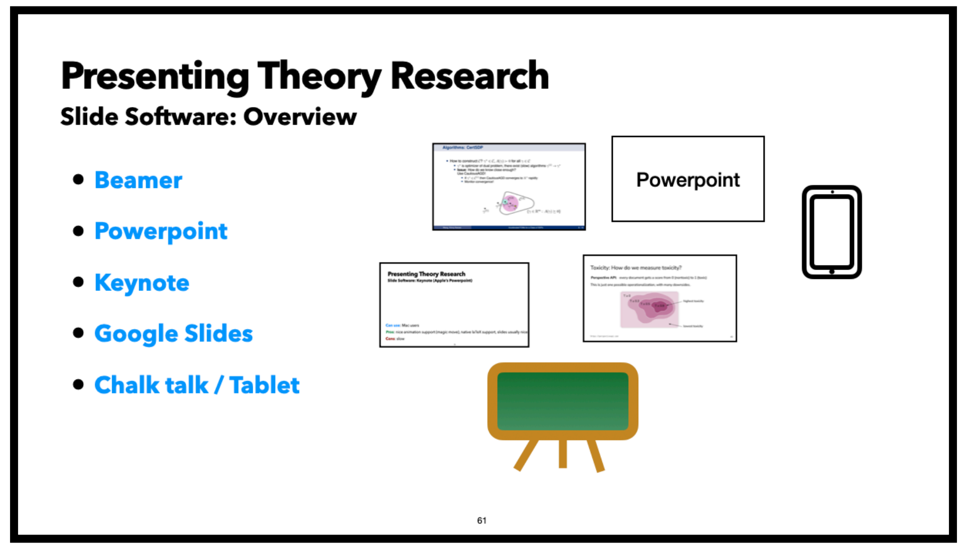

Presenting Theory Research
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Presenting Theory Research

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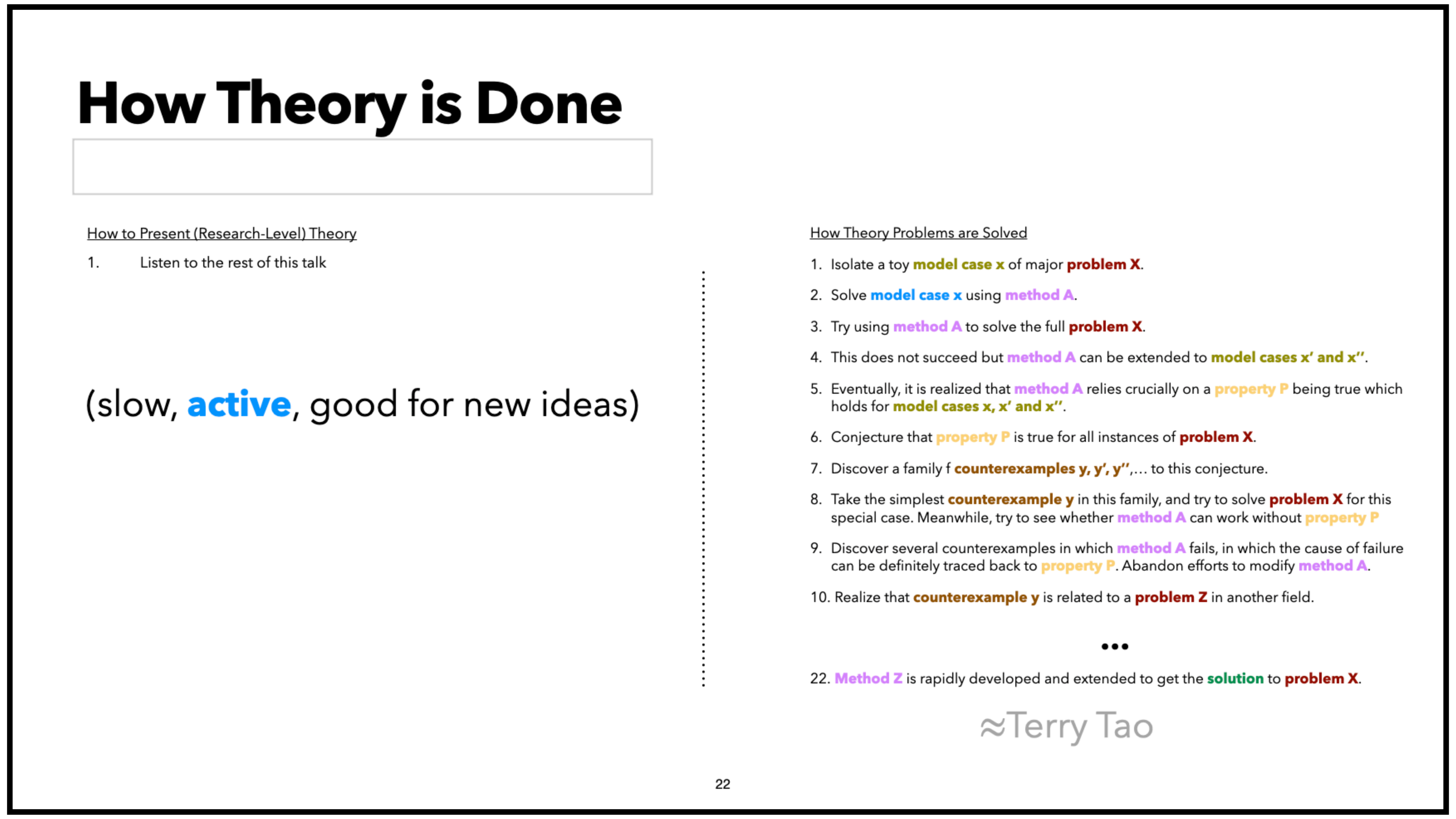

How Theory is Done

How to Present (Research-Level) Theory

1. Listen to the rest of this talk

(slow, **active**, good for new ideas)

How Theory Problems are Solved

1. Isolate a toy **model case x** of major **problem X**.
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•••

22. **Method Z** is rapidly developed and extended to get the **solution** to **problem X**.

≈Terry Tao

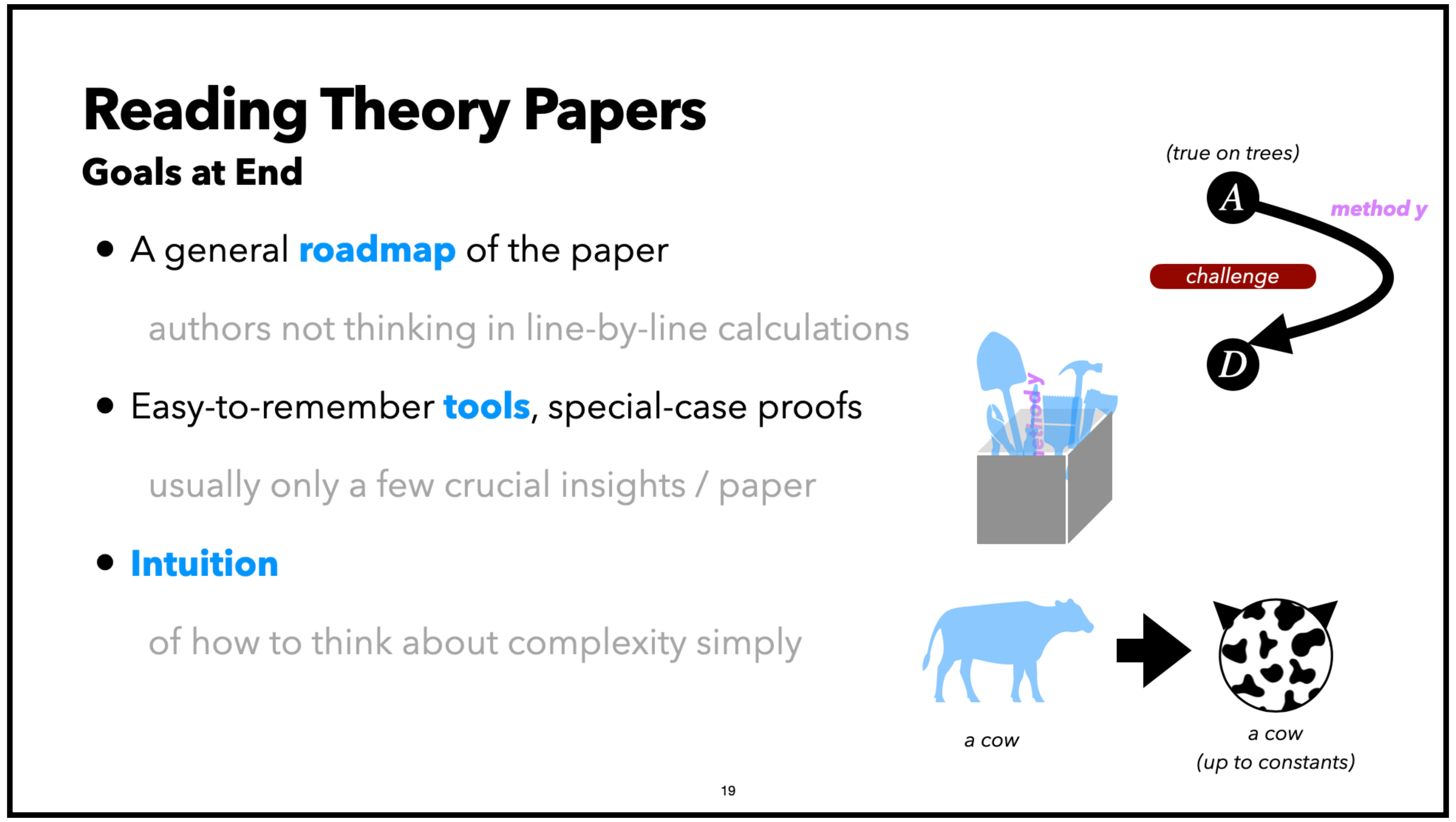
22

Use colors and **bold** to emphasize, deemphasize, show two things related

very useful for complex latex equations

Presenting Theory Research

Slide Best Practices



Reading Theory Papers

Goals at End

- A general **roadmap** of the paper

  authors not thinking in line-by-line calculations

- Easy-to-remember **tools**, special-case proofs

  usually only a few crucial insights / paper

- **Intuition**

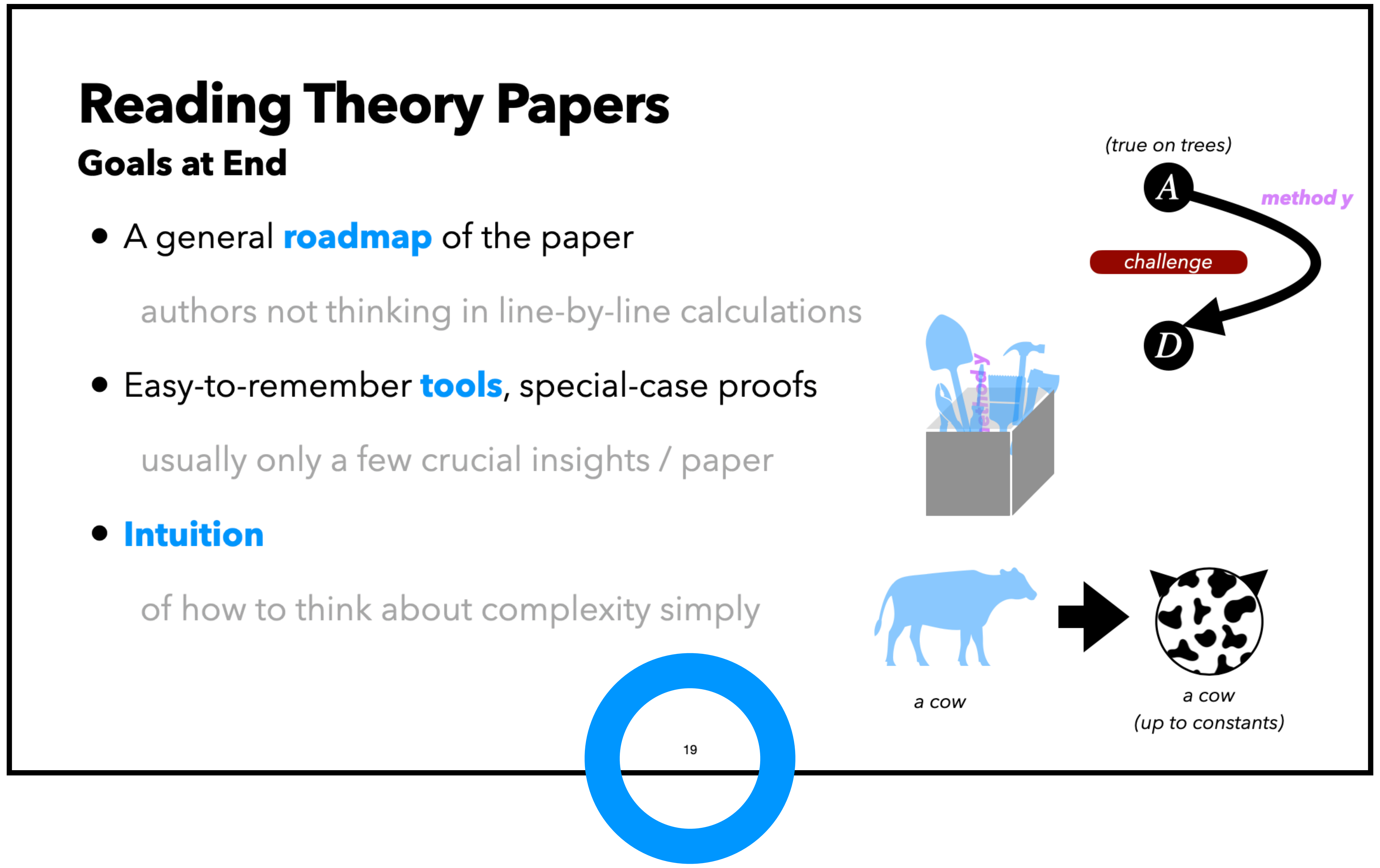
  of how to think about complexity simply

Pick a **(large) font size** and try to stick to it

this talk is an aspirational 48pt

Presenting Theory Research

Slide Best Practices



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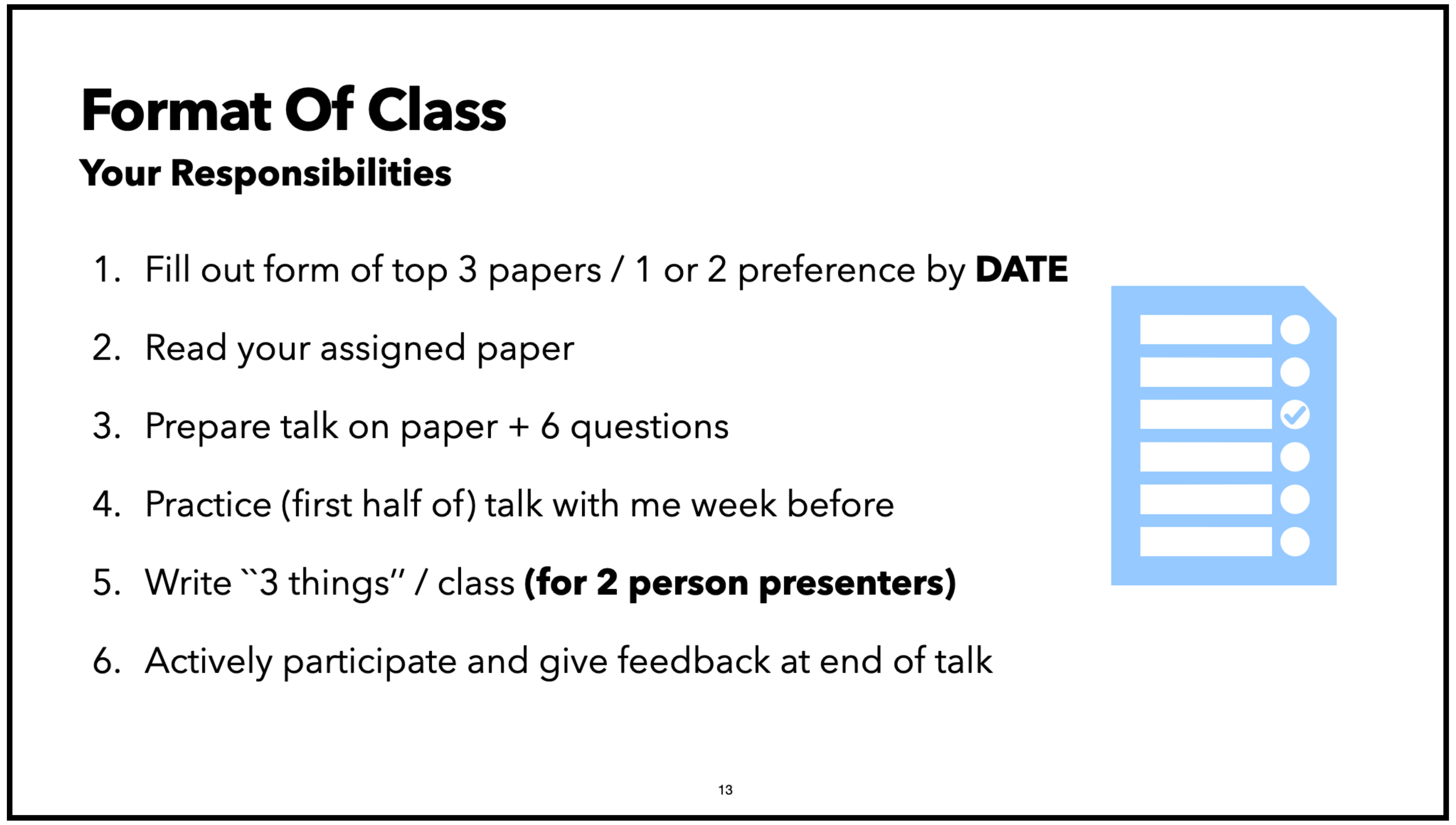
19

Use **slide numbers** (when possible)

helps audience ask questions about specific slides

Presenting Theory Research

Slide Best Practices

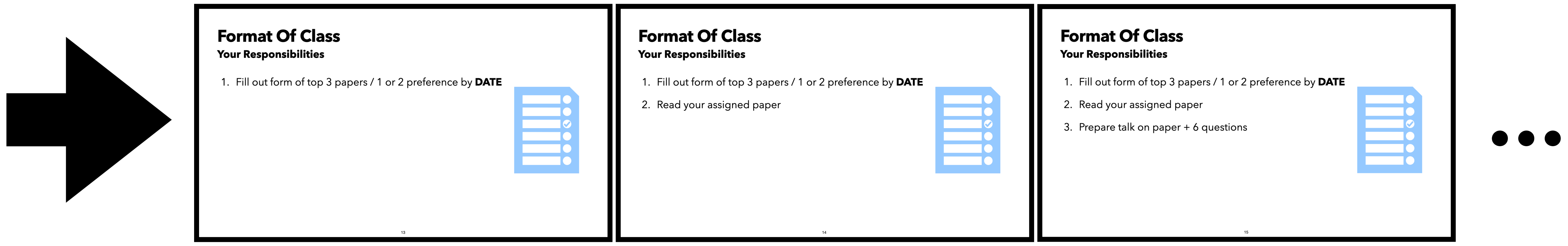


Format Of Class

Your Responsibilities

1. Fill out form of top 3 papers / 1 or 2 preference by **DATE**
2. Read your assigned paper
3. Prepare talk on paper + 6 questions
4. Practice (first half of) talk with me week before
5. Write ``3 things'' / class **(for 2 person presenters)**
6. Actively participate and give feedback at end of talk

13



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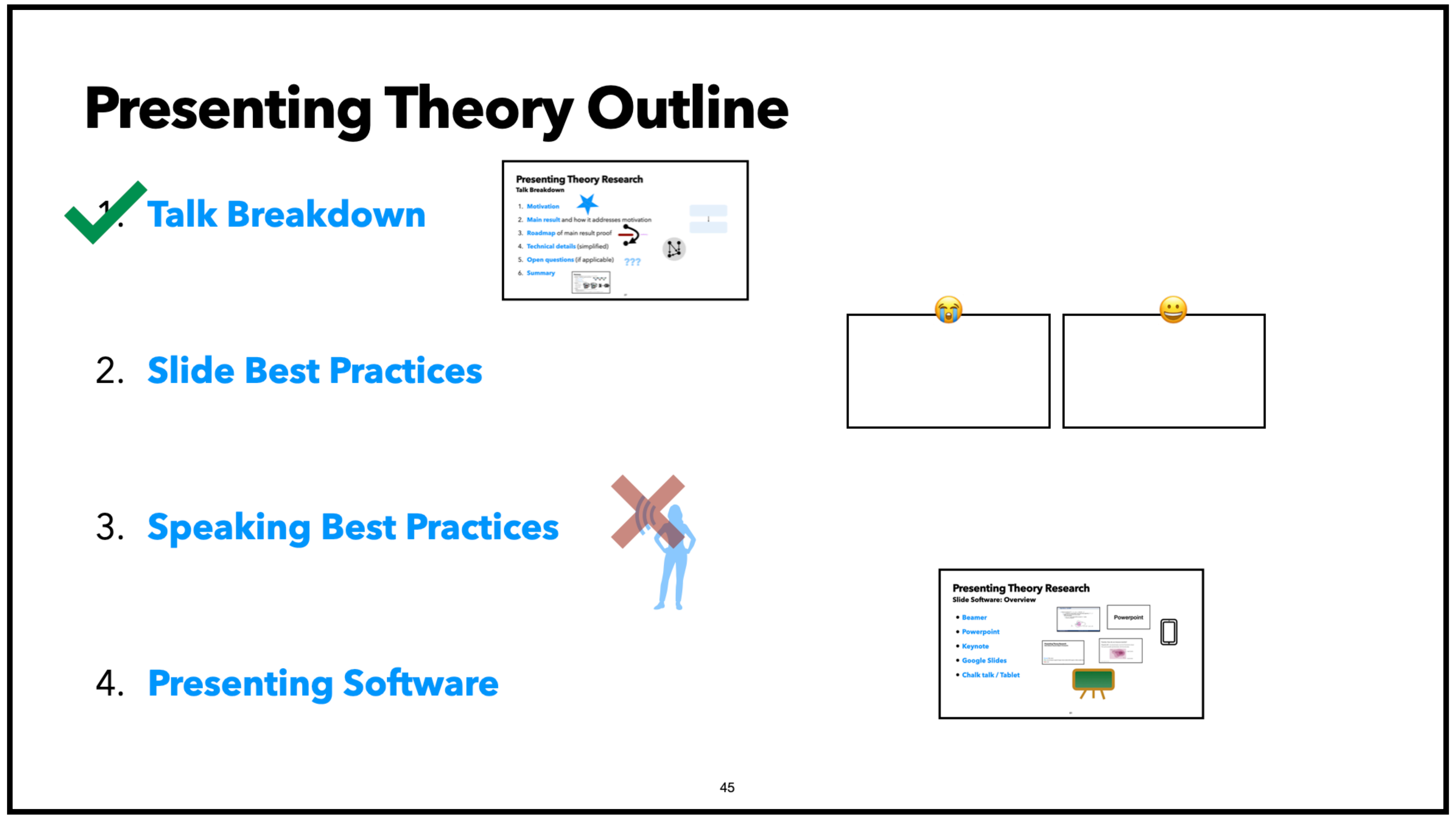
Use **incremental reveals**

makes daunting slides approachable, focuses audience on what you’re saying

Presenting Theory Research

Slide Best Practices



Presenting Theory Outline

1. Talk Breakdown
2. Slide Best Practices
3. Speaking Best Practices
4. Presenting Software

Presenting Theory Research

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???

