

STEFAN NEUMANN

WHAT IT'S LIKE DOING RESEARCH AND A PH.D.

INSPIRED BY A PAINTING
OF LÁSZLÓ FEHÉR

BEFORE WE GET TO THE PAINTING

WHAT I TOLD THE FIRST SEMESTER STUDENTS

- ▶ Computer science is advancing rapidly;
you need to stay on top of the game
 - ▶ 2000s: The internet expands, the first online social networks emerge
 - ▶ 2010s: Mobile internet, Big Data, Deep Learning
 - ▶ 2020s (so far): Generative AI, Large Language Models
- ▶ The technologies behind them are often quite different
- ▶ You need good foundations
- ▶ What I did not tell the first semester students:
 - ➡ You **ALWAYS** have to do research

COMPUTER SCIENTISTS CONSTANTLY DO RESEARCH

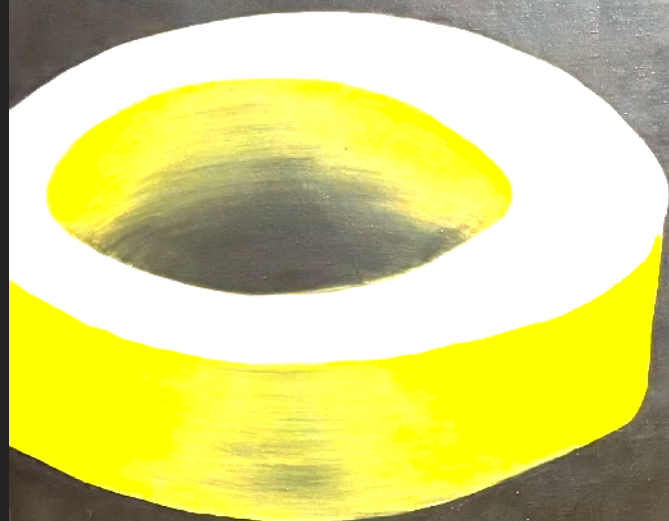
- ▶ As new technologies emerge, you must apply them in your job
 - ➡ Applies to university research, as well as to work in companies
- ▶ To use the new technologies you have to:
 - ▶ Identify their merits and limitations
 - ➡ Skills: Reading and critical thinking
 - ▶ Transfer the new techniques to your domain
 - ➡ Skill: Problem solving
- ▶ **This is what research is about**
- ▶ **Doing academic research provides you the perfect chance to foster these skills**

WHAT IS DOING RESEARCH LIKE?



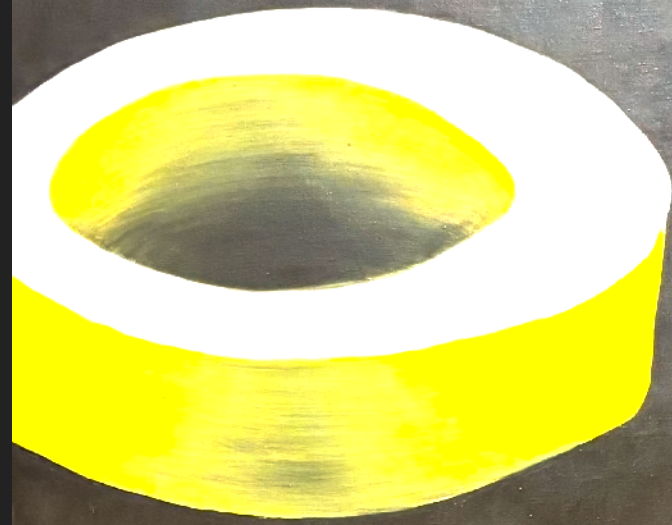
László Fehér:
Kút figurával
(Well with a Figure), 1989