Presenting Theory Research

Slide Software: Overview

- Beamer
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- Chalk talk / Tablet

Powerpoint

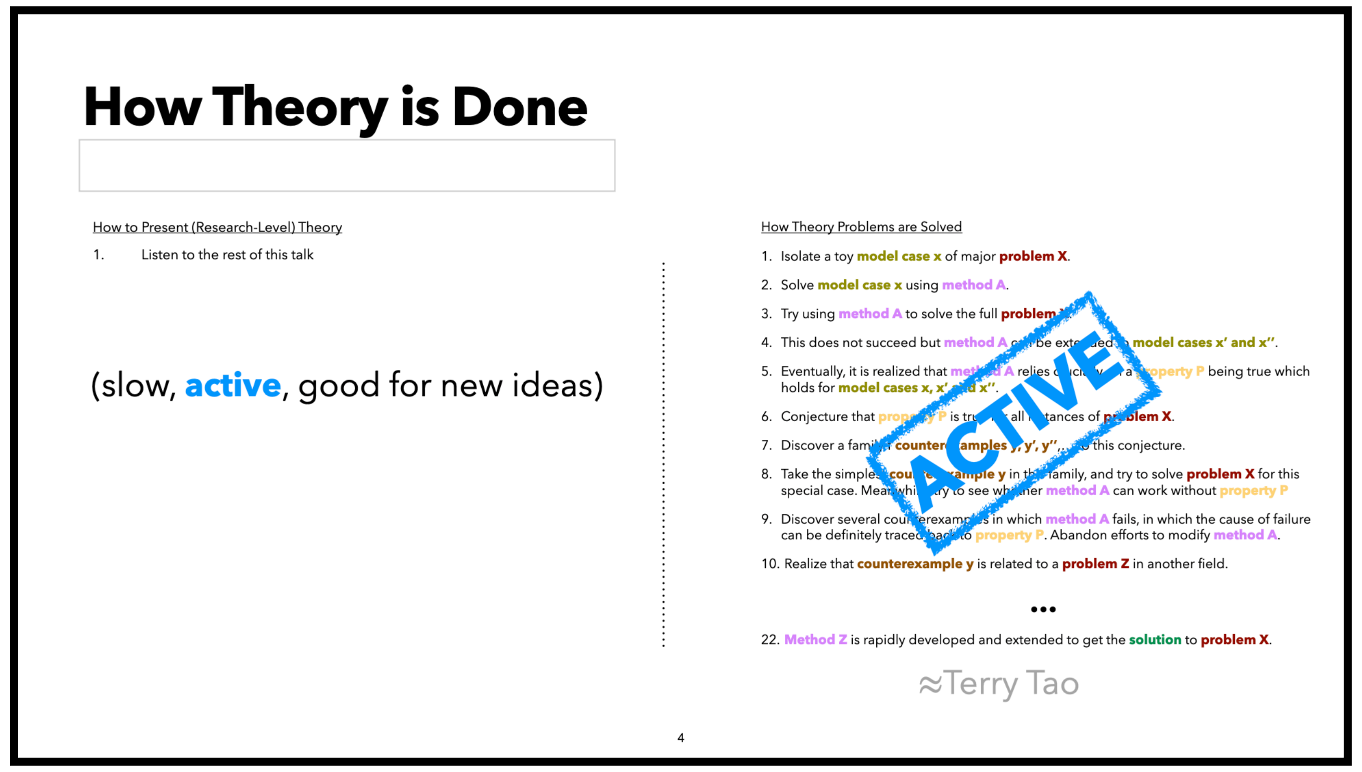
45

Use **outline slides**, return to them often

helps audience keep roadmap in mind

Presenting Theory Research

Slide Best Practices



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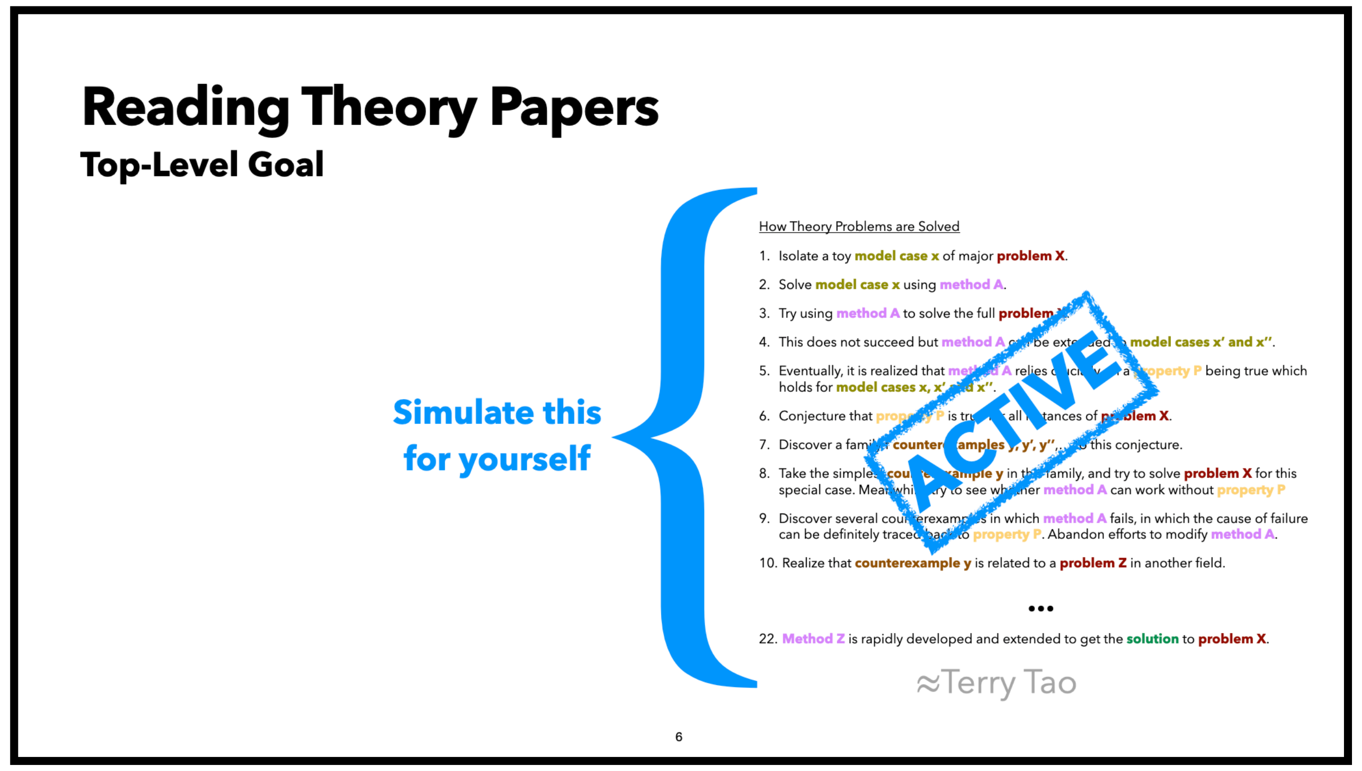
ACTIVE

≈Terry Tao

4



Reading Theory Papers

Top-Level Goal

Simulate this for yourself

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ACTIVE

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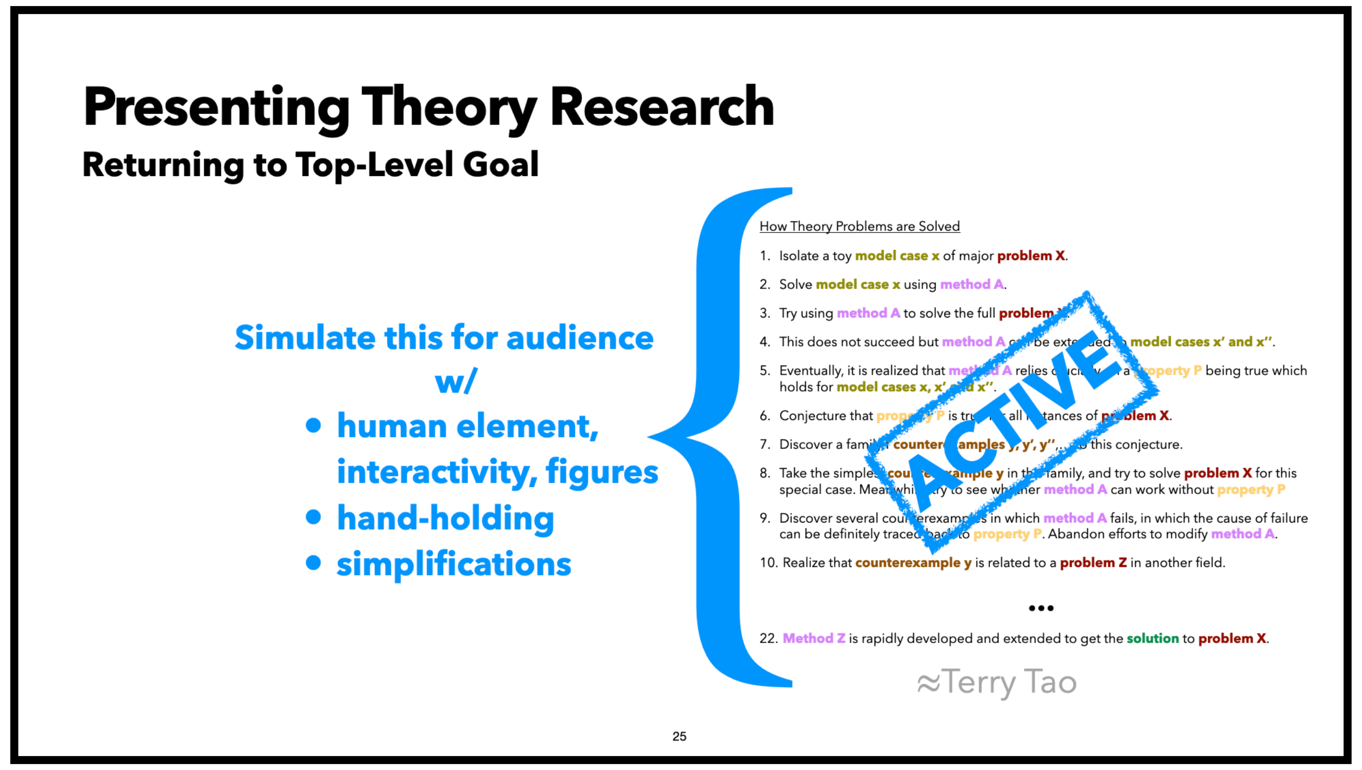
6



Presenting Theory Research

Returning to Top-Level Goal

Simulate this for audience w/

- **human element, interactivity, figures**
- **hand-holding**
- **simplifications**

How Theory Problems are Solved

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ACTIVE

≈Terry Tao

25

Reuse figures to emphasize recurring themes

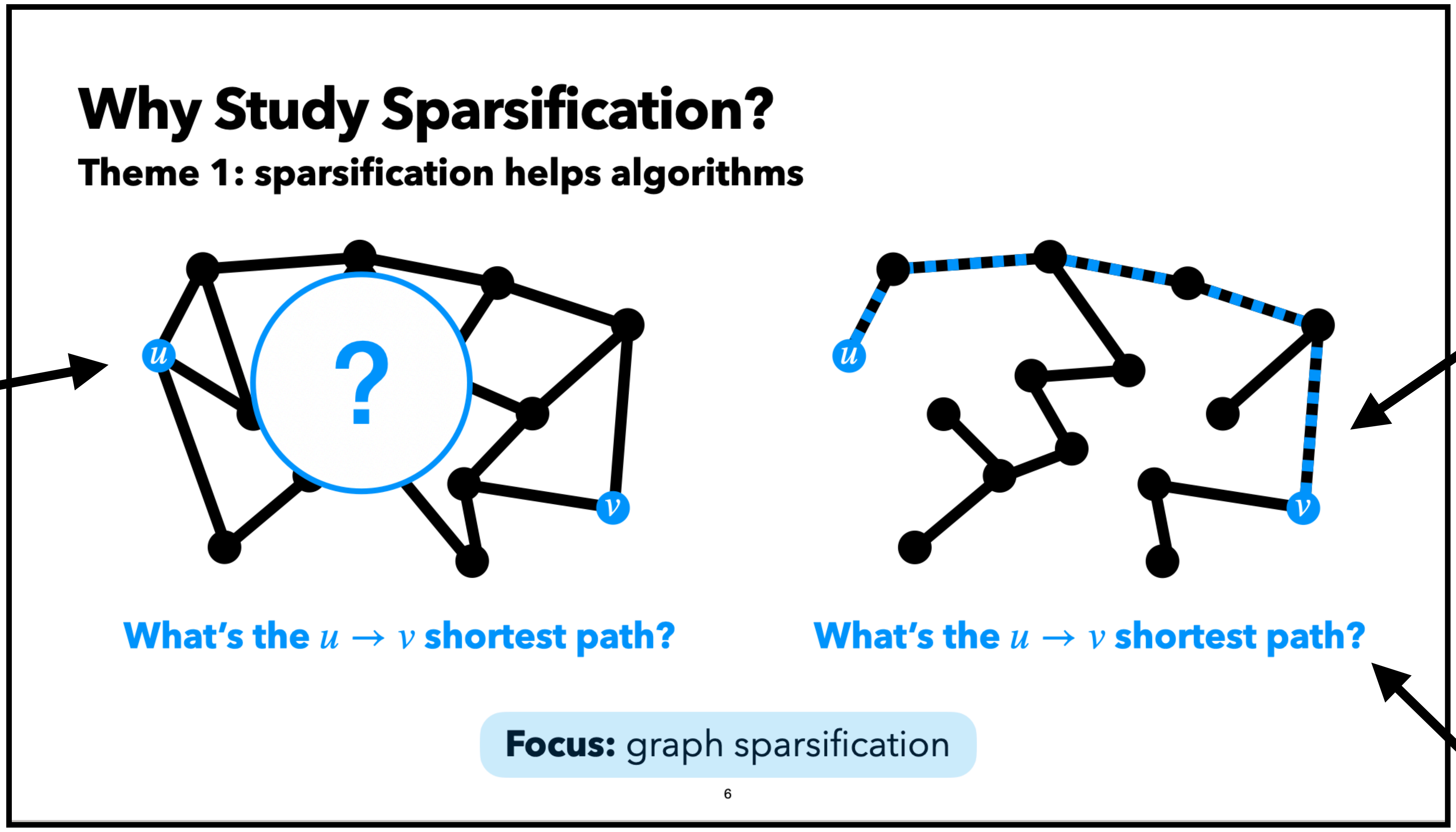
helps audience make connections

Presenting Theory Research

Slide Best Practices

Solid black nodes, edges

“Aqua” Accents



Why Study Sparsification?

Theme 1: sparsification helps algorithms

What’s the $u \to v$ shortest path?

What’s the $u \to v$ shortest path?

Focus: graph sparsification

6

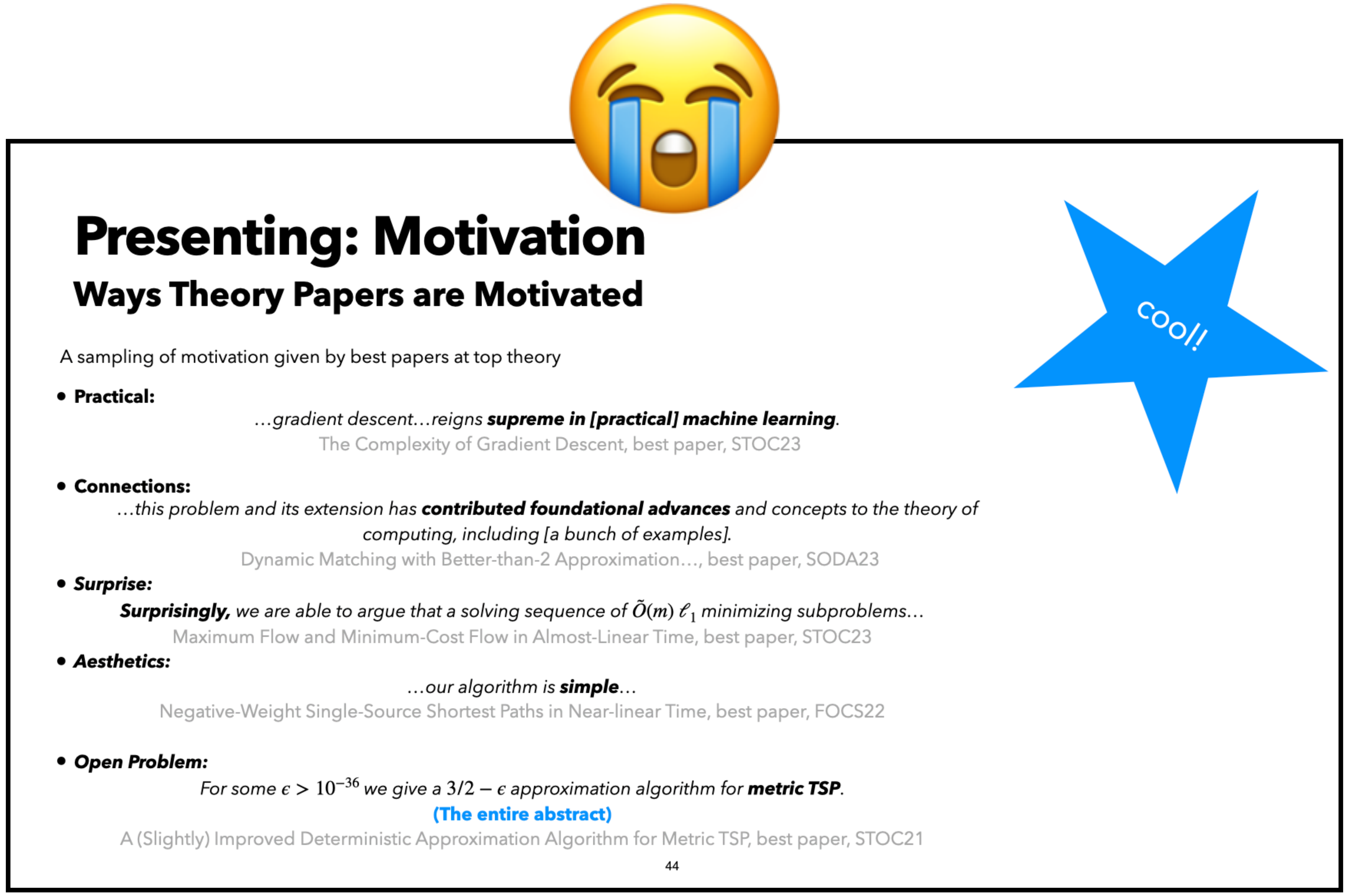
48 pt Avenir Next

Develop a **consistent slide style**

professional value in having a consistent, recognizable style

Presenting Theory Research

Slide Best Practices



Presenting: Motivation

Ways Theory Papers are Motivated

A sampling of motivation given by best papers at top theory

- **Practical:**

  *…gradient descent…reigns **supreme in [practical] machine learning**.*

  The Complexity of Gradient Descent, best paper, STOC23

- **Connections:**

  *…this problem and its extension has **contributed foundational advances** and concepts to the theory of computing, including [a bunch of examples].*

  Dynamic Matching with Better-than-2 Approximation…, best paper, SODA23

- ***Surprise:***

  ***Surprisingly,** we are able to argue that a solving sequence of $\tilde{O}(m)$ ℓ_1 minimizing subproblems…*

  Maximum Flow and Minimum-Cost Flow in Almost-Linear Time, best paper, STOC23

- ***Aesthetics:***

  *…our algorithm is **simple**…*

  Negative-Weight Single-Source Shortest Paths in Near-linear Time, best paper, FOCS22

- ***Open Problem:***

  *For some $\epsilon > 10^{-36}$ we give a $3/2 - \epsilon$ approximation algorithm for **metric TSP**.*

  (The entire abstract)

  A (Slightly) Improved Deterministic Approximation Algorithm for Metric TSP, best paper, STOC21

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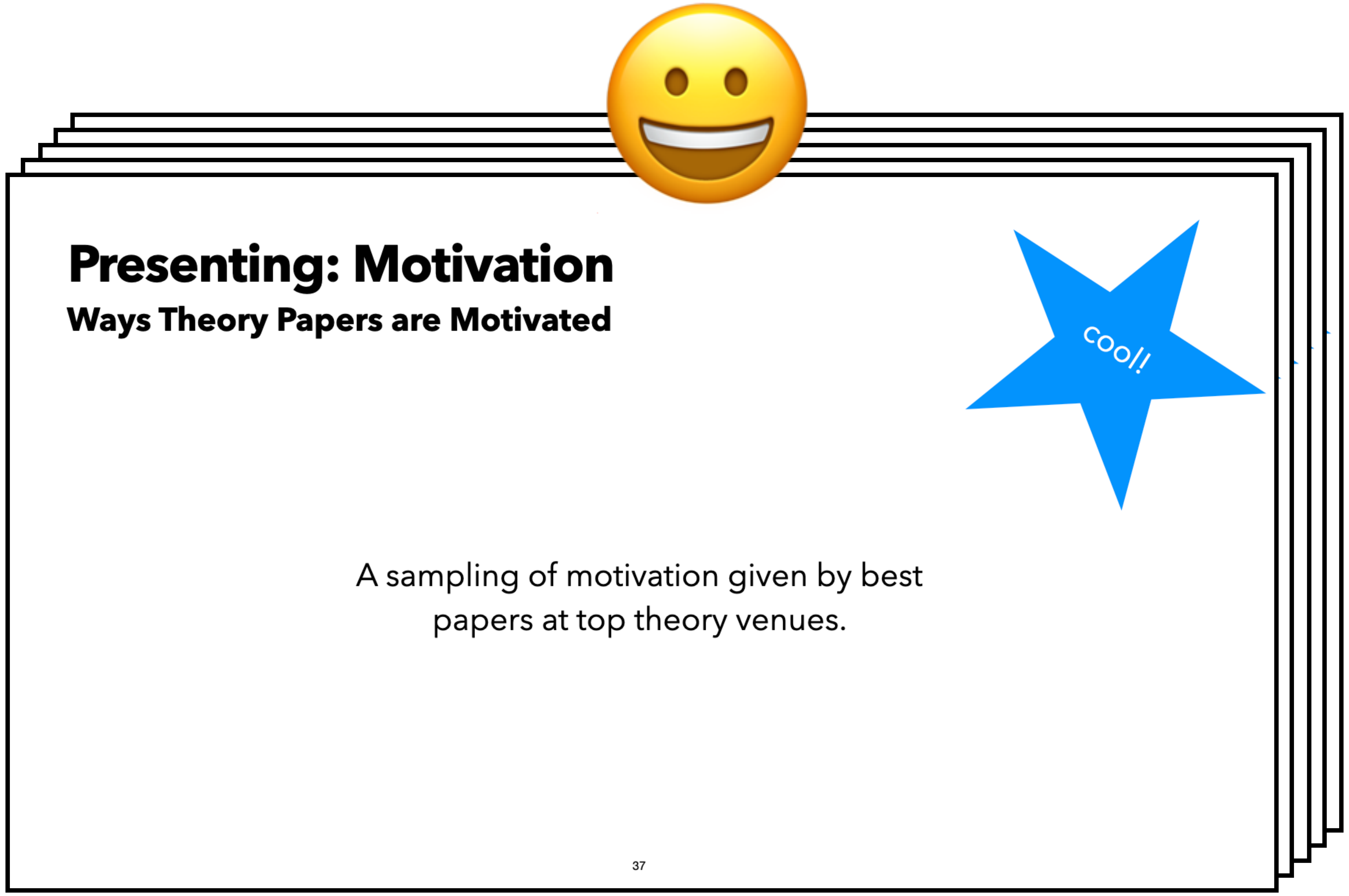


Presenting: Motivation

Ways Theory Papers are Motivated

A sampling of motivation given by best papers at top theory venues.

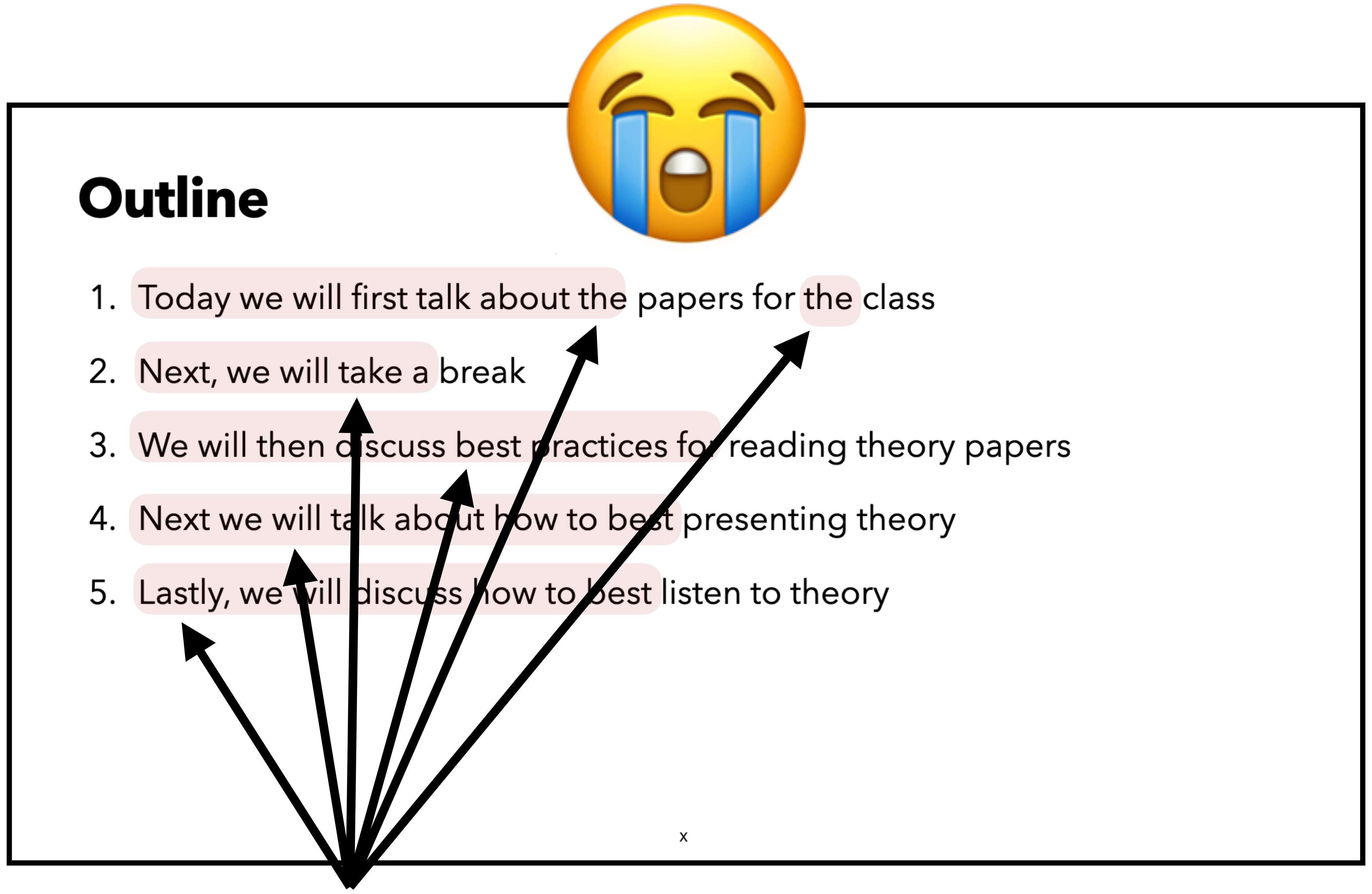
37

Use **more rather than fewer slides**

walls of text will lose audience members

Presenting Theory Research

Slide Best Practices

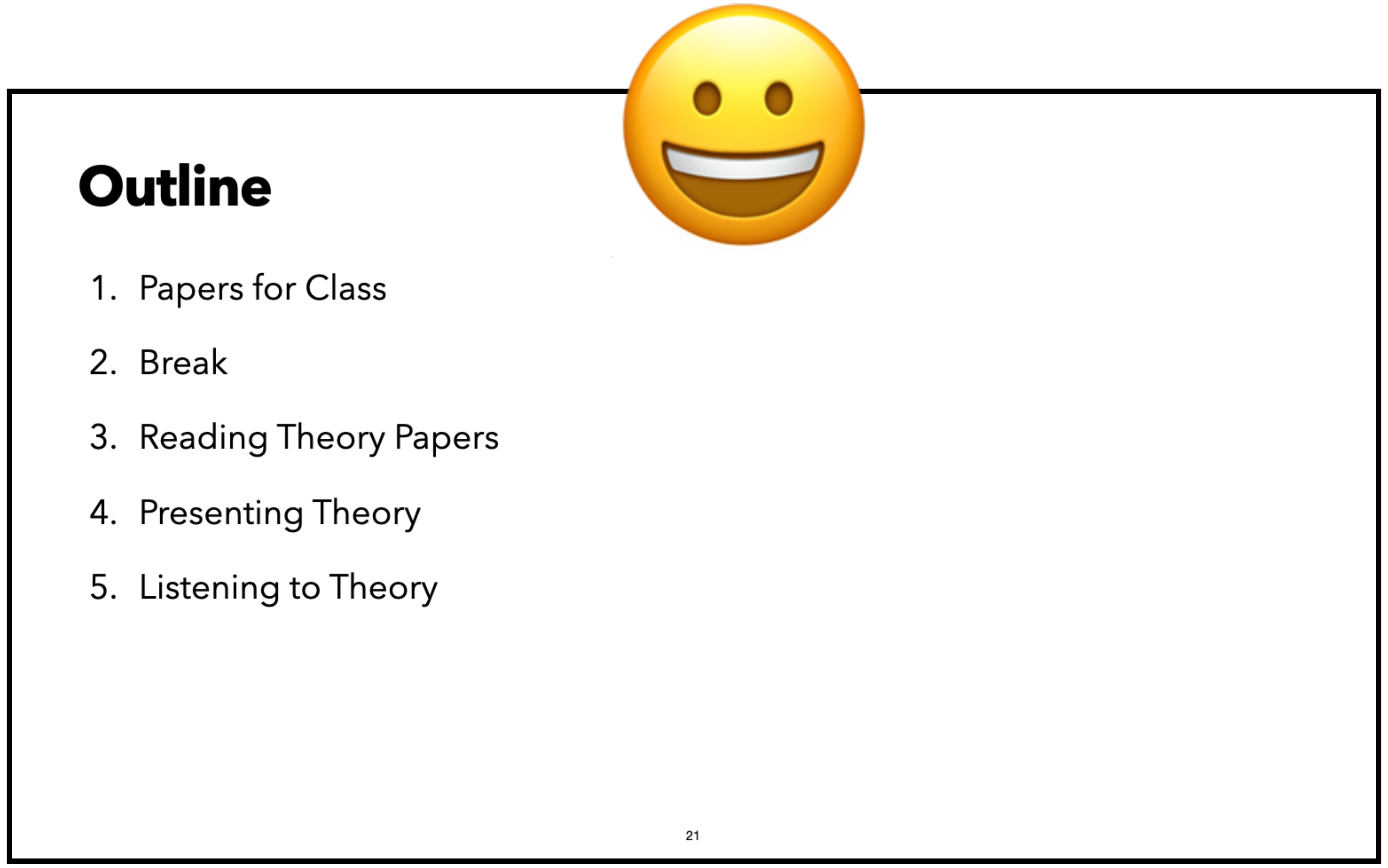


Outline

1. Today we will first talk about the papers for the class
2. Next, we will take a break
3. We will then discuss best practices for reading theory papers
4. Next we will talk about how to best presenting theory
5. Lastly, we will discuss how to best listen to theory

x

clutter



Outline

1. Papers for Class
2. Break
3. Reading Theory Papers
4. Presenting Theory
5. Listening to Theory

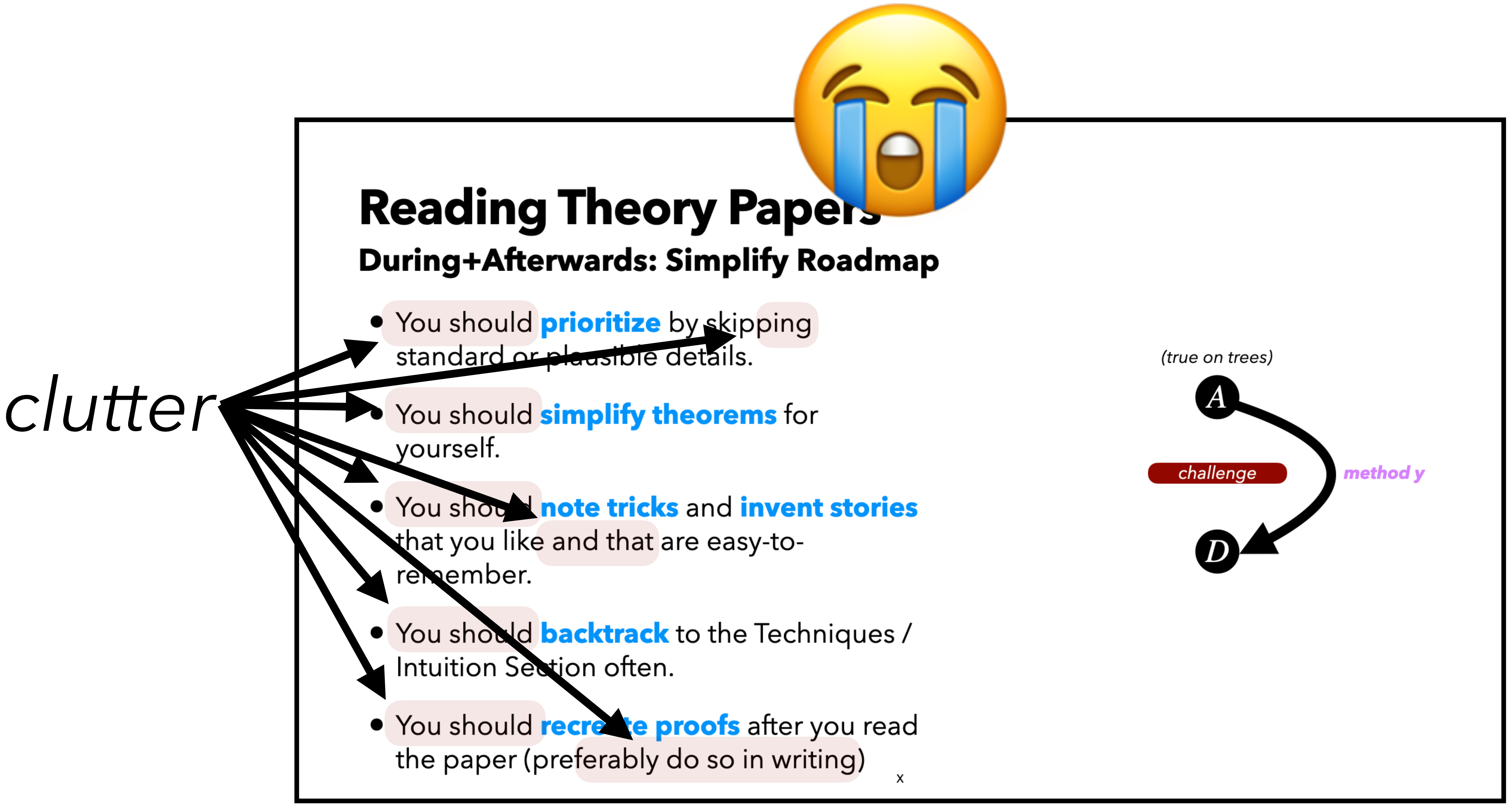
21

Avoid slides as transcription

everything you say doesn't need to go on slide

Presenting Theory Research

Slide Best Practices

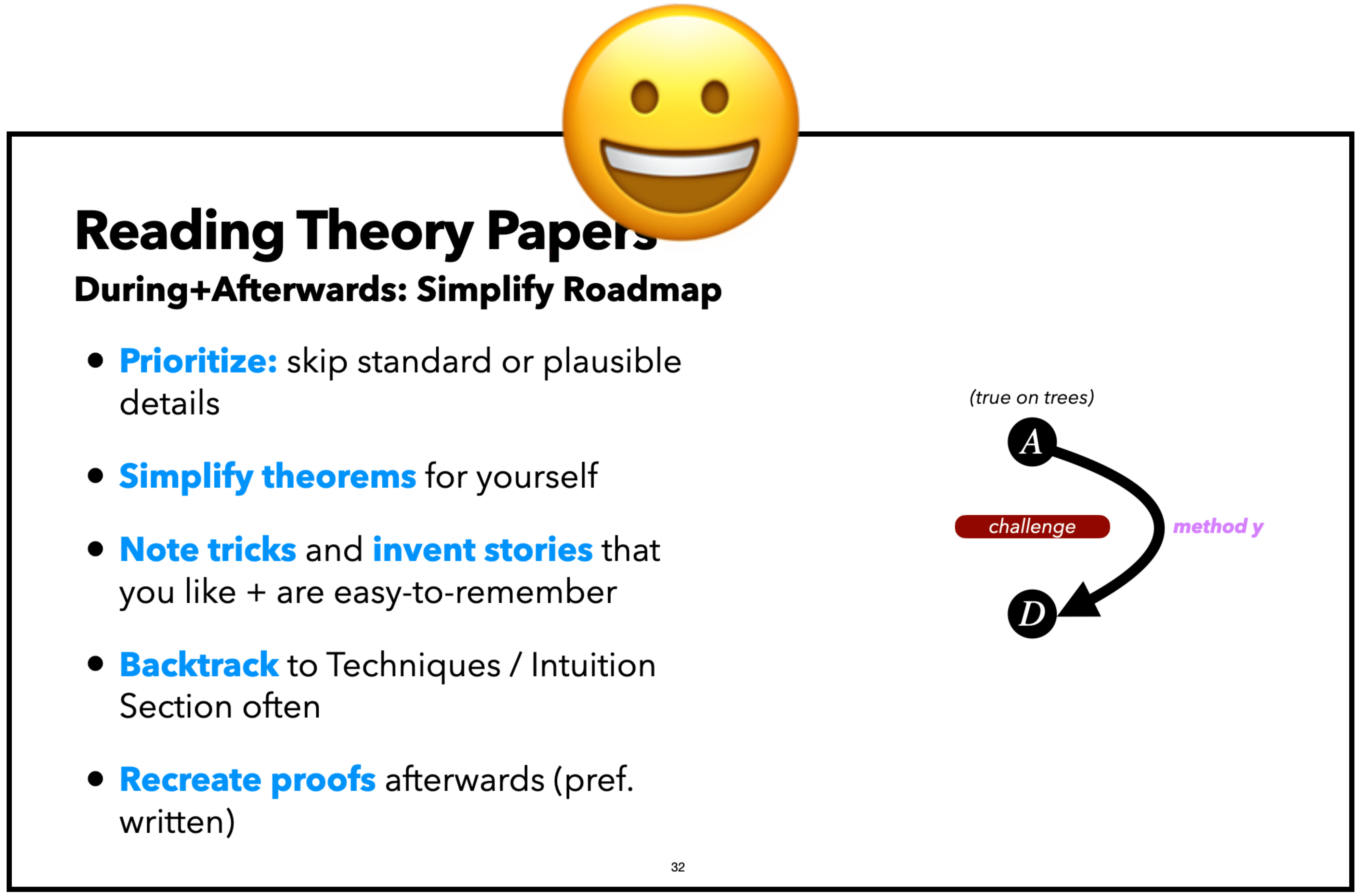


Reading Theory Papers

During+Afterwards: Simplify Roadmap

- You should **prioritize** by skipping standard or plausible details.
- You should **simplify theorems** for yourself.
- You should **note tricks** and **invent stories** that you like and that are easy-to-remember.
- You should **backtrack** to the Techniques / Intuition Section often.
- You should **recreate proofs** after you read the paper (preferably do so in writing)

x



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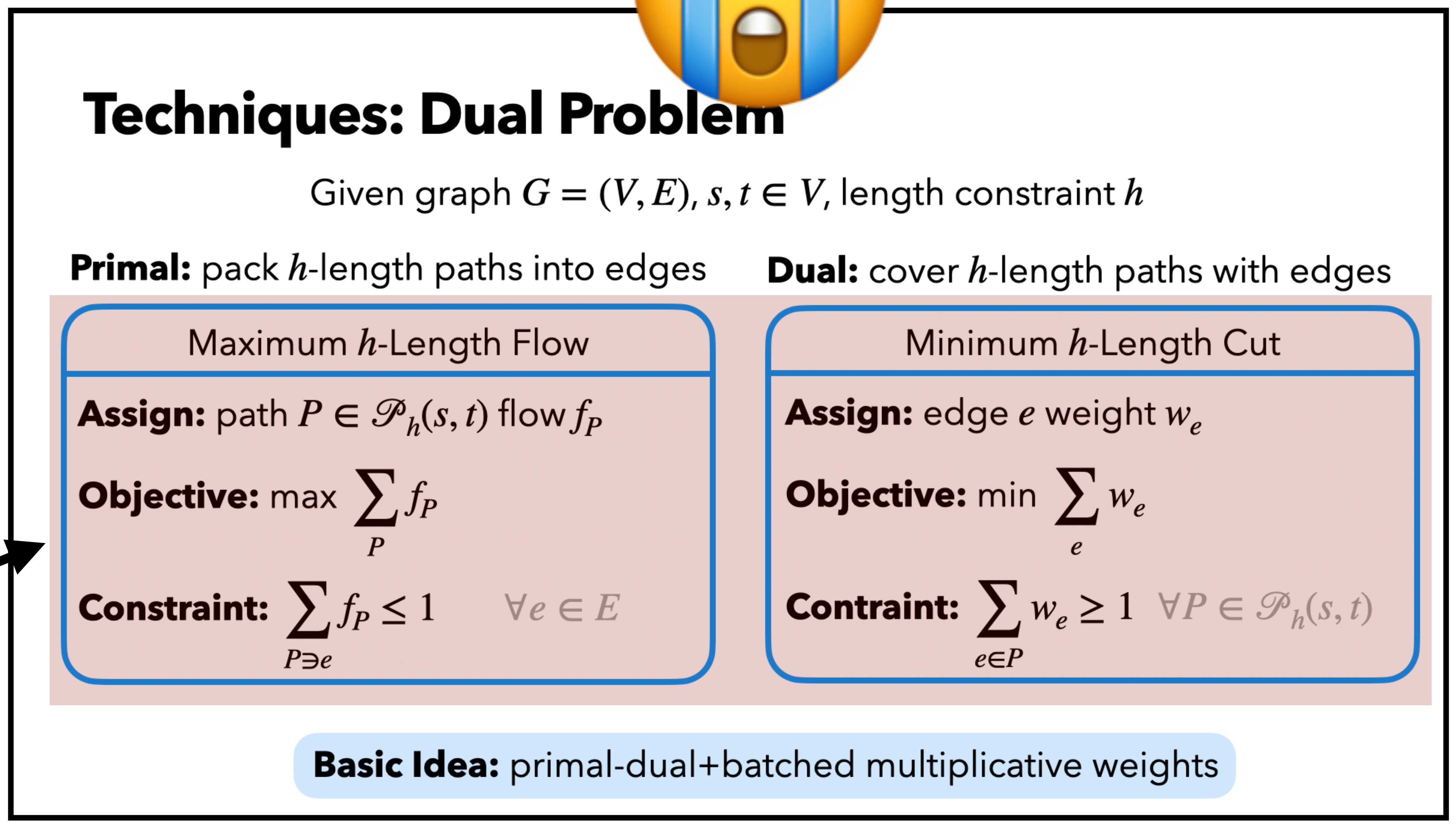
32

Don’t waste space on complete sentences

adds unnecessary visual clutter for audience

Presenting Theory Research

Slide Best Practices



Techniques: Dual Problem

Given graph $G = (V, E)$, $s, t \in V$, length constraint h

Primal: pack h-length paths into edges

Maximum h-Length Flow

Assign: path $P \in \mathcal{P}_h(s,t)$ flow f_P

Objective: max $\sum_P f_P$

Constraint: $\sum_{P \ni e} f_P \leq 1 \quad \forall e \in E$

Dual: cover h-length paths with edges

Minimum h-Length Cut

Assign: edge e weight w_e

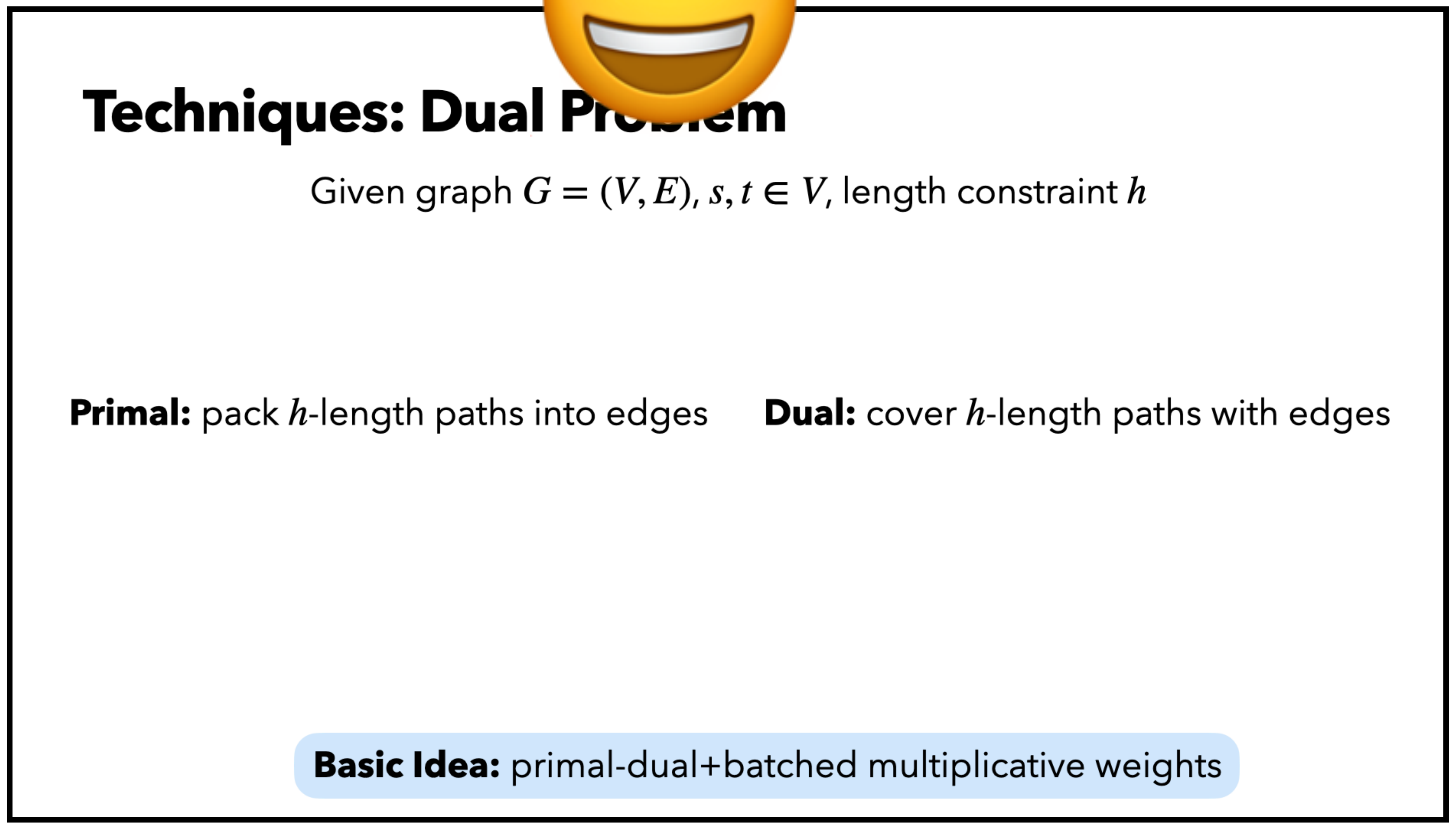
Objective: min $\sum_e w_e$

Contraint: $\sum_{e \in P} w_e \geq 1 \quad \forall P \in \mathcal{P}_h(s,t)$

Basic Idea: primal-dual+batched multiplicative weights

clutter

"Don't worry about this part of the slide"



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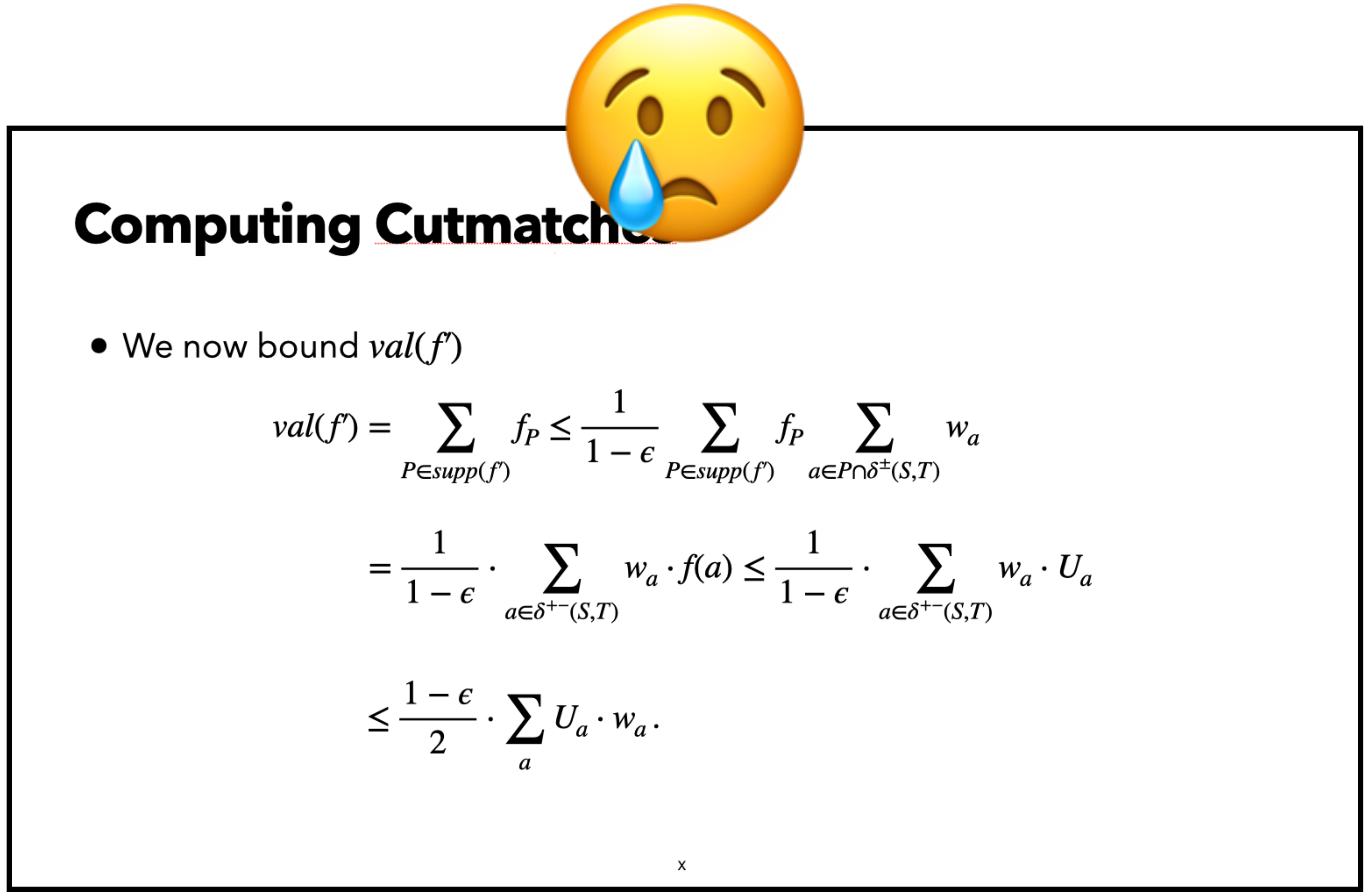
Basic Idea: primal-dual+batched multiplicative weights