**A RESULT
YOU ADMIRE**



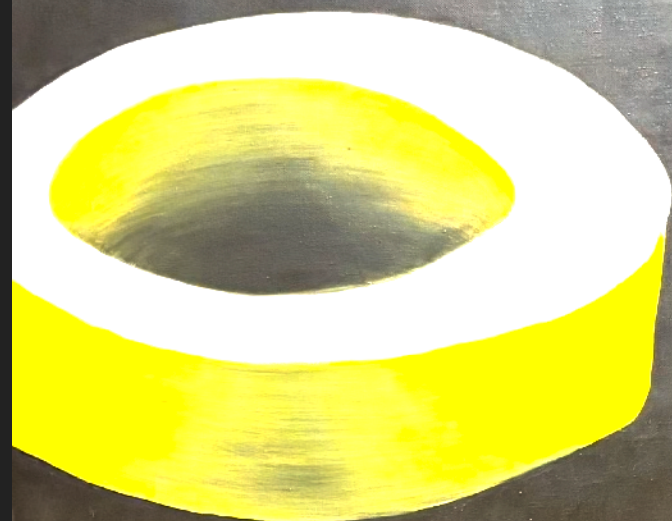
YOU

**THE RESULT
YOU WANT
BUT HAVEN'T**



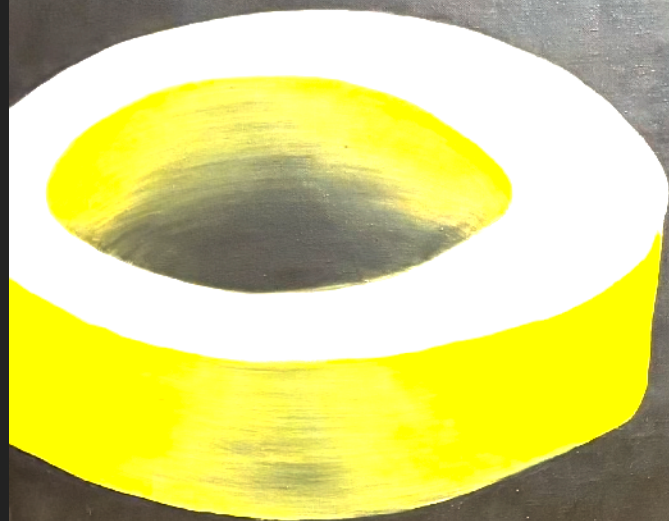
YOU

A COMMON GOAL



OTHER PEOPLE IN YOUR AREA

**THE RESULT
YOU WANT
BUT HAVEN'T**



YOU

THE VOID

NAVIGATING THE DARK

- ▶ We don't know the answers we're looking for, sometimes we don't even know the right questions
- ▶ The problems you work on will be hard
 - ▶ Often you work on them for weeks and still cannot solve them
- ▶ This builds character
 - ▶ You learn a lot about yourself, how you deal with setbacks and frustrations
 - ▶ Be prepared to experience this, enjoy the (little) victories
- ▶ **Very exciting when you solve a problem**
 - ▶ Be the first to solve a problem, the (research) world will remember you

**THE RESULT
YOU WANT
BUT HAVEN'T**



MOTIVATIONS TO DO RESEARCH

- ▶ There are many different reasons to do research
 - ▶ When I was a young Ph.D. student, I asked a lot of senior people:

What motivates you to do research?

- ▶ Quite diverse answers, different research philosophies
- ▶ I recommend you do the same

**THE RESULT
YOU WANT
BUT HAVEN'T**



WHY WE DO RESEARCH

DIFFERENT RESEARCHER TYPES

- ▶ **"The competitors":**
Want to improve existing benchmarks/results;
want to be the best
- ▶ **"The explorers":**
Want to do something nobody has done before;
focus on "new problems"
- ▶ **"The explainers":**
Want to build the best possible understanding of
problems and "the world"
- ▶ **"The aesthetes":**
Find beauty in a problem or area,
want to immerse in that beauty
- ▶ **"The critics":**
Reflect upon impact of trends and technologies;
critique developments and fix biases

- ➔ None of these researcher types is better or worse
- ➔ Find out what type of researcher you are
(that will take some time and experience)

**THE RESULT
YOU WANT
BUT HAVEN'T**



SOME TIPS FOR YOUR RESEARCH

BE PATIENT

- ▶ Reading papers is hard
 - ▶ Takes a while to get used to it, allow yourself that time
- ▶ Doing research means **“standing on the shoulders of giants”**
 - ▶ Learning fundamental results is exciting, you get the chance to learn from the best
 - ▶ What people typically forget:
 - ▶ You start at the giant’s feet, you have to climb unto its shoulders
 - ▶ This takes effort
 - ▶ Understanding something hard is a great achievement in and by itself

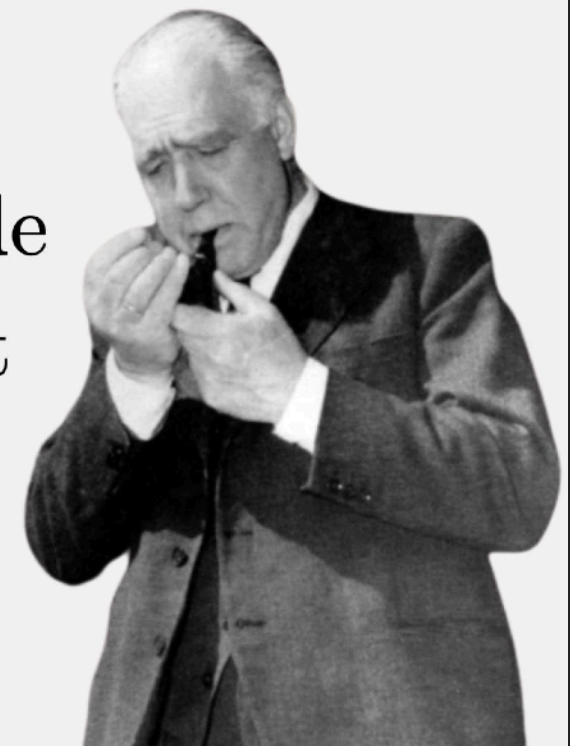


BE RESILIENT

- ▶ Doing research is hard
 - ▶ Courses give you “solvable problems” and you have a moment success within a couple of minutes or hours
 - ▶ Research is not like that
 - ▶ Often weeks with only “negative answers”
- ▶ Allow yourself to make mistakes
 - ▶ Failure is a learning opportunity
 - ▶ Reflect on how and why you failed