Don't include unnecessary details

everything on your slide should have a purpose

Presenting Theory Research

Slide Best Practices



Computing Cutmatch

- We now bound $val(f')$

$$val(f') = \sum_{P \in supp(f')} f_P \leq \frac{1}{1-\epsilon} \sum_{P \in supp(f')} f_P \sum_{a \in P \cap \delta^{\pm}(S,T)} w_a$$

$$= \frac{1}{1-\epsilon} \cdot \sum_{a \in \delta^{+-}(S,T)} w_a \cdot f(a) \leq \frac{1}{1-\epsilon} \cdot \sum_{a \in \delta^{+-}(S,T)} w_a \cdot U_a$$

$$\leq \frac{1-\epsilon}{2} \cdot \sum_a U_a \cdot w_a \,.$$

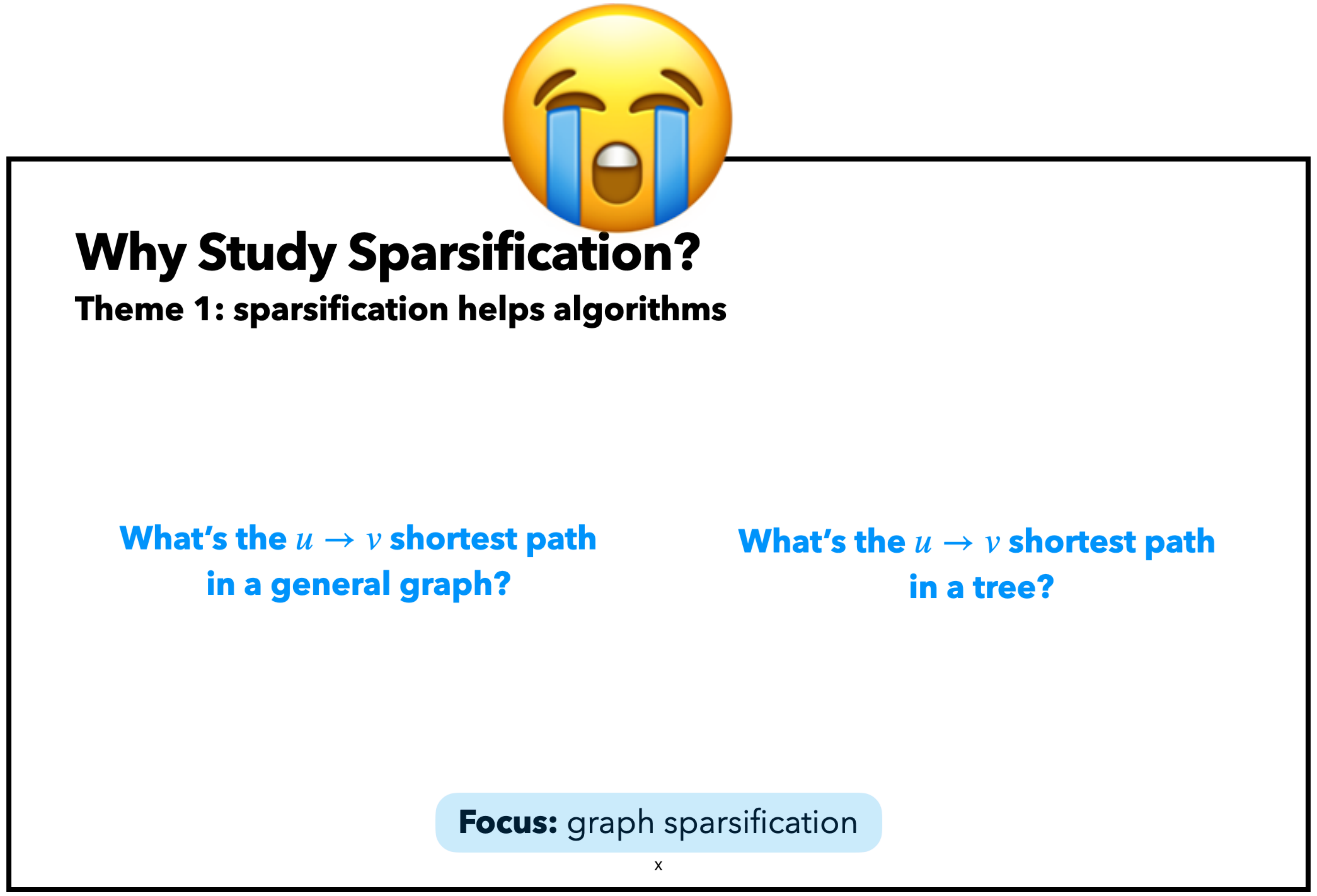
x

Use as **little laTex** as possible

ask self if this can be illustrated with a picture / is this really needed?

Presenting Theory Research

Slide Best Practices



Why Study Sparsification?

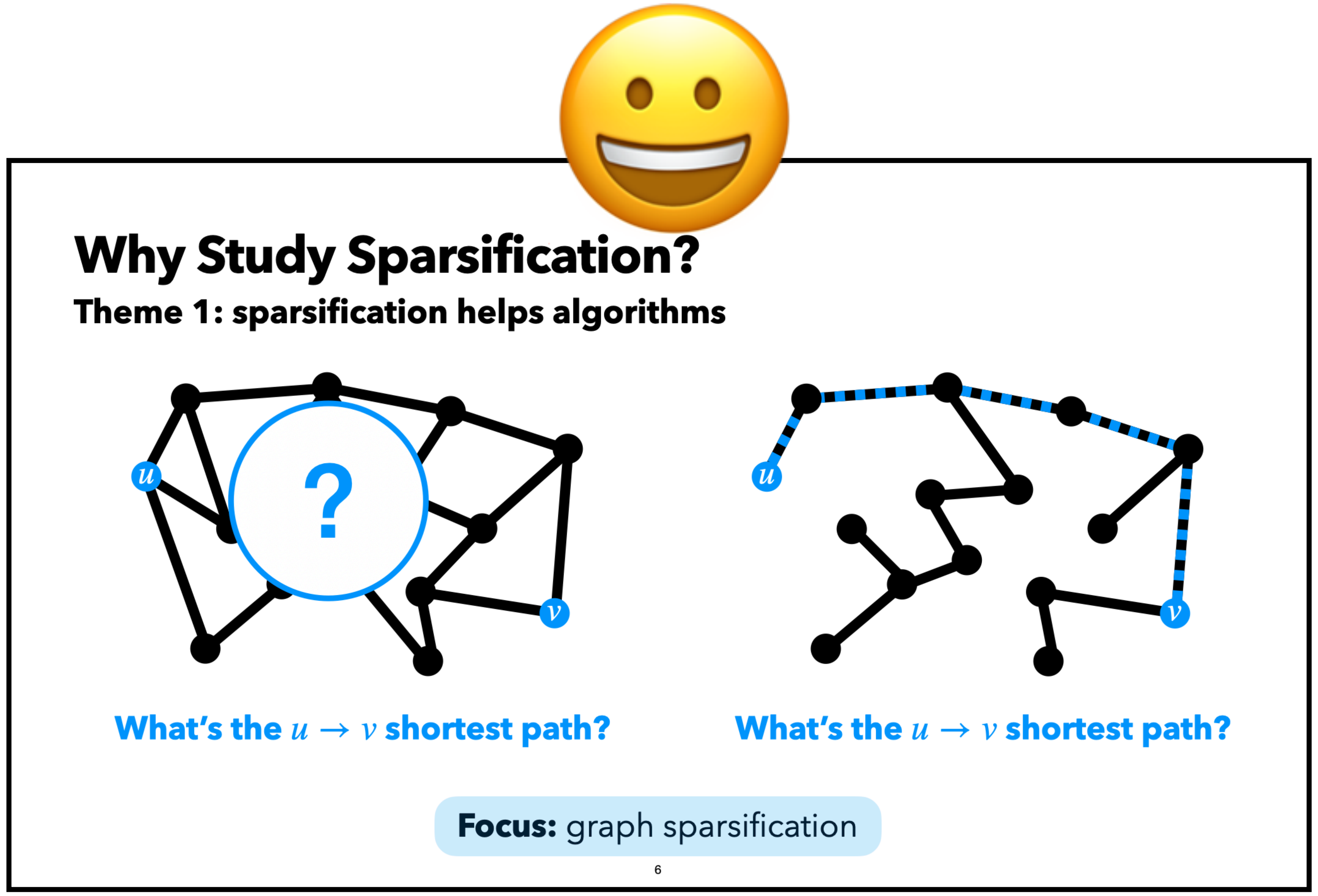
Theme 1: sparsification helps algorithms

What's the $u \to v$ shortest path in a general graph?

What's the $u \to v$ shortest path in a tree?

Focus: graph sparsification

x



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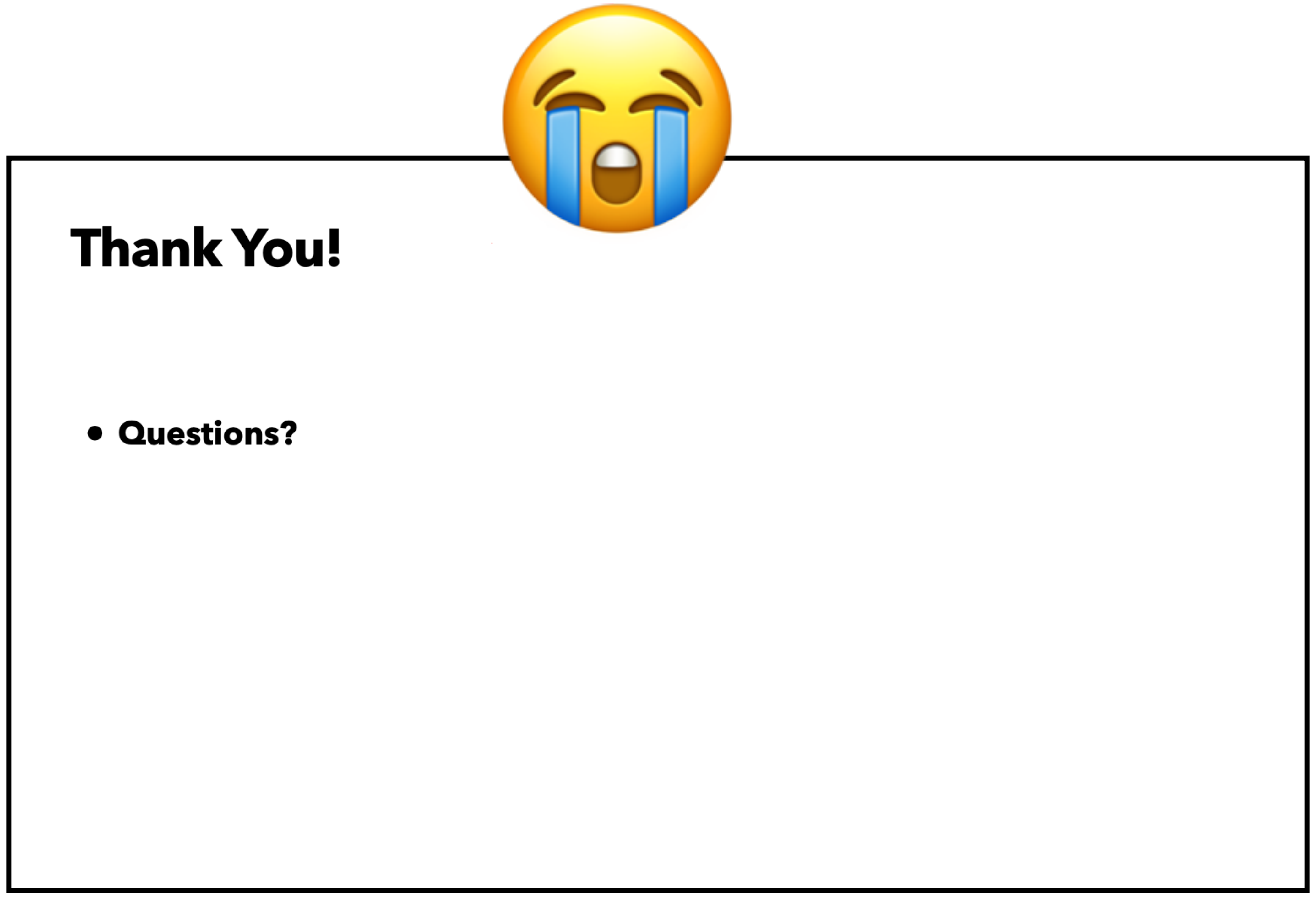
6

Use as many **figures** as possible

very little theory research done without pictures

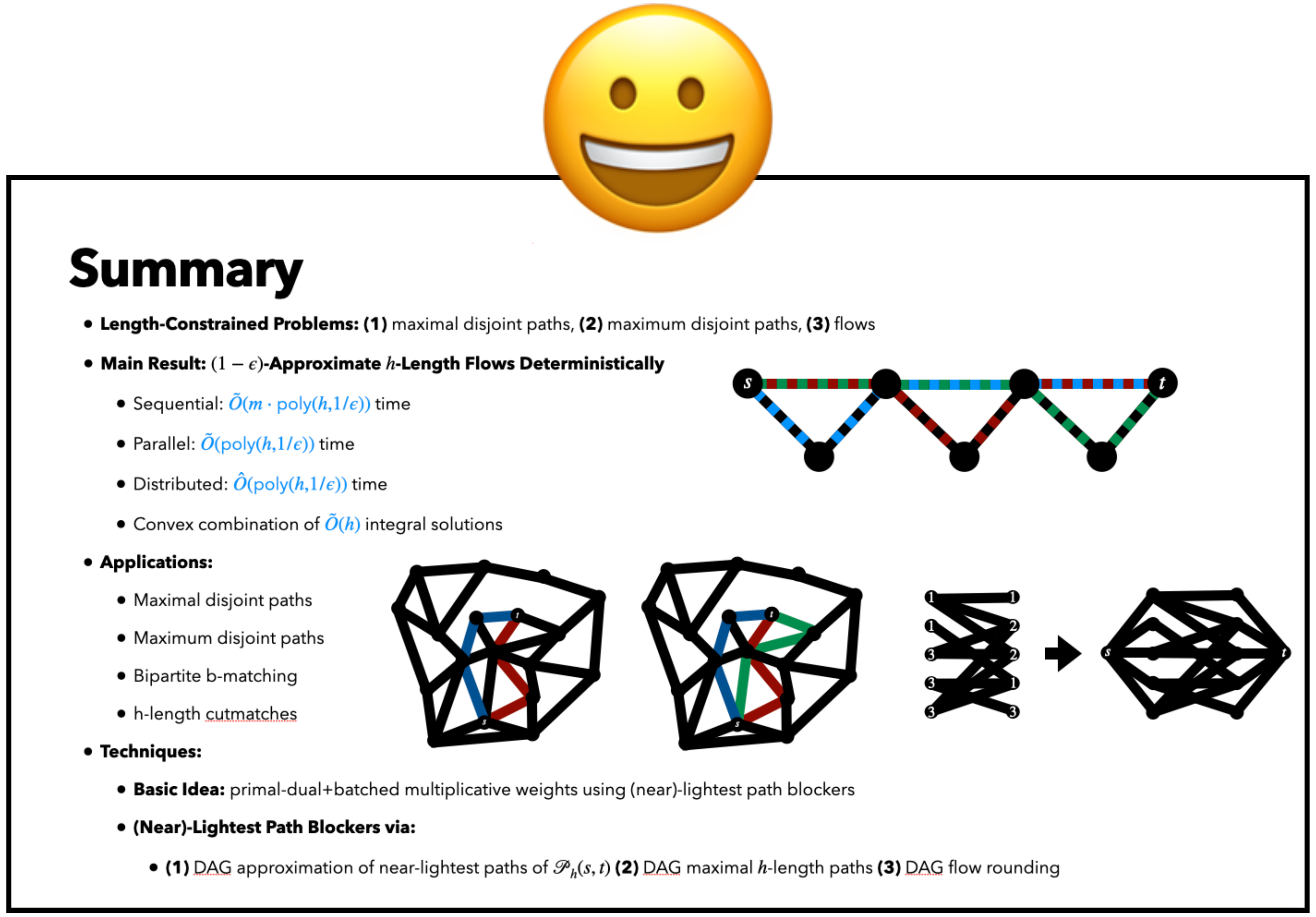
Presenting Theory Research

Slide Best Practices



Thank You!

- **Questions?**



Summary

- **Length-Constrained Problems: (1)** maximal disjoint paths, **(2)** maximum disjoint paths, **(3)** flows
- **Main Result:** $(1-\epsilon)$**-Approximate** h**-Length Flows Deterministically**
  - Sequential: $\tilde{O}(m \cdot \mathrm{poly}(h, 1/\epsilon))$ time
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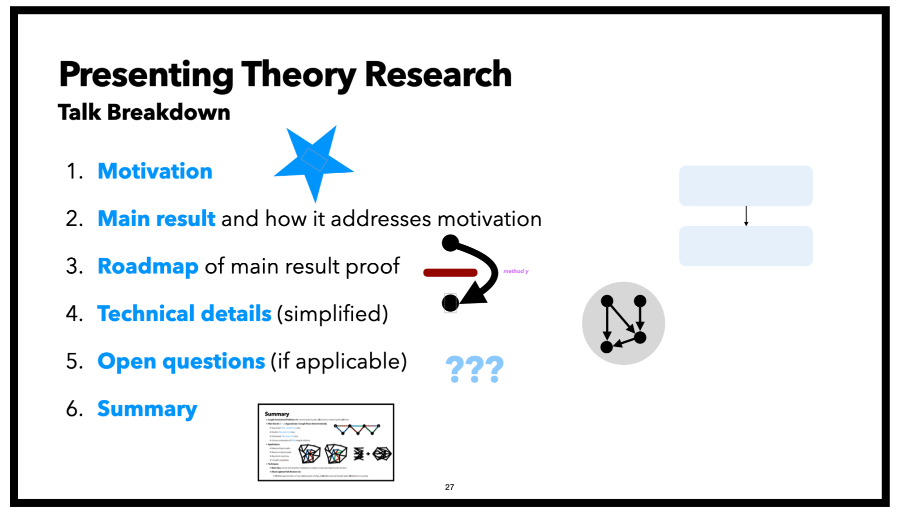
Use your **last slide to summarize**

this is your most valuable "slide real estate"

Presenting Theory Outline

1. ✓ **Talk Breakdown**



Presenting Theory Research

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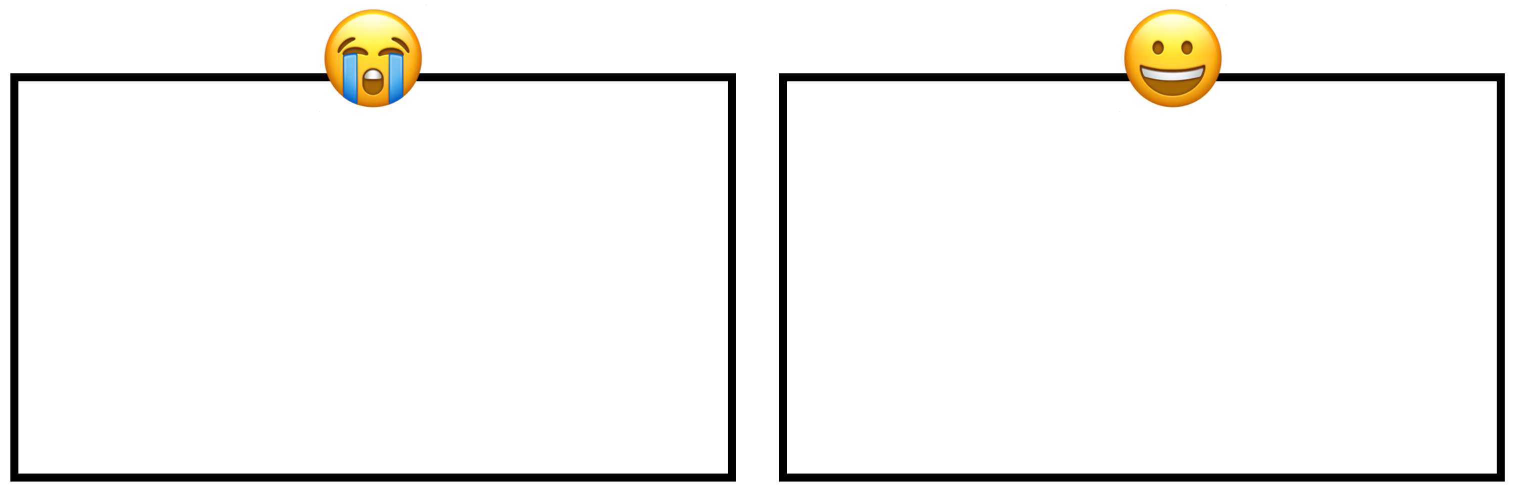

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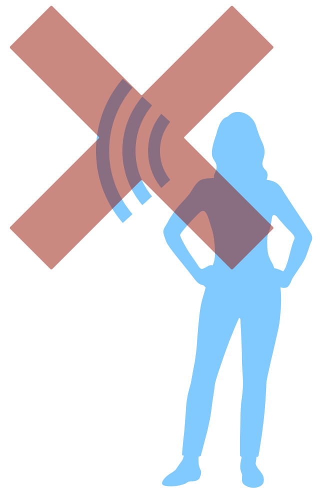

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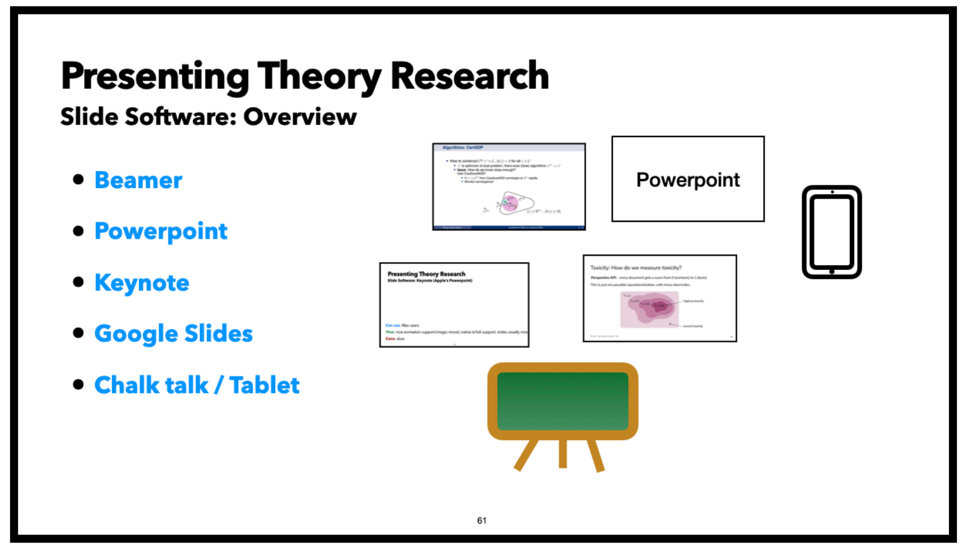

Presenting Theory Research

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Powerpoint
Presenting Theory Research
Toxicity: How do we measure toxicity?
61