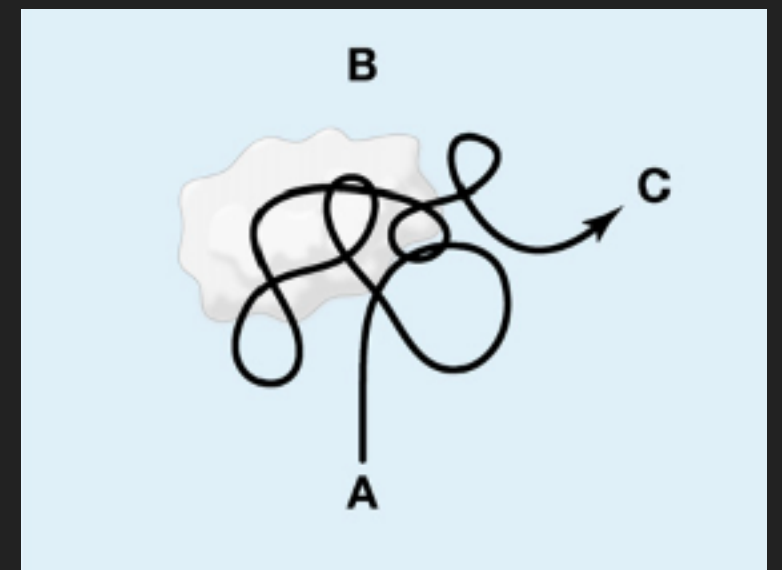
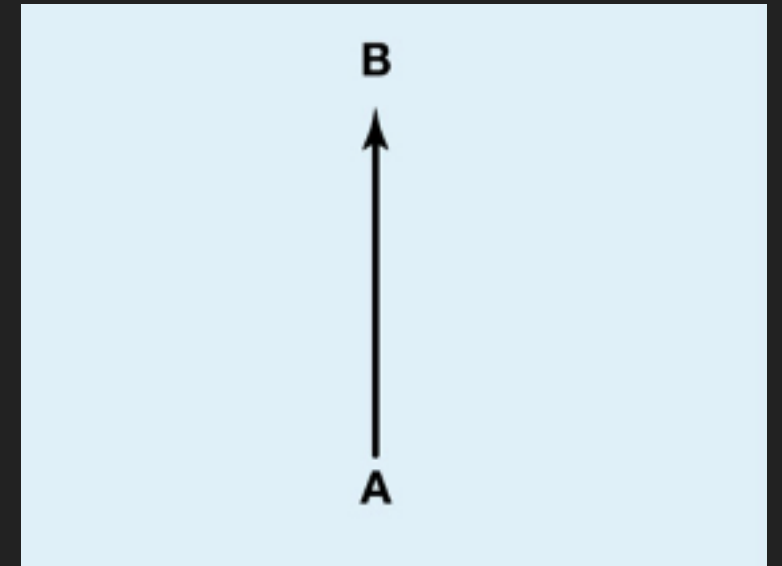
“An expert is a person who has made all the mistakes that can be made in a very narrow field”

Niels Bohr



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- ▶ Allow yourself to make mistakes
 - ▶ Failure is a learning opportunity
 - ▶ Reflect on how and why you failed
- ▶ Often you reach an alternative goal
 - ➔ Reaching goals after long time of working towards them feels much sweeter than immediate success



FOCUS ON YOUR DEVELOPMENT

- ▶ Your Ph.D. lays the foundation for your career (in research or in the industry)
 - ➡ Focus on developing lasting skills, now you have the time to do it
- ▶ Focus on research that excites **you**
- ▶ Strive to learn interesting, foundational techniques
 - ➡ With good foundations many things come much easier in the long run
- ▶ Be careful doing “semi-interesting” projects just because they are “low risk and have a good chance to provide publications”
 - ➡ If the result comes too easily, can be a missed learning opportunity (about yourself and also technically)
 - ➡ It is okay to do it sometimes, just don't do it too much

HAVE FUN DOING RESEARCH

- ▶ Doing research in CS is inevitable
- ▶ Doing research can be a lot of fun
 - ▶ Find a goal/project that motivates you
 - ▶ Find out what type of researcher you are
- ▶ This is your chance to do what excites **you**
- ▶ **Be curious and shoot for the stars**
- ▶ **Up next:**
Doing a Ph.D. is more than just doing research



László Fehér: Kút figurával
(Well with a Figure), 1989

Based on talks by [Jilles Vreeken](#)
and [Pauli Miettinen](#)

HOW TO SURVIVE A PH.D.

PH.D. = RESEARCH + TEACHING + ADMINISTRATION + EMOTIONS + ...

LACK OF WORK-
LIFE BALANCE

IMPOSTER
SYNDROME

INDUSTRY PEOPLE
EARN MORE \$\$\$

DOING A PH.D. IS
MORE THAN JUST
DOING RESEARCH

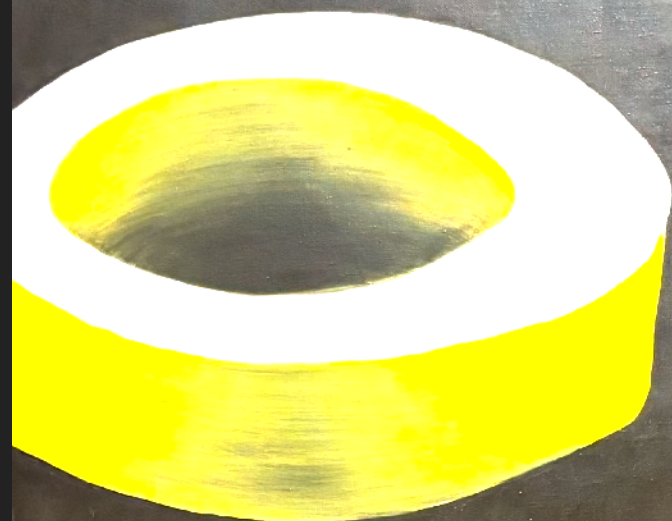
SLOW RESEARCH
PROGRESS

PAPER REJECTED

BUGGY
ALGORITHMS

TEACHING DUTIES

**FOCUS ON
RESEARCH**



YOU

-
- ▶ I survived a Ph.D. and won awards for my thesis
 - ▶ The second half of the talk:

How you can do the same
survive and come out on top

WRONG

DISCLAIMER

- ▶ I survived a Ph.D. and won awards for my thesis

- ▶ The second half of the talk:

How you can do the same,
survive and come out on top

- ▶ Lottery winners will tell you to play the lottery
 - ▶ They will even explain you their “strategy” to win the lottery
- ▶ Any advice you’ll get is useless
 - ▶ What worked for me doesn’t have to work for you
 - ▶ Take my input, see what works for you



MY MAIN ADVICE

**DON'T
PANIC**

BUT WHY WOULD ANYBODY PANIC?

- ▶ During a Ph.D. **everybody** learns that
 - ▶ juggling many tasks is demanding
 - ▶ there are people who are smarter than you
 - ▶ you're not good at everything
 - ▶ and being good at courses isn't enough
 - ▶ doing what you're told may not be enough
 - ▶ life is unfair (but you knew that already from kindergarten)
 - ▶ others will be luckier and get better results or better jobs

DON'T PANIC

Control the process and focus on steady gains, every day.

FOUR STRATEGIES TO AVOID PANICKING

- ▶ Manage expectations
- ▶ Remind yourself of the great aspects of doing a Ph.D.
- ▶ Control your (research) process
- ▶ Get help when you need it

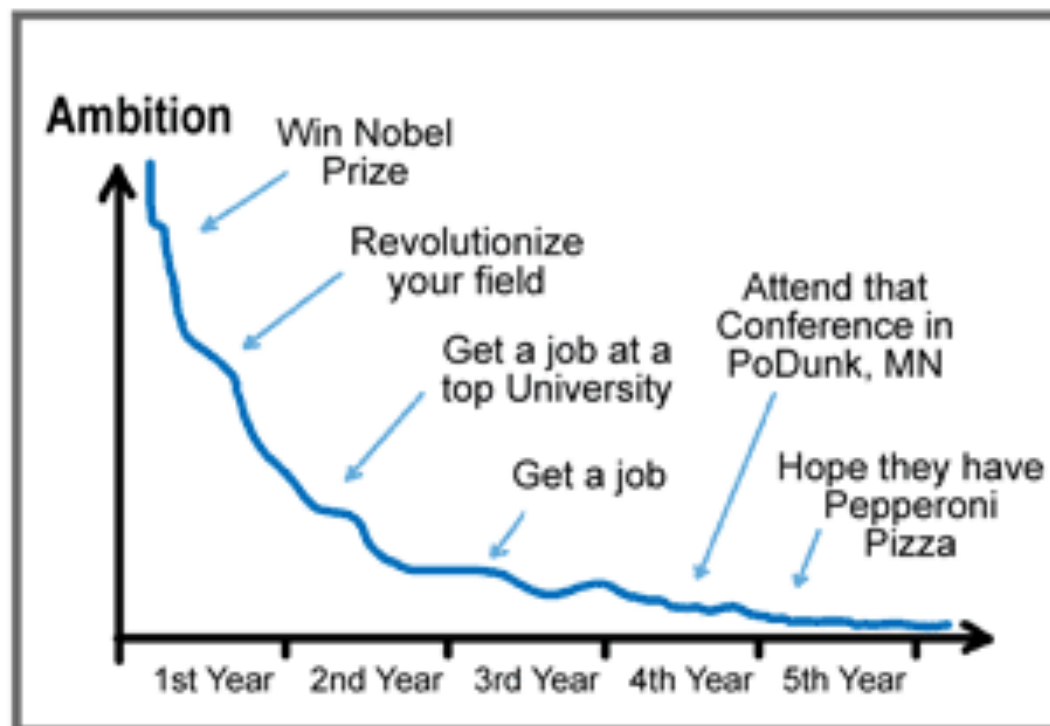
STRATEGY 1:

MANAGING EXPECTATIONS



I'M GOING
TO CHANGE
THE WORLD!

YOUR LIFE AMBITION - What Happened??