Presenting Theory Outline

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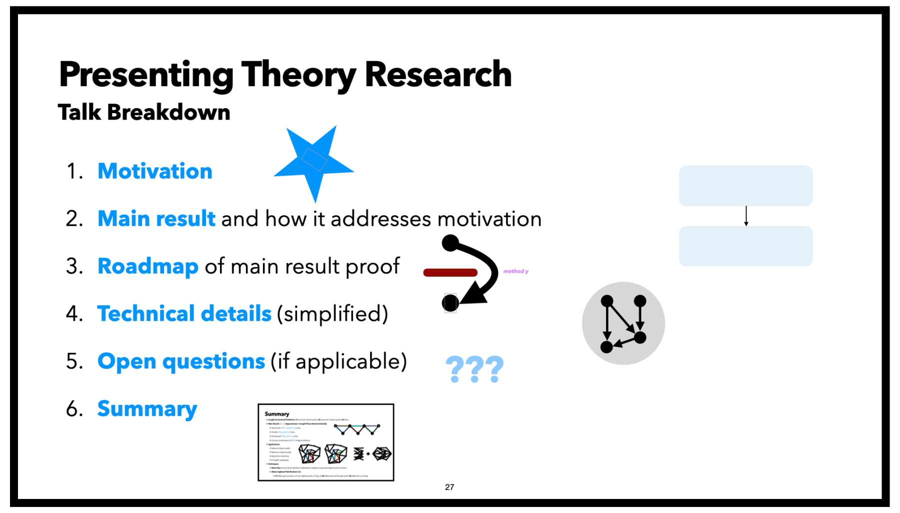

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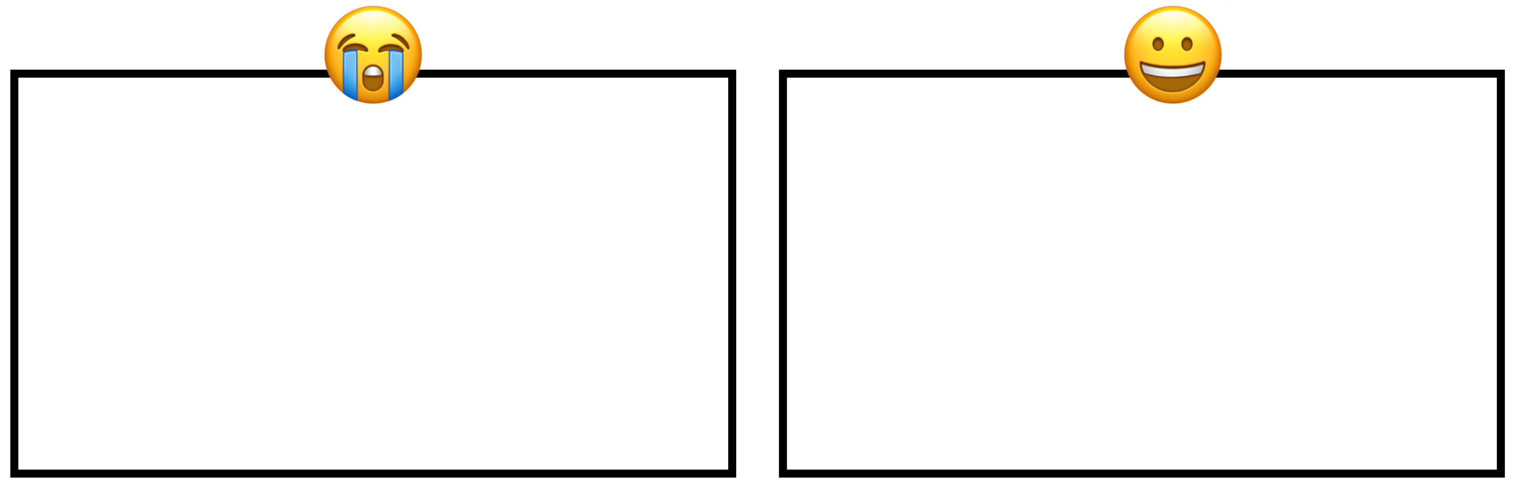

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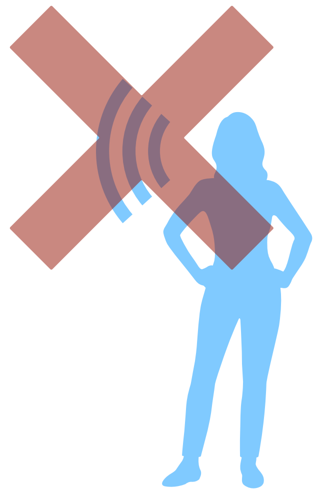

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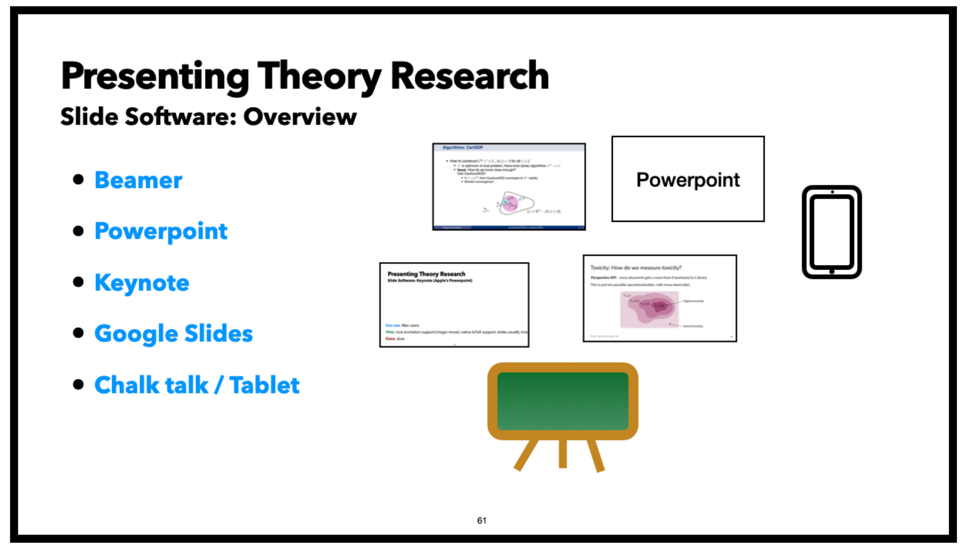

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Presenting Theory Research

Speaking Best Practices: Speaking Don’ts

- **Don’t use fillers**

  pause instead

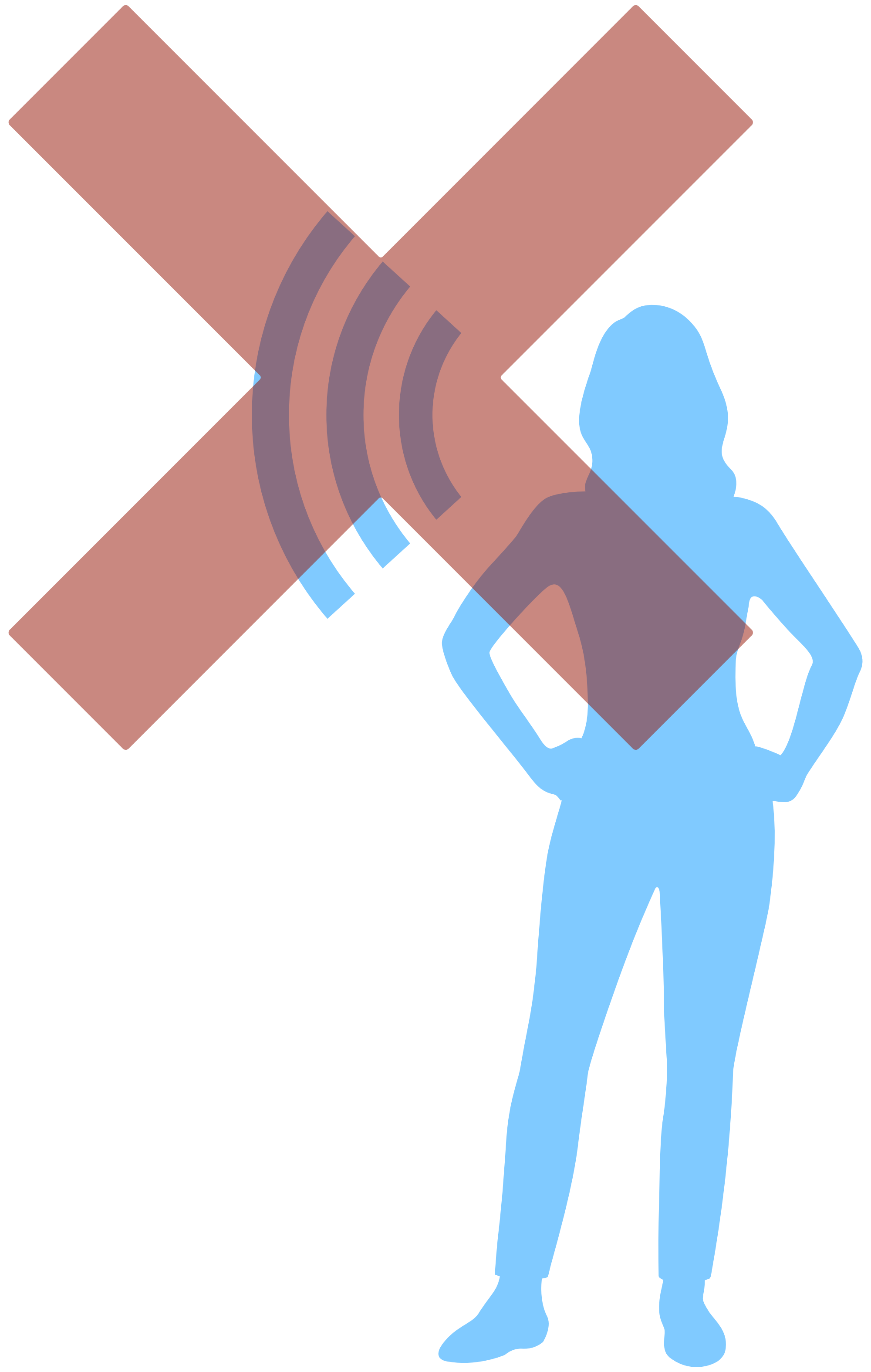
- **Don’t stand behind podium**

  at least not always, point at things on slides etc.

- **Don’t read off notes / slides**

  at least not word-for-word

- **Don’t speak too quickly / quietly**



Presenting Theory Research

Speaking Best Practices: Consider Your Audience

- **Cater talk** to audience

  if talking to non-experts then provide background

- Give audience **chances to re-onboard**

  e.g. make talk modular

- **Beginning of talk** is most valuable time

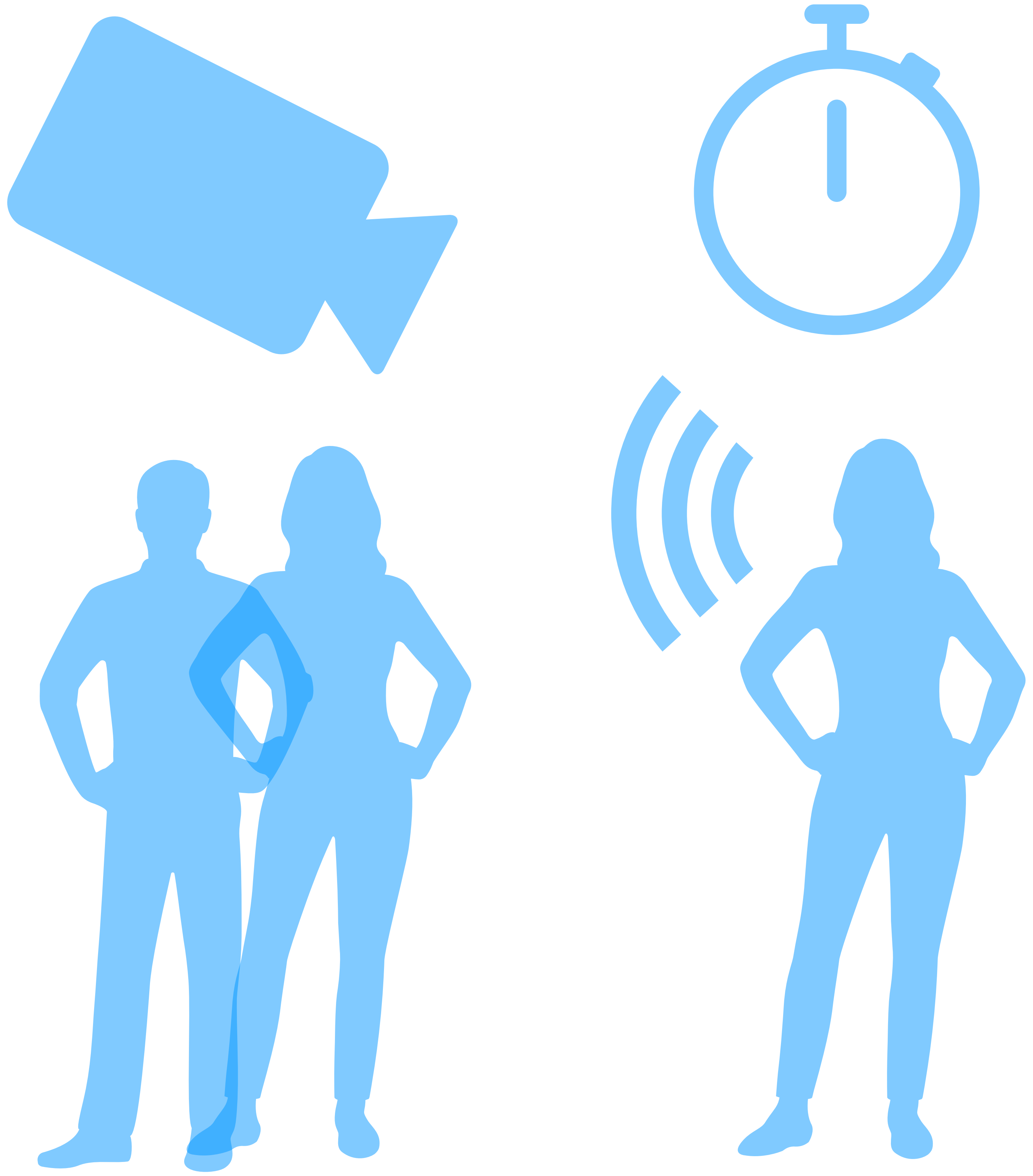
  have most audience attention here, get to main result

- **Restate questions**

Presenting Theory Research

Speaking Best Practices: Practicing

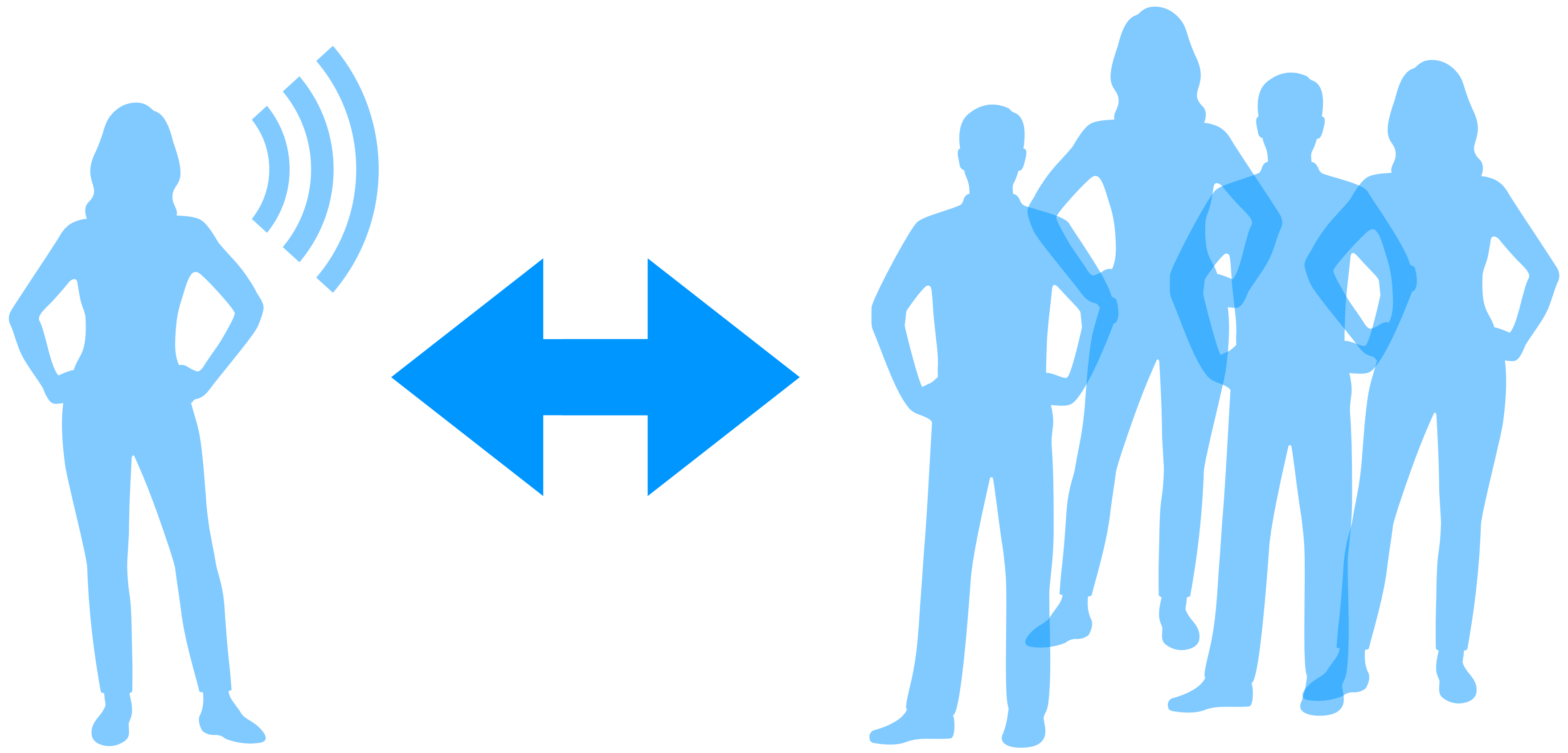
- **Practice your talk** beforehand
  - Ideally **with audience**
  - **Time yourself**
  - **Budget ~20%** of your time for questions / interruptions
  - **Record** yourself



Presenting Theory Research

Speaking Best Practices: Interactivity

- Make your talk as **interactive** as possible
  - At least **6 prepared questions** for class
  - **Pause**
    - for questions often
    - at key moments
    - be comfortable waiting awkwardly
  - **Jokes** are good (as long as they aren't bad)



Presenting Theory Research

Speaking Best Practices: Miscellaneous

- Preparing good talks **takes time**

  I usually budget ~1 week of work/hr

- Cover **a few thing well**

  speaking quickly to cover more is no fun

- All this is **aspirational**
- **Have fun!**

  orient towards chance to tell people cool stuff!

Presenting Theory Outline

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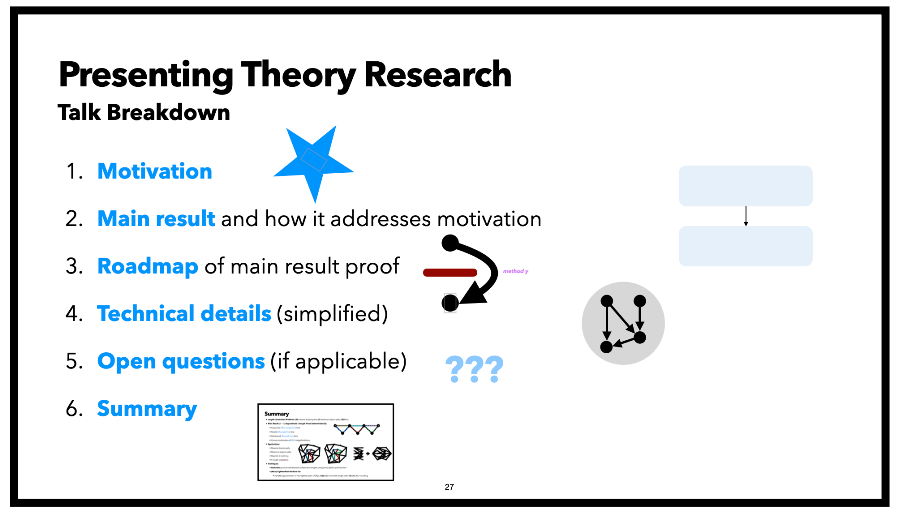

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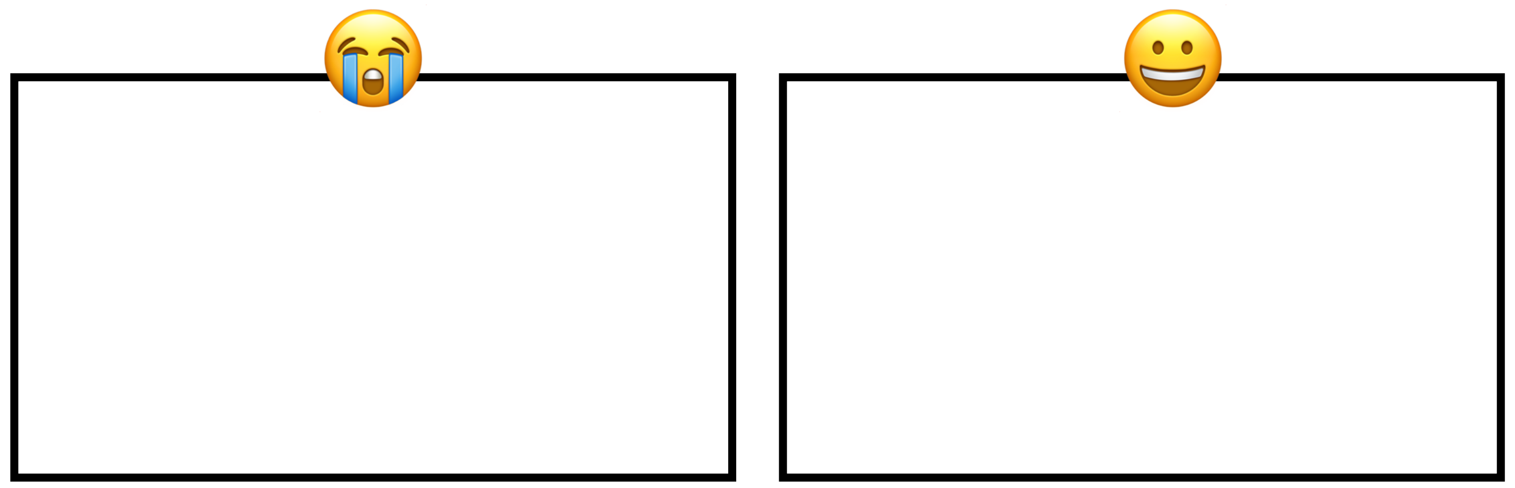

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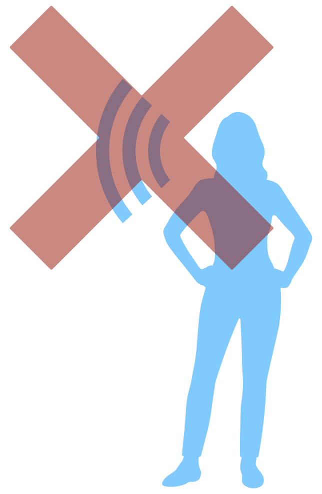

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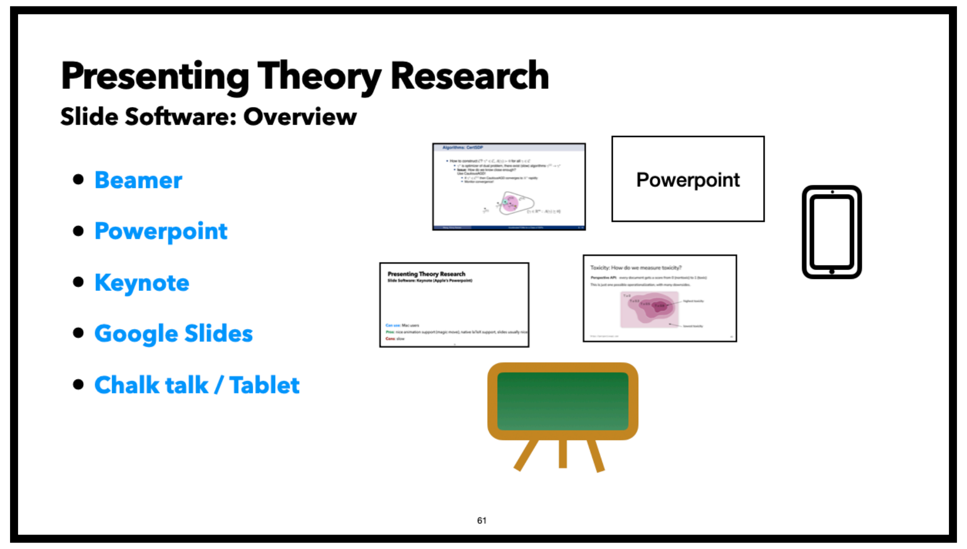

Presenting Theory Research

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Algorithms: CertSDP
Powerpoint
Presenting Theory Research
Slide Software: Keynote (Apple's Powerpoint)
Toxicity: How do we measure toxicity?

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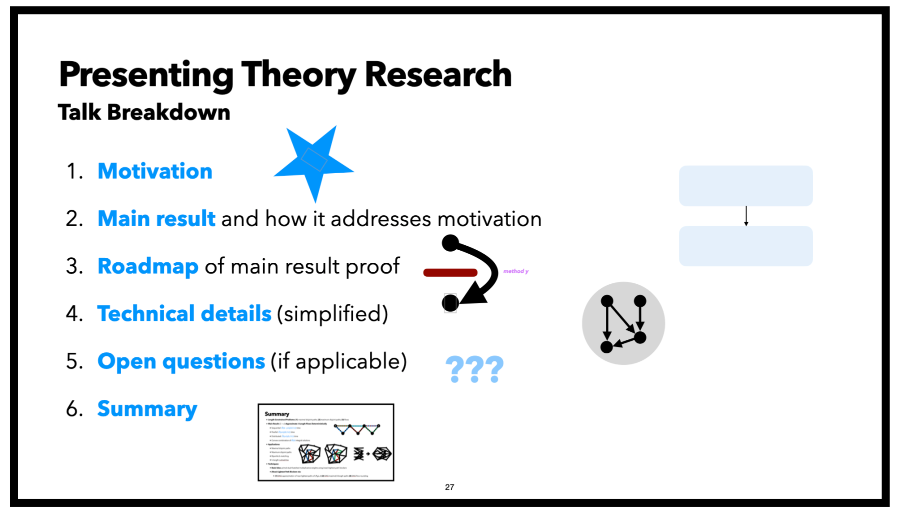

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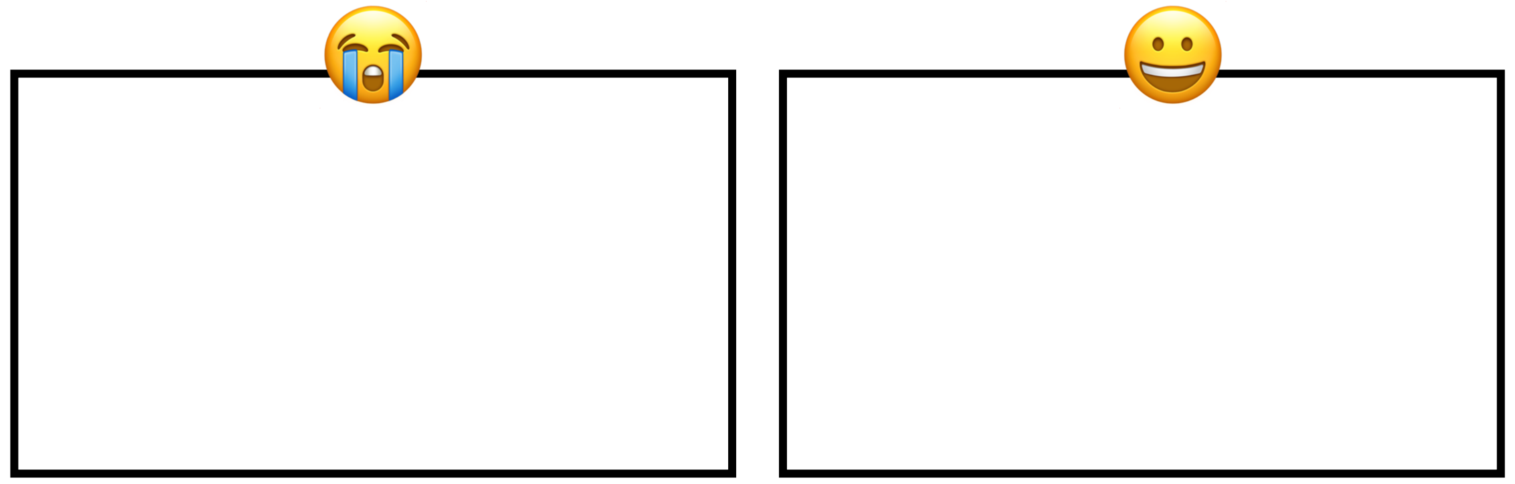

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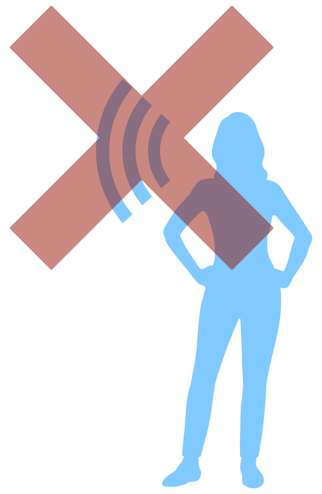

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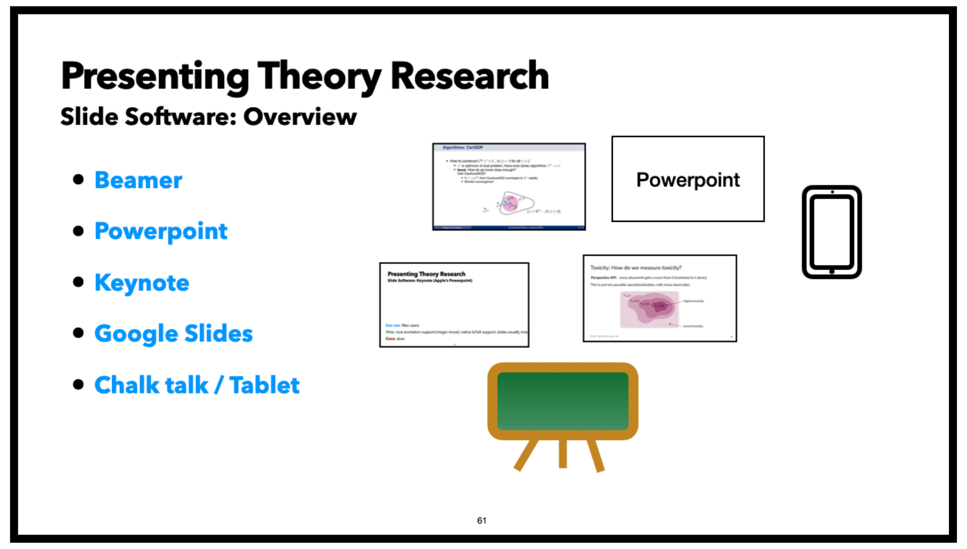

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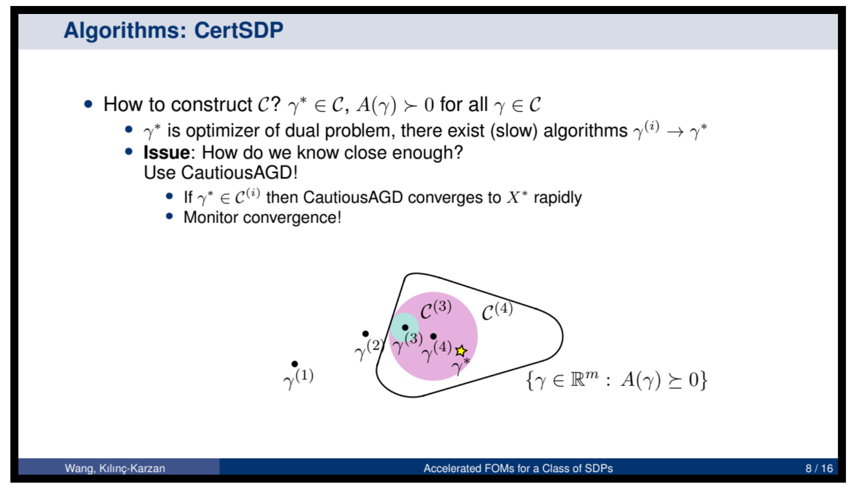
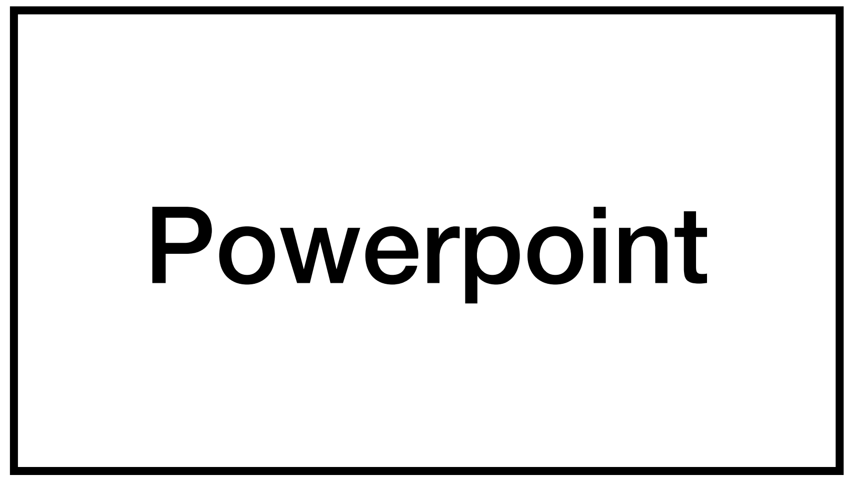


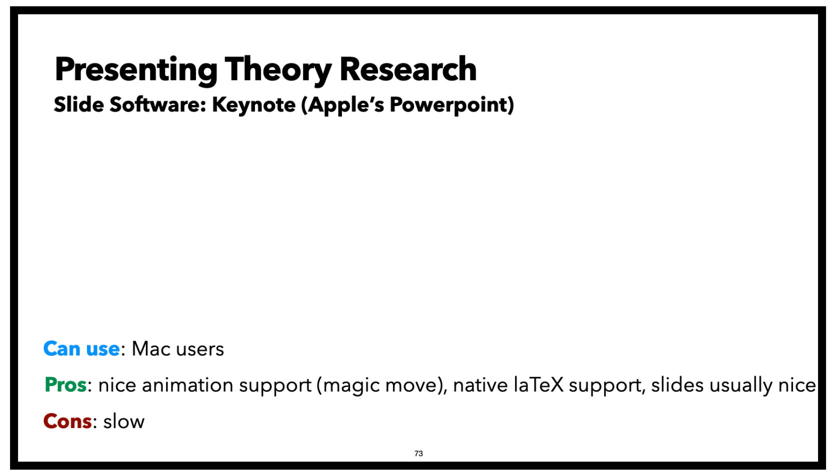
Algorithms: CertSDP

- How to construct $\mathcal{C}$? $\gamma^* \in \mathcal{C}$, $A(\gamma) \succ 0$ for all $\gamma \in \mathcal{C}$
  - γ^* is optimizer of dual problem, there exist (slow) algorithms $\gamma^{(i)} \to \gamma^*$
  - **Issue**: How do we know close enough?
    Use CautiousAGD!
    - If $\gamma^* \in \mathcal{C}^{(i)}$ then CautiousAGD converges to X^* rapidly
    - Monitor convergence!

Wang, Kılınç-Karzan Accelerated FOMs for a Class of SDPs 8 / 16



Powerpoint



Presenting Theory Research

Slide Software: Keynote (Apple's Powerpoint)

Can use: Mac users

Pros: nice animation support (magic move), native laTeX support, slides usually nice

Cons: slow

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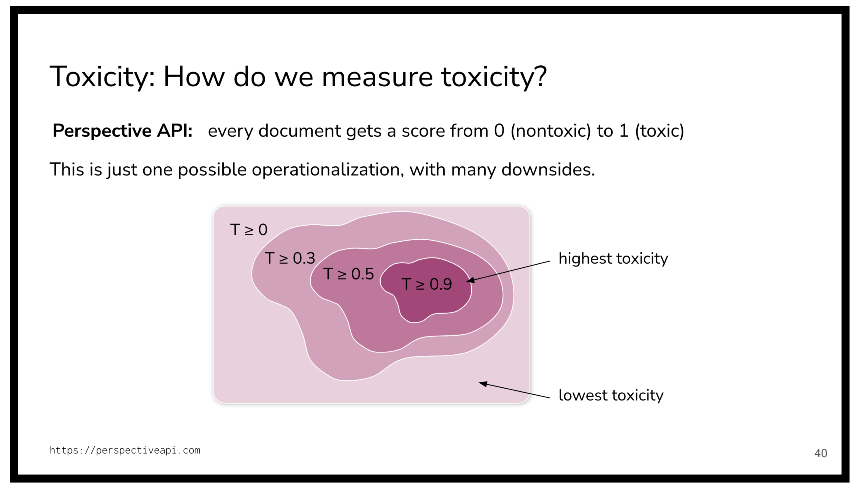


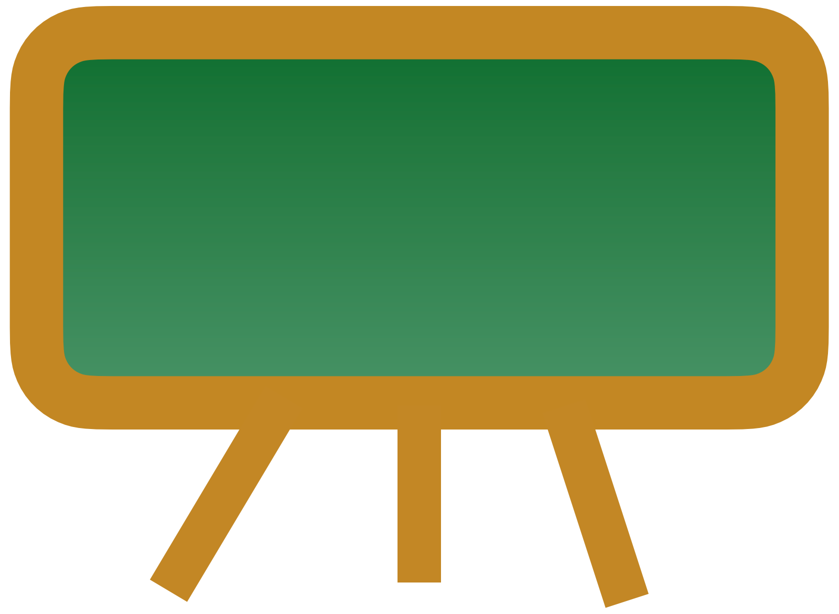
Toxicity: How do we measure toxicity?

Perspective API: every document gets a score from 0 (nontoxic) to 1 (toxic)

This is just one possible operationalization, with many downsides.

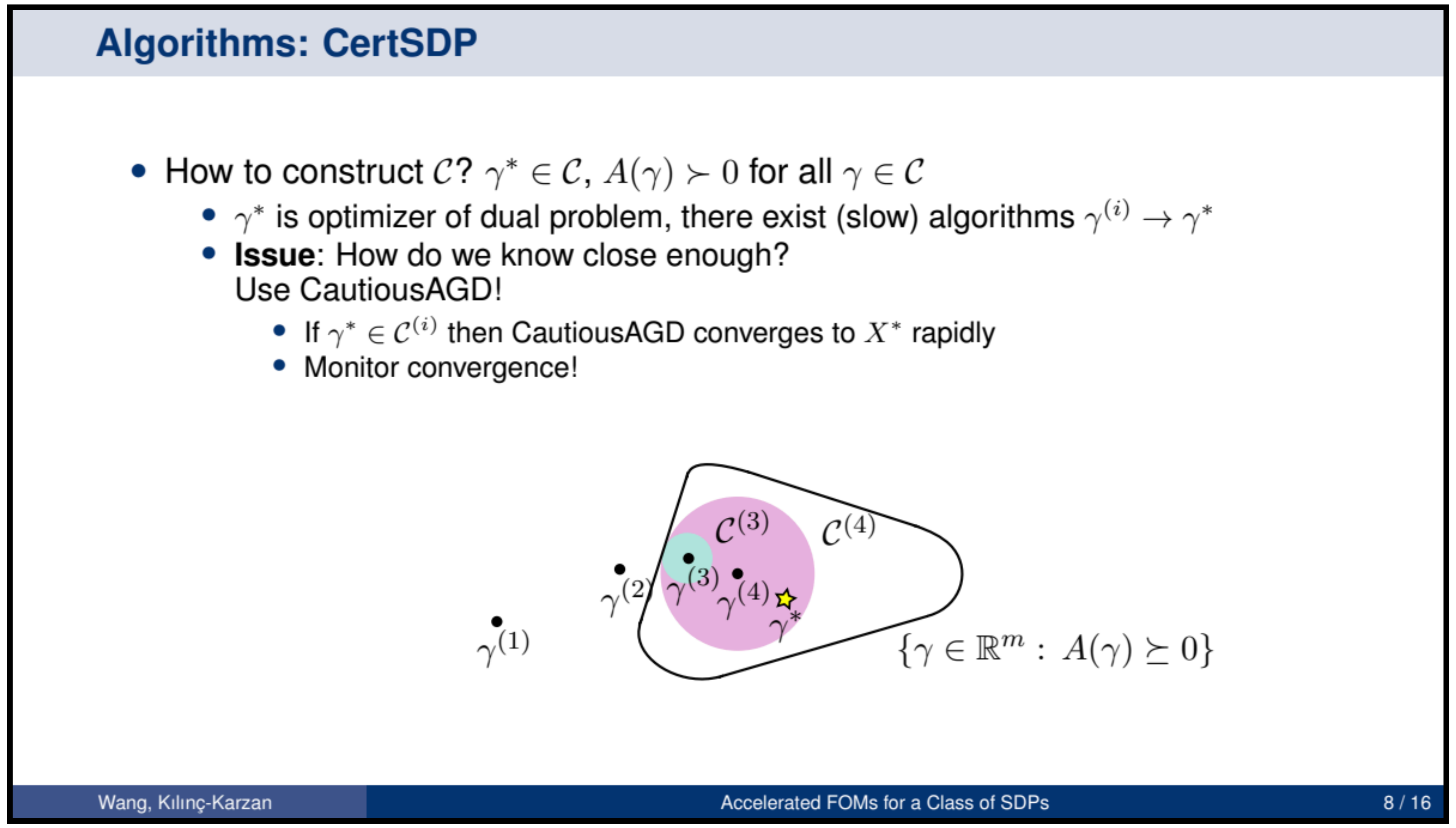
https://perspectiveapi.com

40



Presenting Theory Research

Slide Software: Beamer



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Wang, Kılınç-Karzan Accelerated FOMs for a Class of SDPs 8 / 16

Courtesy of Alex L. Wang

Can use: anybody that can write laTeX (even Overleaf etc.)

Pros: making slides similar to writing laTeX, fast, a lot of premade templates

Cons: easy to cram slides with laTeX, average talk quality low

Presenting Theory Research

Slide Software: Powerpoint

Powerpoint

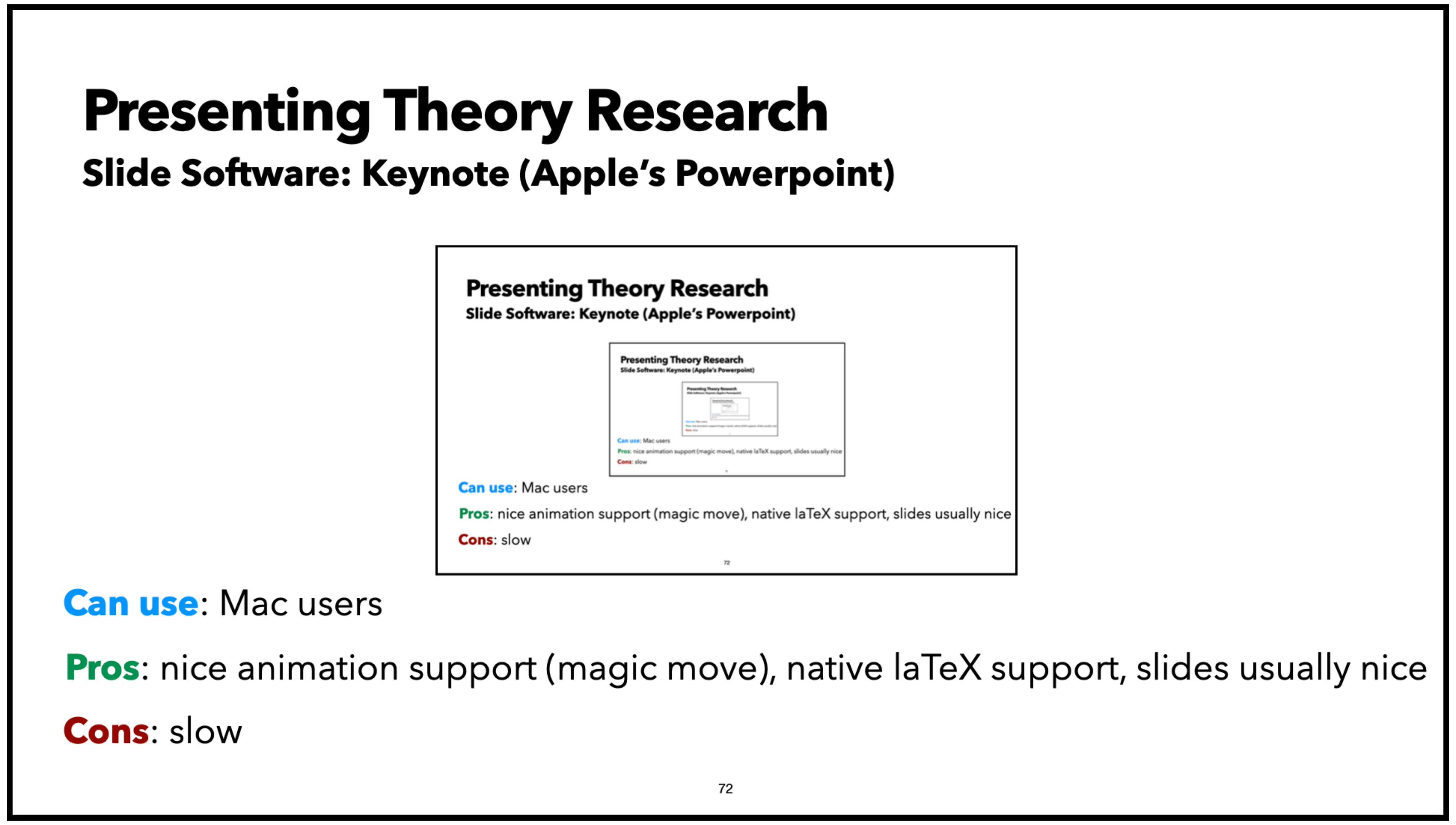
Can use: Windows users

Pros: nice animation support, native laTeX support, slides usually nice

Cons: slow

Presenting Theory Research

Slide Software: Keynote (Apple’s Powerpoint)