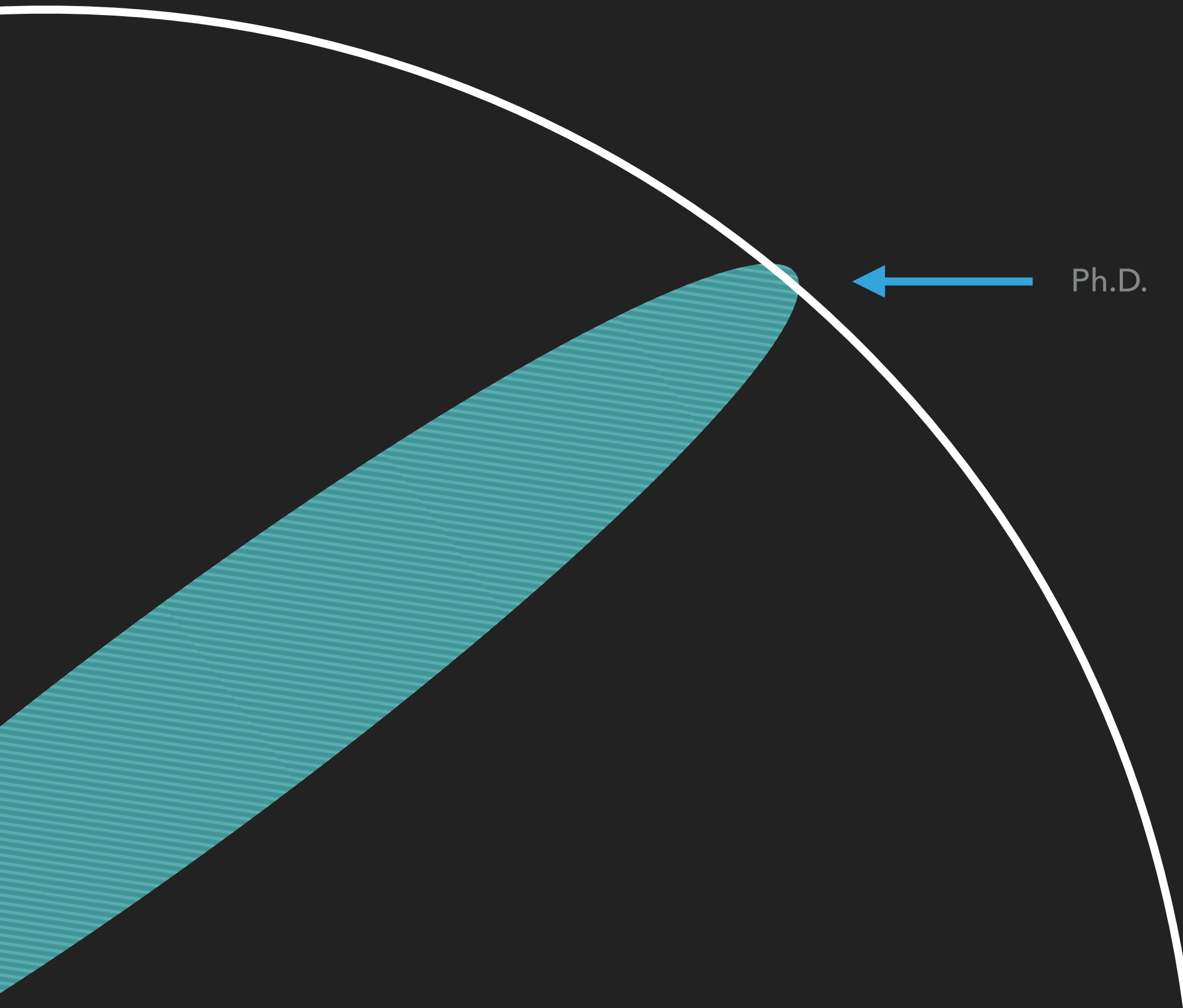
JORGE CHAM © 2008

WWW.PHDCOMICS.COM

Imagine a
circle that
contains all
of human
knowledge



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Ph.D.

WHY YOU PROBABLY WON'T CHANGE THE WORLD

- ▶ World-changing results are rare, really rare
 - ▶ Science is postmodern: many small steps rather than few big ones
 - ▶ Big problems are big because they're **hard**
- ▶ You **should** work on big problems
 - ▶ Best way to obtain interesting results
 - ▶ Just don't be upset if you can't solve them
 - ▶ **Personal anecdote:**
Once, I couldn't solve a problem and got mad.
A senior colleague's reply: "Oh, you still take it personally?"
- ▶ A lot of people publish around ~4 papers during their Ph.D.
 - ▶ Expect 1 year of work per paper
 - ▶ This is still a great achievement, because writing papers is hard!

STRATEGY 2:

**REMINDE YOURSELF WHAT IS
GREAT ABOUT DOING A PH.D.**

YOU WANT TO KNOW MORE

- ▶ You're curious and fascinated by the topic
- ▶ With a bit of luck, you can increase the knowledge of the human kind
- ▶ You learn so much about yourself
(what motivates you, what fascinates you, ...)
- ▶ You get paid to think about problems that fascinate you
 - ▶ Once-in-a-lifetime opportunity for many people



WHAT'S COOL IN GRAD SCHOOL/ACADEMIA

- ▶ The freedom
 - ▶ You can control what you do and when you do it
- ▶ ~~The travel~~ Zoom meetings
 - ▶ Join the academia, see the world
- ▶ The other grad students
 - ▶ Fascinated on the quasi-polynomial graph isomorphism algorithm? You'll never walk alone!

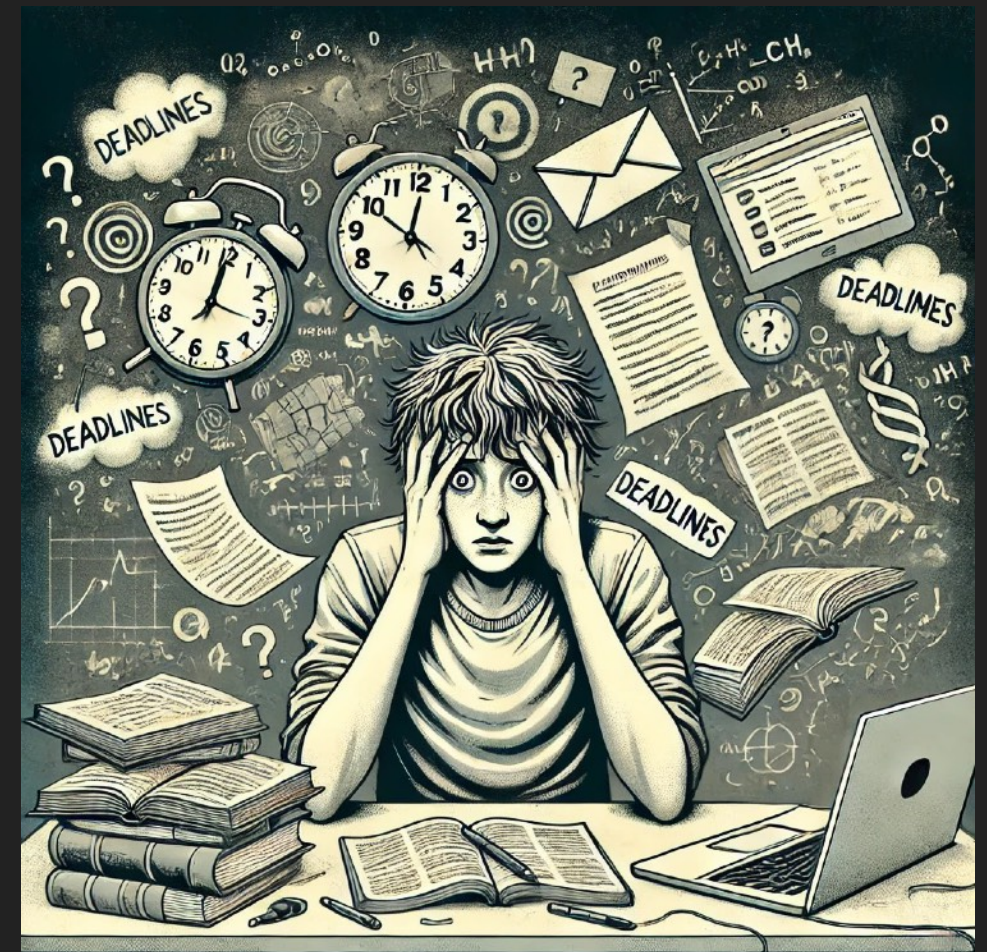
STRATEGY 3:

**CONTROLLING THE
PROCESS**

WHAT YOU
CAN (NOT)
CONTROL

MANY THINGS ARE OUT OF YOUR CONTROL

- ▶ Whether you solve the problem you work on
 - ▶ It might be too difficult or unsolvable
 - ▶ Somebody else might solve it before you
- ▶ Whether your paper gets accepted or rejected
 - ▶ Peer review can be quite random
- ▶ Whether you get a lot of citations
 - ▶ Very hard to predict which works will have impact
- ▶ Focussing on outcomes can make you very unhappy very quickly
 - ▶ **Outcomes**
= paper accepted or rejected, problem solved or not, ...
- ▶ **"Out of control" doesn't mean you have no influence**
 - ▶ It just means that ultimately external factors will determine the outcome



THINGS YOU CAN CONTROL

- ▶ You can't control the outcomes, but you can **control the process**
- ▶ Ensure that every day you do the best work you can
 - ▶ Ensure that every day you work hard
 - ▶ Some days you go in the right direction, some days you don't. That's OK
 - ▶ Critically reflect on your progress and on how you approach your work (research and everything else too)
- ▶ Submit papers when you cannot improve them further
 - ▶ You have done all you can, the rest is not up to you
- ▶ If you focus on the process, there are **no regrets**
 - ▶ You did your best, you cannot do better
 - ▶ Typically, good processes lead to **good outcomes**



WRITING SCHEDULES

- ▶ Maintain a writing schedule
 - ▶ Helps you stay organized and keep track of your progress
 - ▶ Plan one week ahead
 - ▶ Each day ε progress $\implies$ 200ε progress after 1 year!
 - ▶ In the real world, constants matter!
 - ▶ Forces you to be honest with yourself

Writing Schedule

Date	Project	Done	Task	Comment
Mon, 16 Sep 2019	Dynamic ISI	☒	Continue incorporating Monika's comments.	Done.
	FIS Lower Bounds	☒	Prepare presentation of Trevisan paper for Holger.	Done.
Tue, 17 Sep 2019	Dynamic ISI	☒	Continue incorporating Monika's comments.	Done.
	Repartitioning	☒	Take notes about discussion with Monika.	Done. Also contains notes about old meeting with Harald and Stefan.
Wed, 18 Sep 2019	Streaming Biclustering	☒	Take note that asymmetric Hamming distances satisfies triangle inequality and the consequences of this.	Done.
Thu, 19 Sep 2019	Dynamic ISI	☐	Continue incorporating Monika's comments.	Procrastinated.