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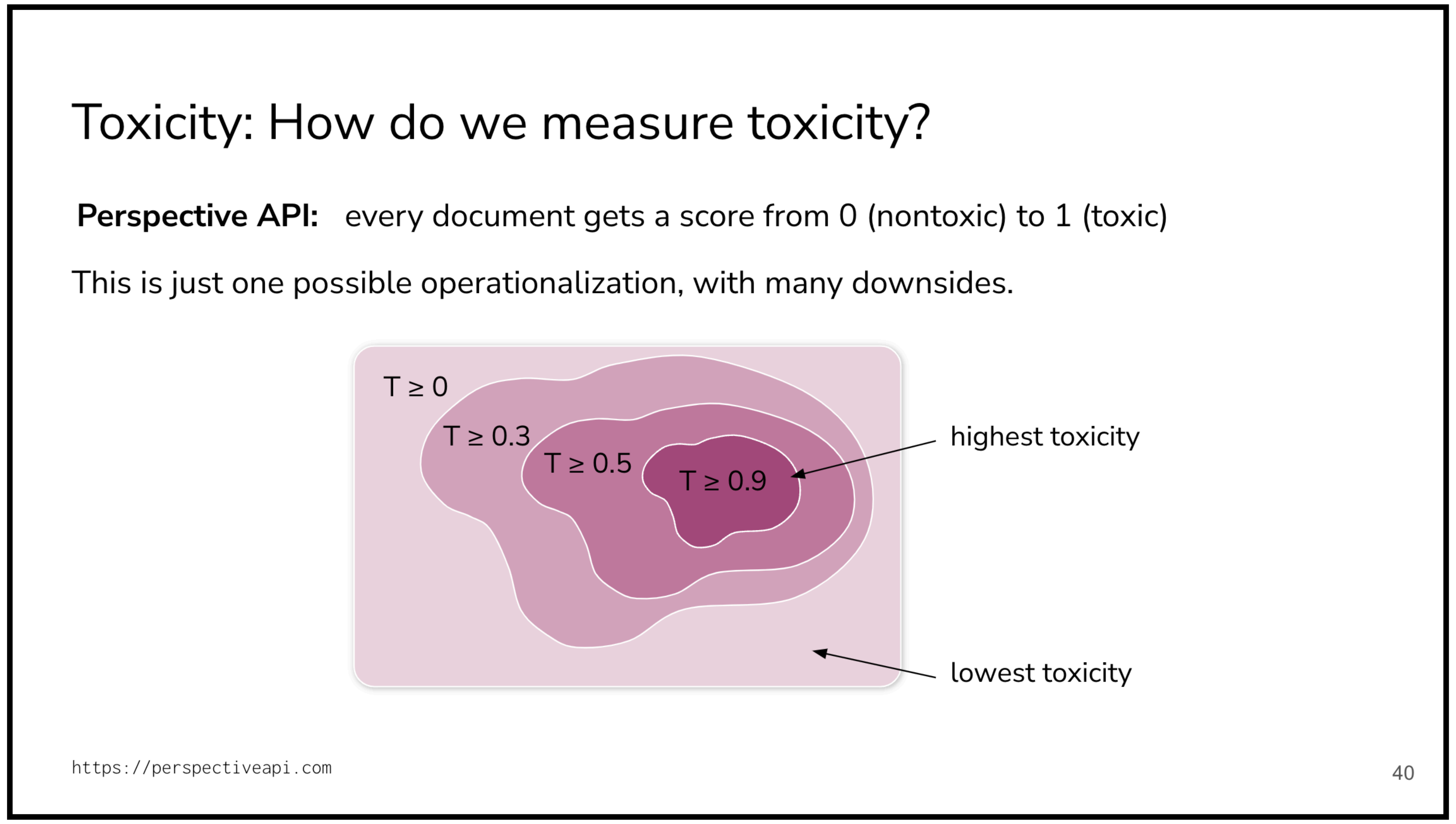
Presenting Theory Research

Slide Software: Google Slides



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https://perspectiveapi.com

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Courtesy of Greg Yauney

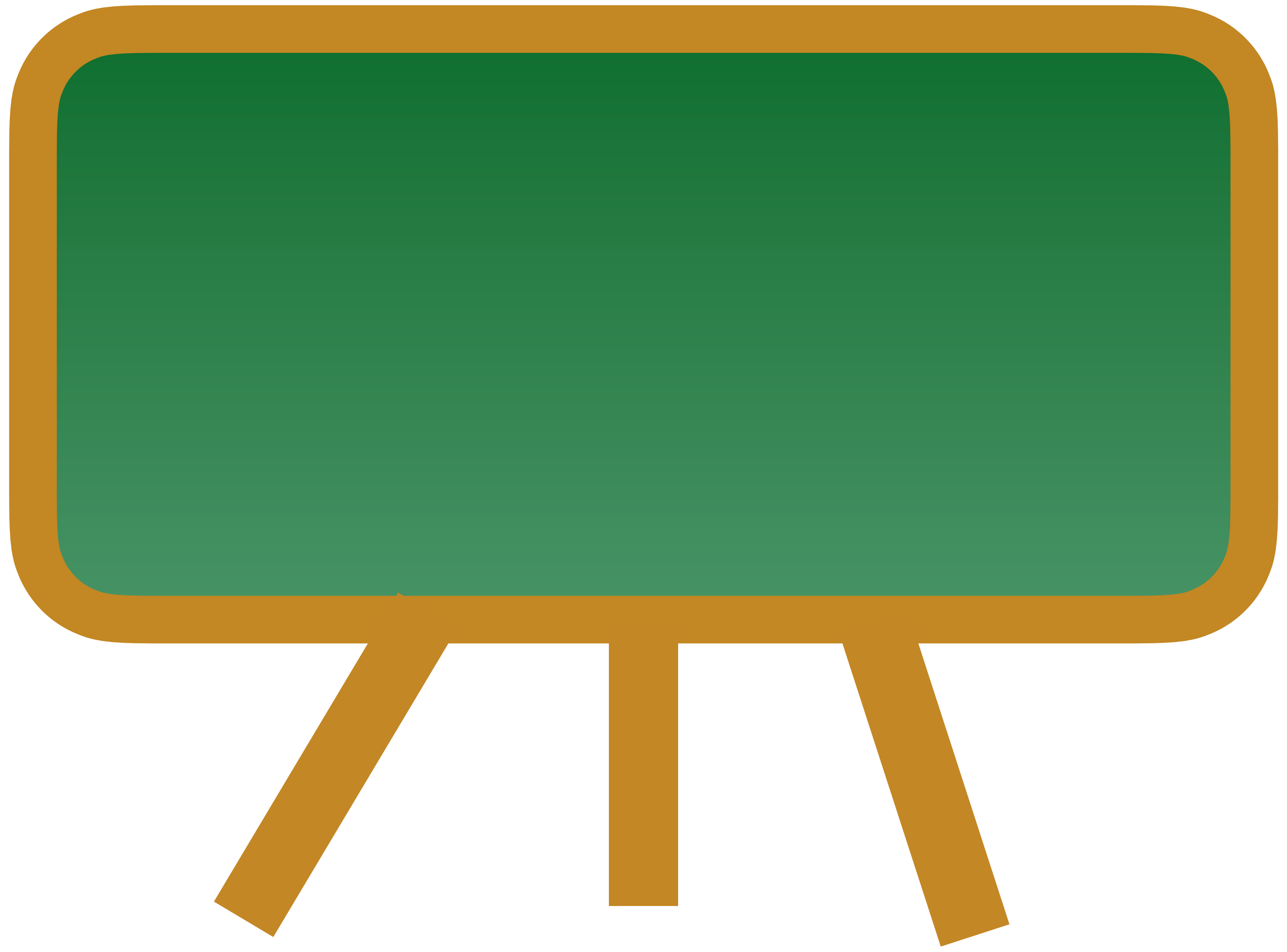
Can use: anybody with a browser

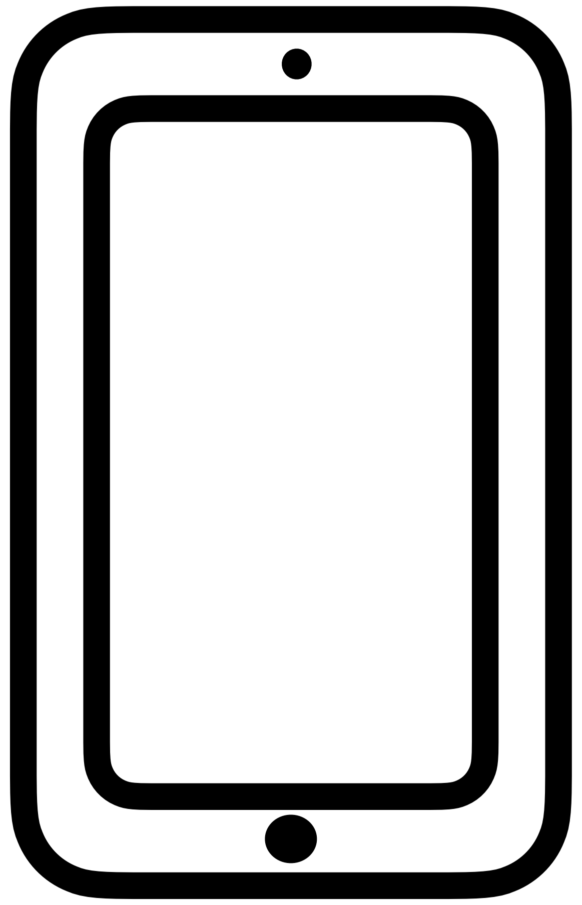
Pros: slides usually nice, easy to collaborate on a talk

Cons: slow, no native laTeX support (have to use e.g. *https://latex2png.com/*)

Presenting Theory Research

Slide Software: Chalk Talk





Can use: anybody

Pros: forces you to present slowly, easy to use many pictures, pre-draw on tablet

Cons: can waste time drawing figures, hard to pace correctly, annoying to practice

Presenting Theory Outline

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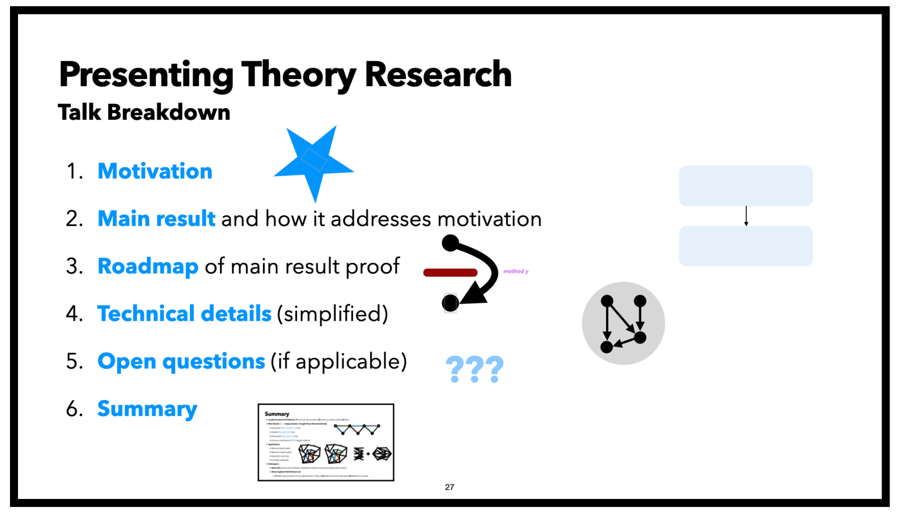

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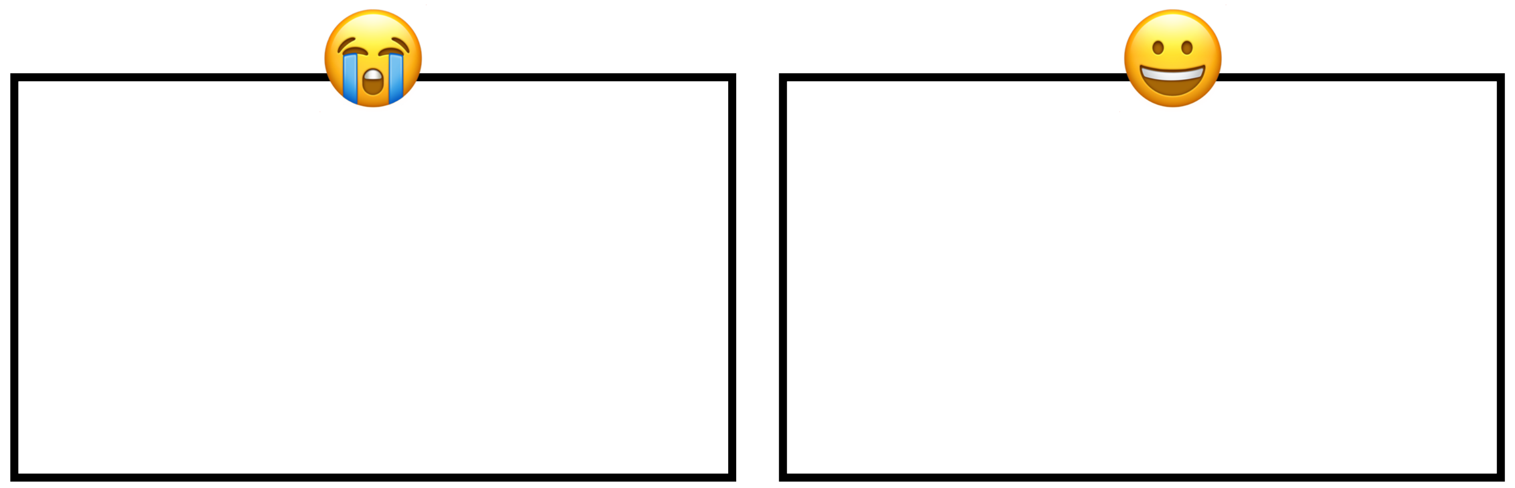

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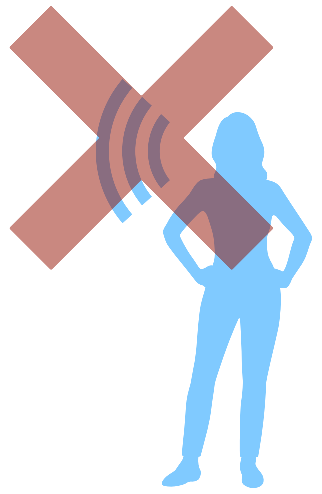

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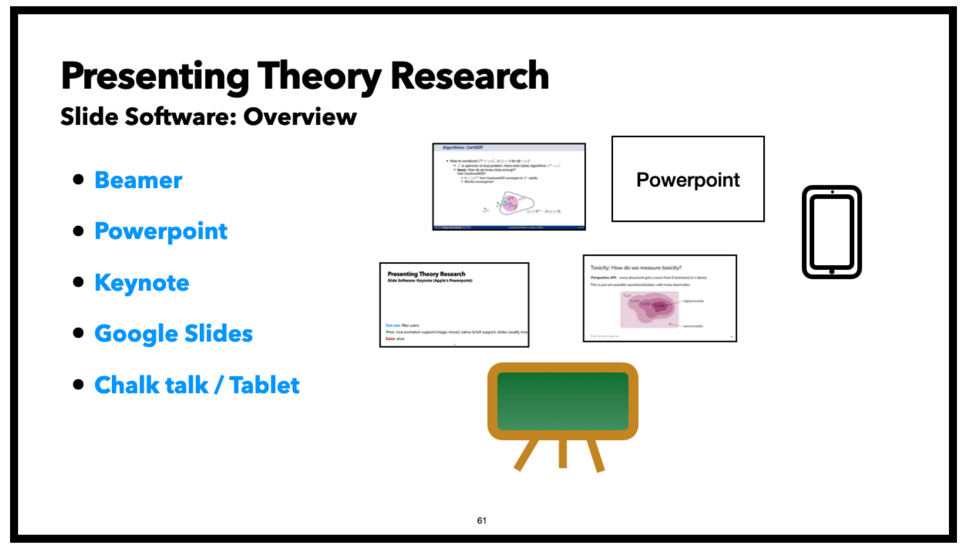

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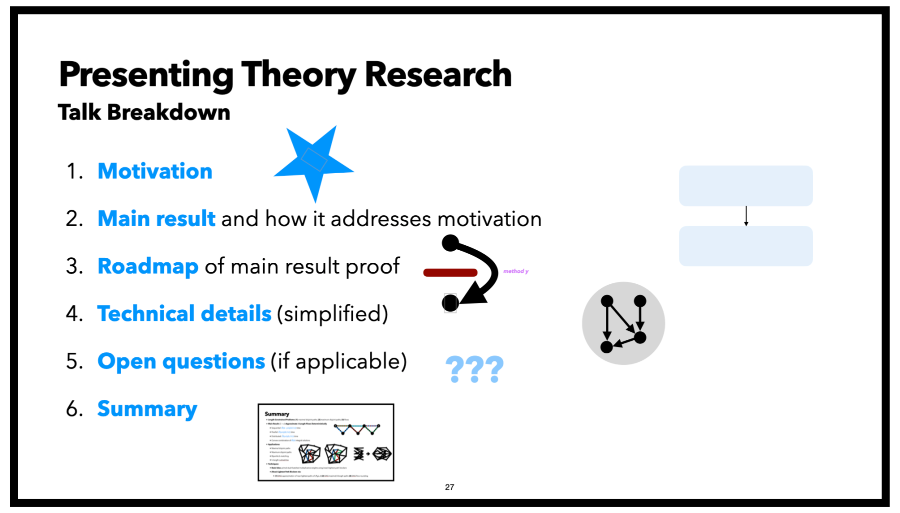

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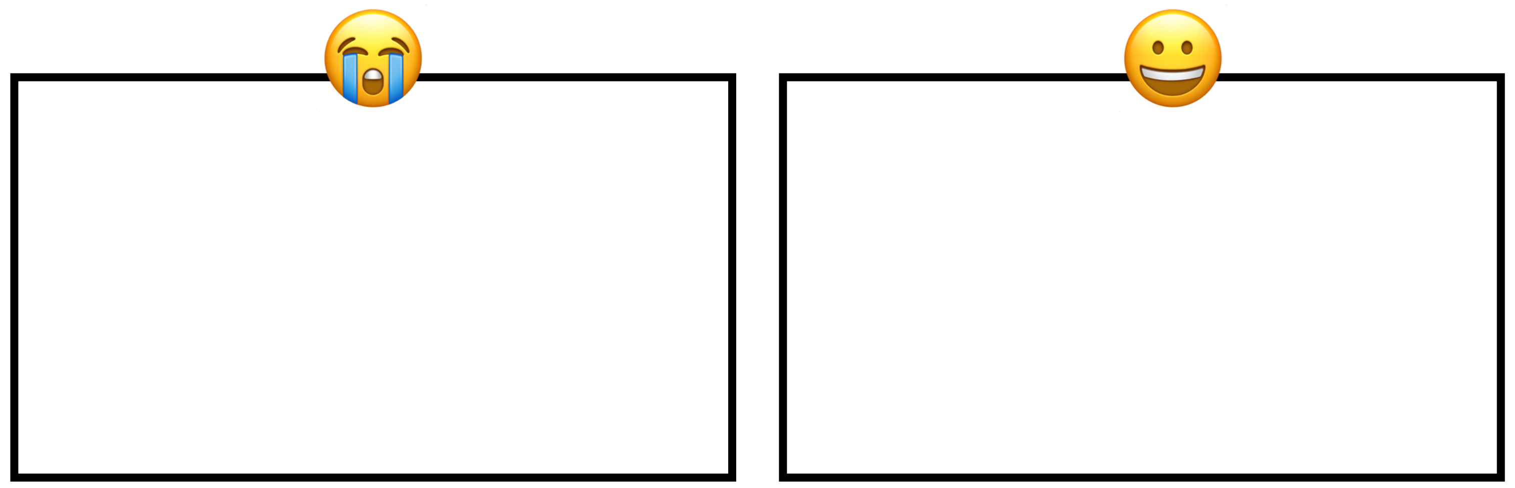
✓ 2. Slide Best Practices



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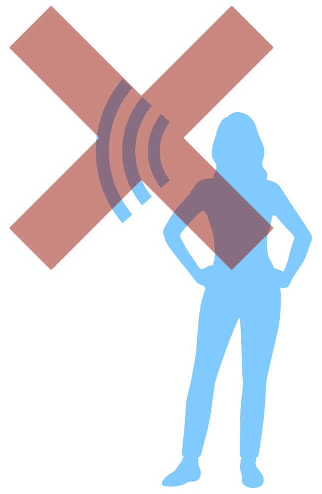
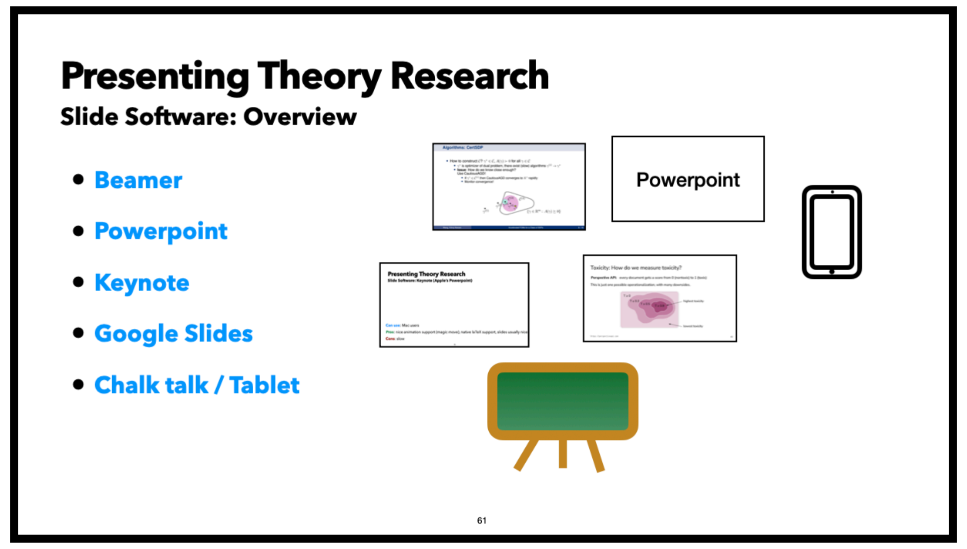


✓ 4. Presenting Software



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Some Nice Algorithms Talks

- **Roie Levin** (@ Rutgers, Brown Alum!): https://www.youtube.com/watch?v=a4y0u6mgFYU
- **Ellen Vitercik** (@ Stanford): https://www.youtube.com/watch?v=3_6A_Qof9MI
- **Thatchaphol Saranurak** (@ U. Mich.): https://www.youtube.com/watch?v=4tTdU08_YBo&list=PLVw32sKsg0NuBGS8rqsRFxKAq5pYhzd2K
- **Merav Parter** (@ Weizmann): https://www.youtube.com/watch?v=_nVHZT1onlU
- **Jelani Nelson** (@ Berkeley): https://www.youtube.com/watch?v=svTs3yJl7-8
- **Anupam Gupta** (@ CMU): https://www.youtube.com/watch?v=HUYUQJQm_10
- **Rico Zenklusen** (@ ETHZ): https://www.youtube.com/watch?v=nMSIEoRQvvI

(Other resources/ blog posts on course webpage)

Listening to Theory Research

Listening to Theory Research

Top-Level Goal

Get a taste of this

How Theory Problems are Solved

1. Isolate a toy **model case x** of major **problem X**.
2. Solve **model case x** using **method A**.
3. Try using **method A** to solve the full **problem X**.
4. This does not succeed but **method A** can be extended to **model cases x' and x''**.
5. Eventually, it is realized that **method A** relies crucially on a **property P** being true which holds for **model cases x, x' and x''**.
6. Conjecture that **property P** is true for all instances of **problem X**.
7. Discover a family of **counterexamples y, y', y''**,… to this conjecture.
8. Take the simplest **counterexample y** in this family, and try to solve **problem X** for this special case. Meanwhile, try to see whether **method A** can work without **property P**
9. Discover several counterexamples in which **method A** fails, in which the cause of failure can be definitely traced back to **property P**. Abandon efforts to modify **method A**.
10. Realize that **counterexample y** is related to a **problem Z** in another field.

…

22. **Method Z** is rapidly developed and extended to get the **solution** to **problem X**.