WRITING SCHEDULES

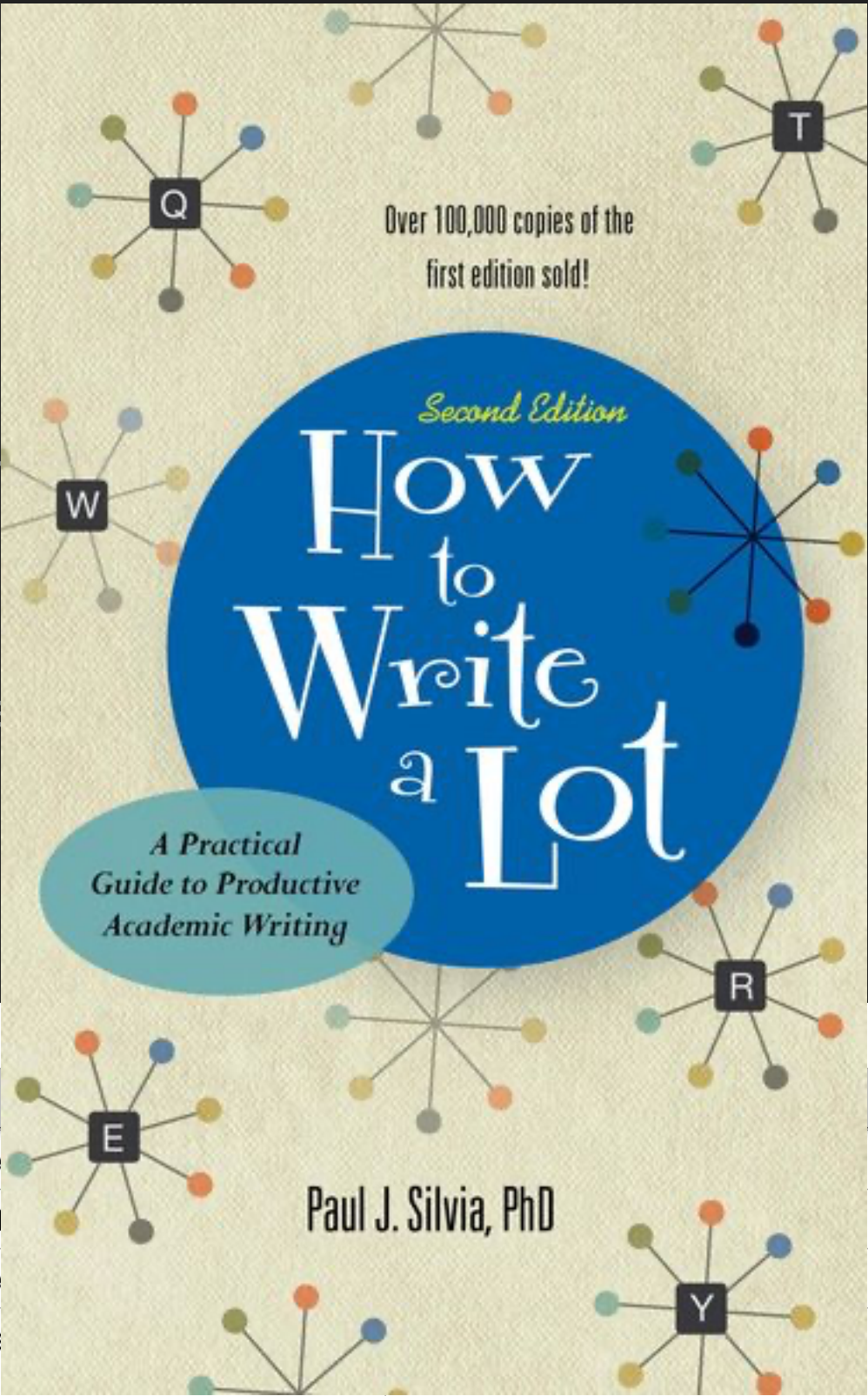
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DEALING WITH YOUR ADVISOR

- ▶ Keep your advisor up-to-date
- ▶ Don't expect your advisor to remember the things you say on the hallway
- ▶ Figure out how you best work together
 - ▶ Some people like email, some don't
 - ▶ Make your communication short and precise
 - ▶ Train your communication!



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BUT EVEN WITH THE BEST PROCESS...
SOMETIMES YOU'LL BE STUCK

STRATEGY 4:

**GET HELP WHEN YOU
NEED IT**

WHO YOU'RE GONNA CALL WHEN THE PROBLEMS COME?

YOU'RE STUCK – WHAT TO DO

- ▶ Ask your advisor



YOU'RE STUCK – WHAT TO DO

- ▶ Ask your advisor
 - ▶ Ask your fellow students & postdocs, too!
- ▶ Keep banging your head?
 - ▶ Sometimes it helps
 - ▶ Sometimes its best to just take a break. No need to keep your chair warm. Do other things or call it a day. Who knows, you might even figure it out that way.