ACTIVE

≈Terry Tao

Listening to Theory Research

Goals at End

- A general **roadmap** of the paper

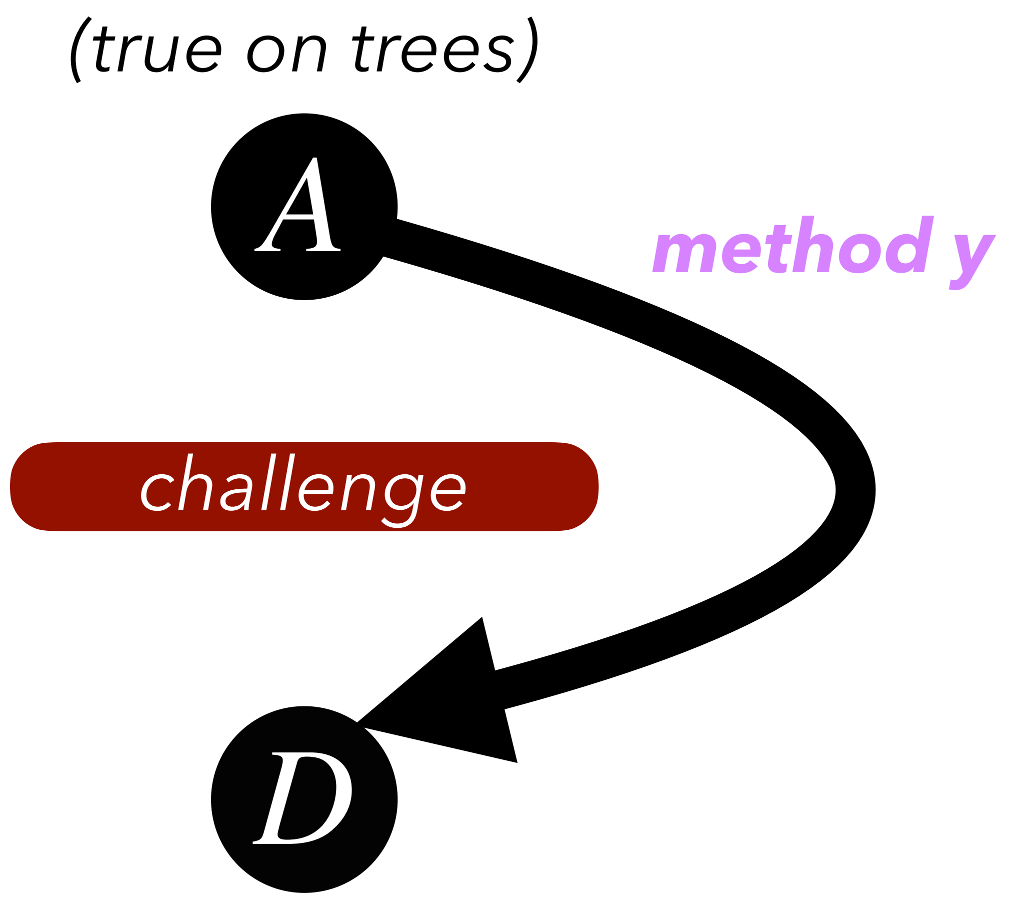
  authors not thinking in line-by-line calculations

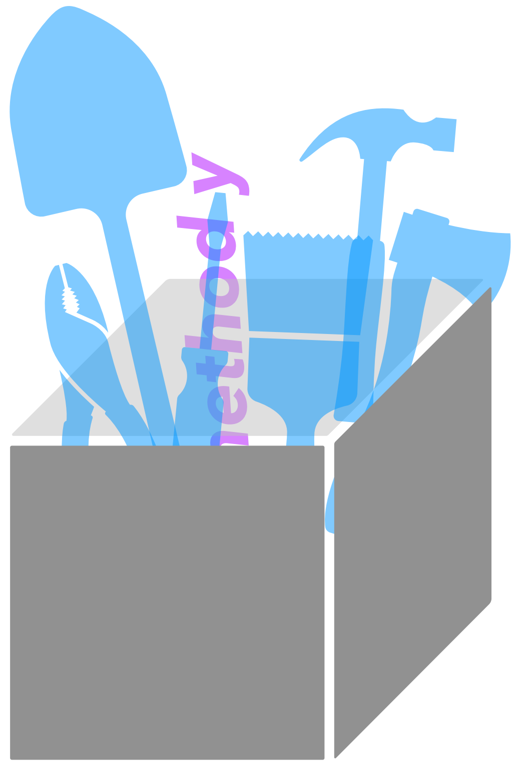
- Easy-to-remember **tools**, special-case proofs

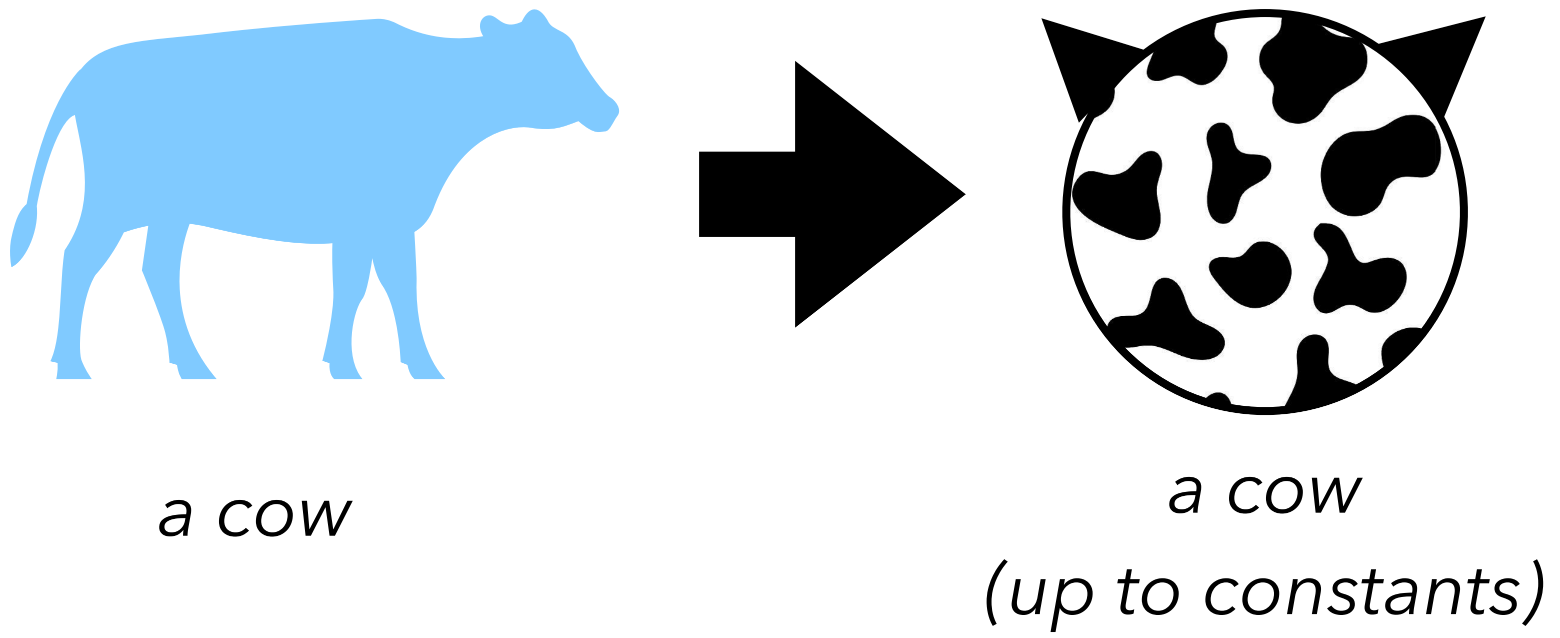
  usually only a few crucial insights / paper

- **Intuition**

  of how to think about complexity simply







Listening to Theory Research

Make it Active for Yourself

- Via **“reading theory” recs**

  guess what’s coming, try to simplify, etc.

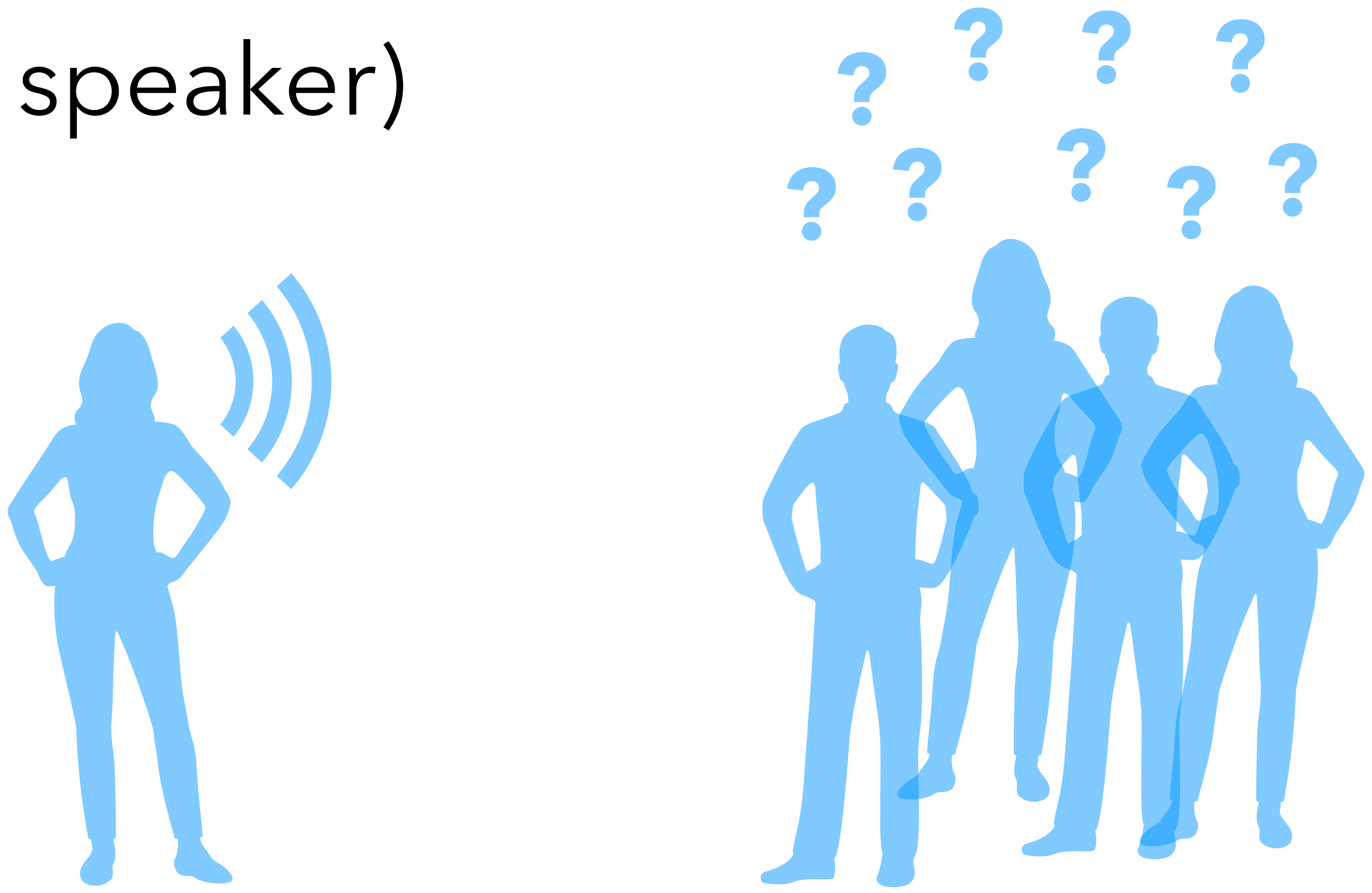
- **Asking questions** (good for you, audience and speaker)

  out loud or in your head

- **Answering questions**

  (mostly) in your head; be nice to speaker

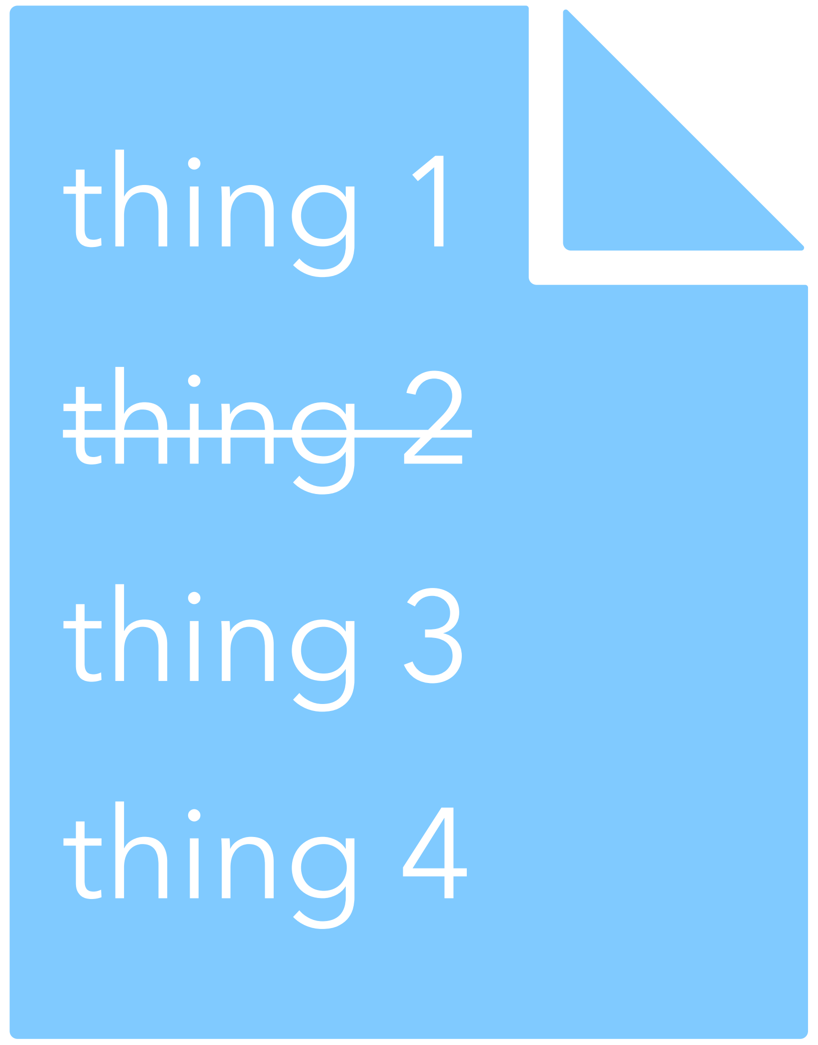
- **Three Things Exercise**



Listening to Theory Research

Three Things Exercise (of Ravi Vakil @Stanford)

- **Goal:** (exactly) three things to remember from talk
  - Definition
  - Theorem
  - Nice simple proof / intuition
  - Cute motivation
  - A follow-up question to work on
- During talk write down things as they come; if you exceed three, delete one



thing 1

~~thing 2~~

thing 3

thing 4

Listening to Theory Research

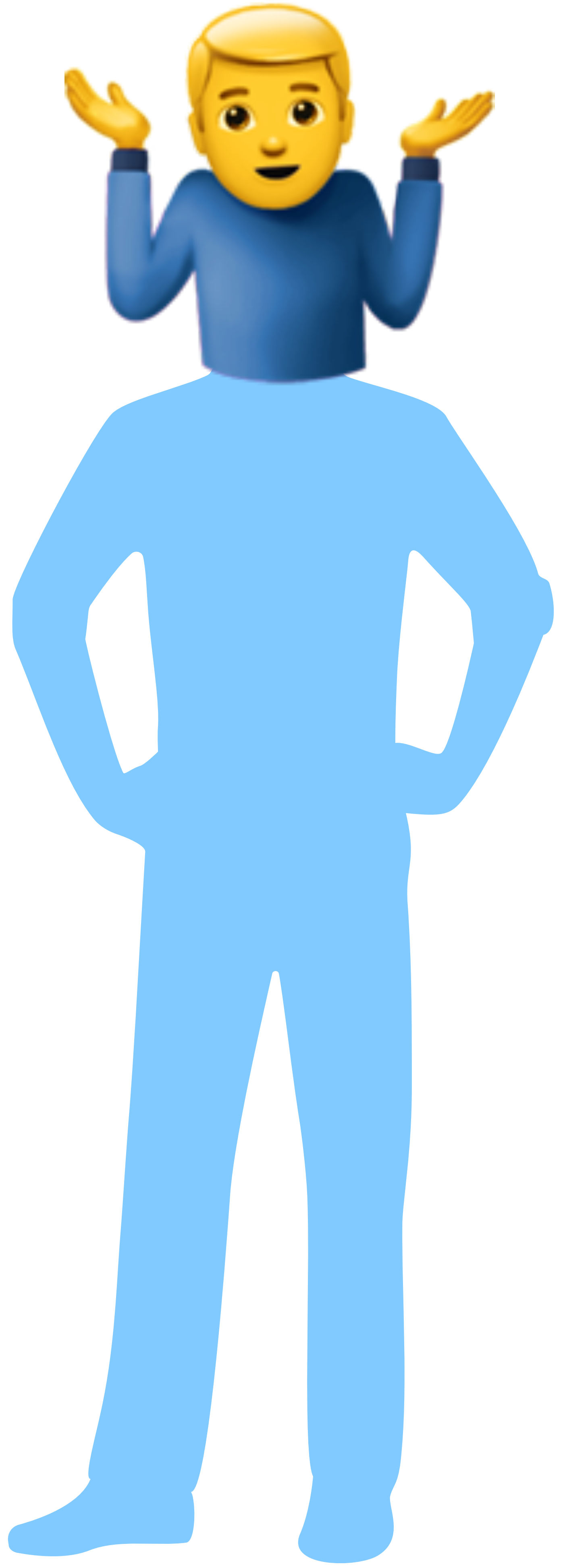
General Tips on Getting Lost

- Most **talks are bad**

  confusion is often well-justified

- If you get lost look for **chances to re-onboard**

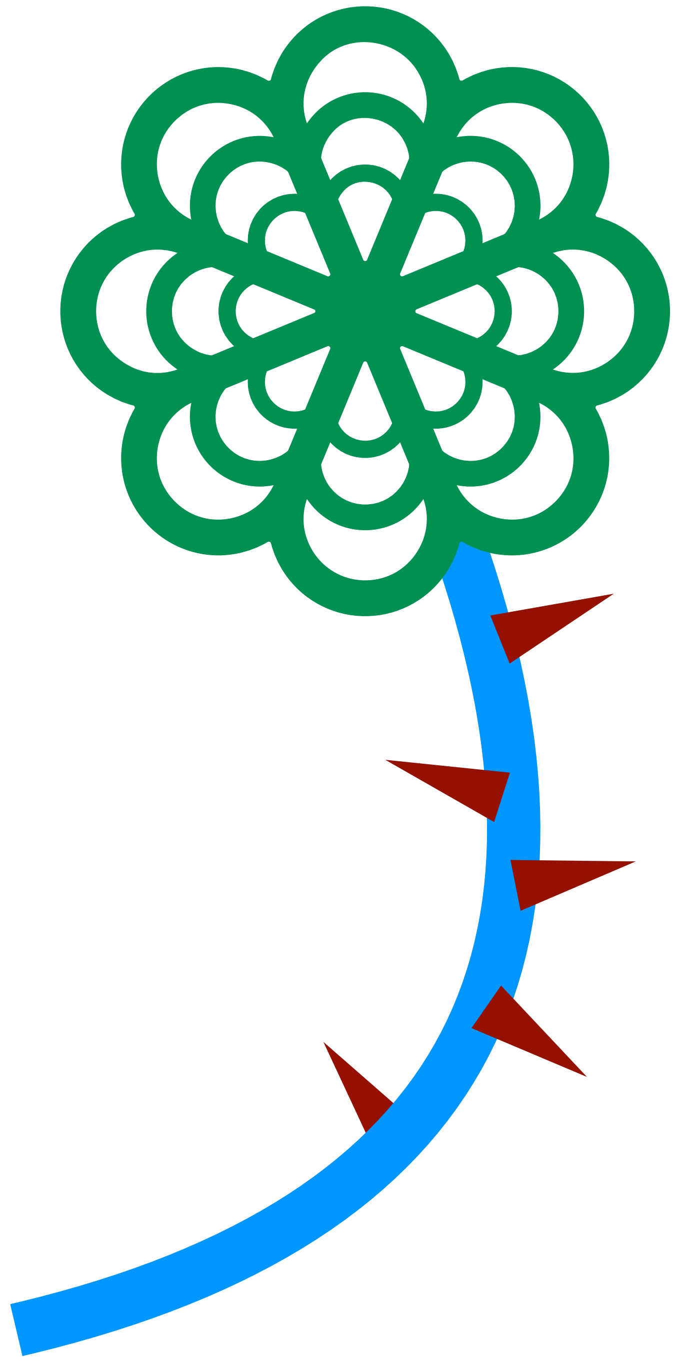
  or ask for them



Listening to Theory Research

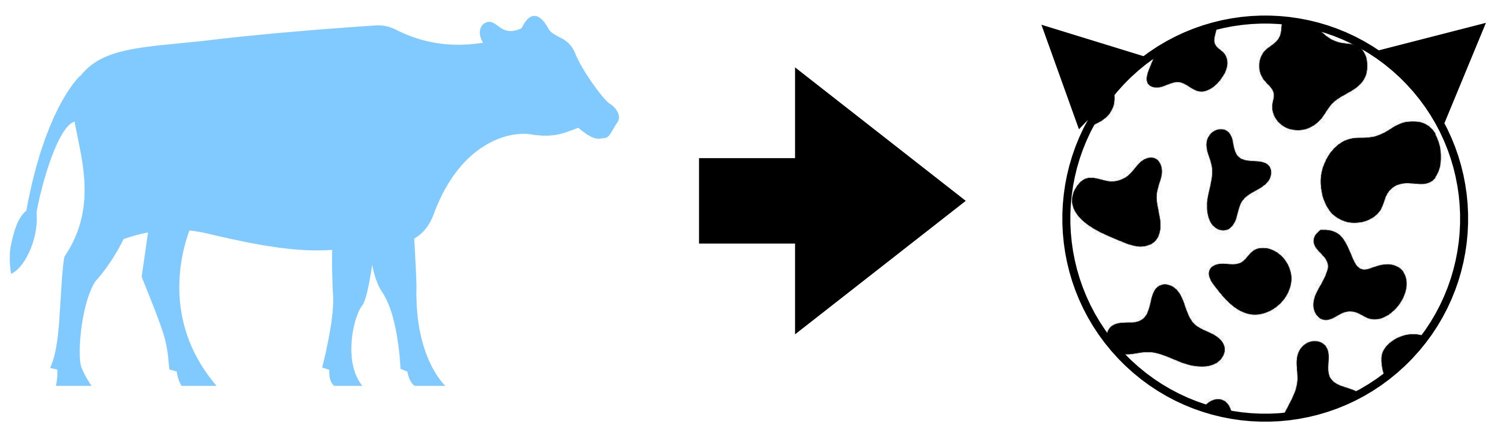
Crits in This Class

- Last **~15 minutes** of talk
- **rose** + **thorn**: try to give one thing done well, one confusion / improvement
- Chance for you to get a sense of:
    - What **you** did/didn't like for your talk(s)
    - What the **audience** did/didn't like

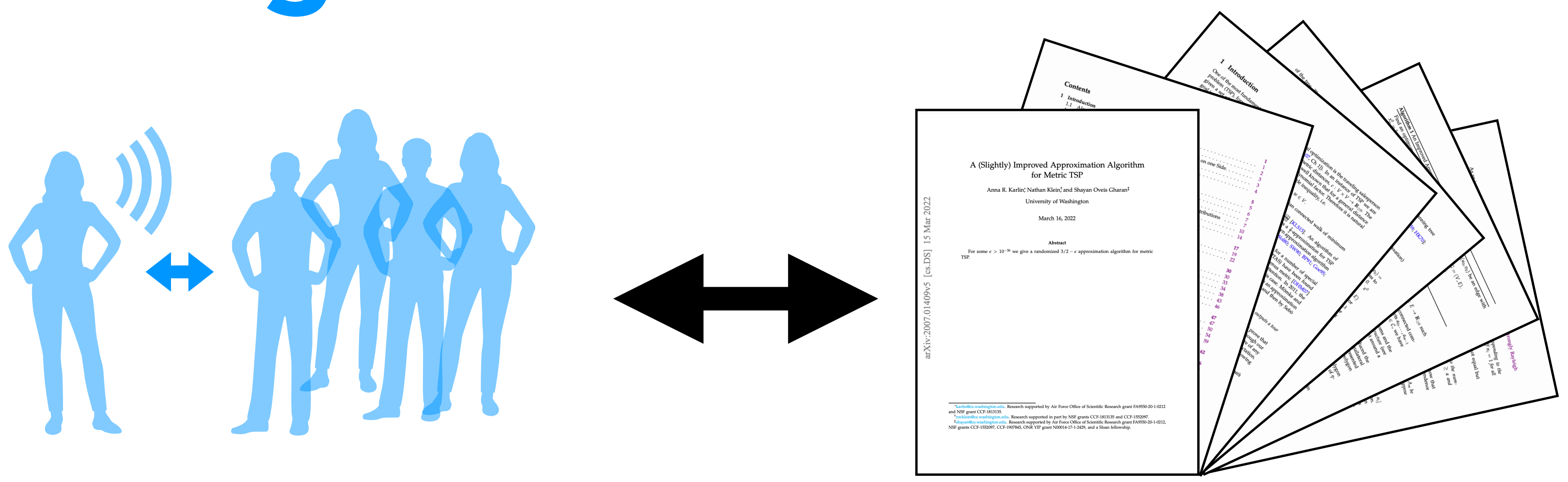


Summary

- Doing theory is **active**
- **Reading**



- **Presenting**



1 hour presentation

93 pages

- **Listening**

How Theory Problems are Solved

1. Isolate a toy **model case x** of major **problem X**.
2. Solve **model case x** using **method A**.
3. Try using **method A** to solve the full **problem X**.
4. This does not succeed but **method A** can be extended to **model cases x′ and x′′**.
5. Eventually, it is realized that **method A** relies crucially on a **property P** being true which holds for **model cases x, x′ and x′′**.
6. Conjecture that **property P** is true for all instances of **problem X**.
7. Discover a family of **counterexamples y, y′, y′′**, ... to this conjecture.
8. Take the simplest **counterexample y** in the family, and try to solve **problem X** for this special case. Meanwhile, try to see whether **method A** can work without **property P**
9. Discover several counterexamples in which **method A** fails, in which the cause of failure can be definitely traced back to **property P**. Abandon efforts to modify **method A**.
10. Realize that **counterexample y** is related to a **problem Z** in another field.

• • •

22. **Method Z** is rapidly developed and extended to get the **solution** to **problem X**.

ACTIVE

≈Terry Tao