YOU'RE STUCK – WHAT TO DO

- ▶ Ask your advisor
- ▶ Ask your friend
- ▶ Keep banging your head
- ▶ Sometimes
- ▶ Sometimes your chair will know, you



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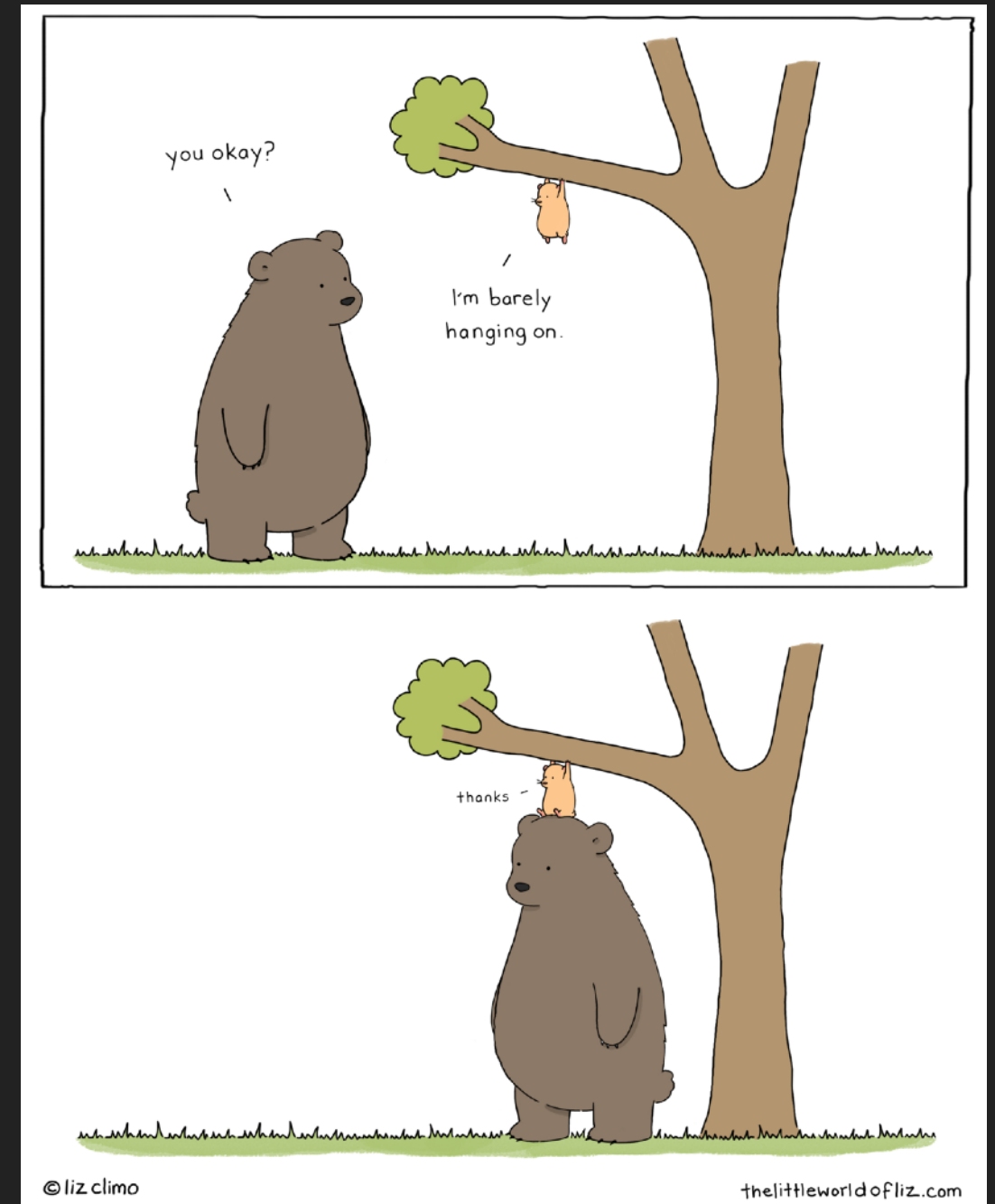
DEALING WITH STRESS

- ▶ Doing a Ph.D. can be very stressful
 - ▶ You have to navigate the darkness
 - ▶ You do many things for the first time
 - ▶ Competitive people put themselves under a lot of pressure
 - ▶ Many of you even live in a new country
- ▶ Find some friends inside and outside of academia
- ▶ Meditate if that's your thing



GET SOME HELP IF YOU NEED IT

- ▶ Depression levels among Ph.D. students are high
- ▶ TU Wien offers help:
 - ▶ Individual counseling ([Link](#))
 - ▶ The ombuds office helps you deal with conflicts and abuse ([Link](#))
- ▶ There is no pride in suffering and getting no help



FOUR STRATEGIES TO AVOID PANICKING

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- ▶ Control your (research) process
- ▶ Get help when you need it

DON'T PANIC

Control the process and focus on steady gains, every day.

RESOURCES

- ▶ “Don’t Panic” talks by [Jilles Vreeken](#) and [Pauli Miettinen](#)
 - ▶ This talk is based on their talks, see also references therein
- ▶ Liz Climo (thelittleworldofliz.com)
- ▶ Piled Higher & Deeper (phdcomics.com)
- ▶ Sue Moon: “A few tips I wish I had before I met my advisor”
- ▶ Yannis Smaragdakis: “PhD Rants and Raves – be afraid, be very afraid”
- ▶ Eamonn Keogh: “How to do good data mining research, get it published, and get it cited”

ALL THE BEST WITH YOUR PH.D.

► How to survive a Ph.D.?

- **Don't panic**
- Control the process, focus on steady gains, every day
- Find a goal/project that excites **you**
- Maintain a writing schedule
- Make friends and support each other
- Aim to become the best researcher you can be, don't just measure outcomes
- Don't listen to me, do your own thing
- Slides available online:
neumannstefan.com/files/research-phd-tips.pdf



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