

STEFAN NEUMANN

HOW TO NAVIGATE RESEARCH AND YOUR PH.D.

**INSPIRED BY A PAINTING
OF LÁSZLÓ FEHÉR**

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

▶ This 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
- ▶ This 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

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

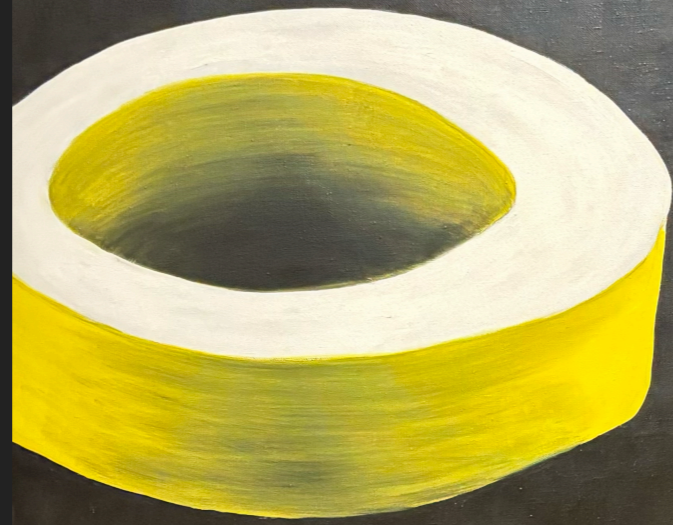
Fehér László
1989. május 12.

**A RESULT
YOU ADMIRE**



YOU

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



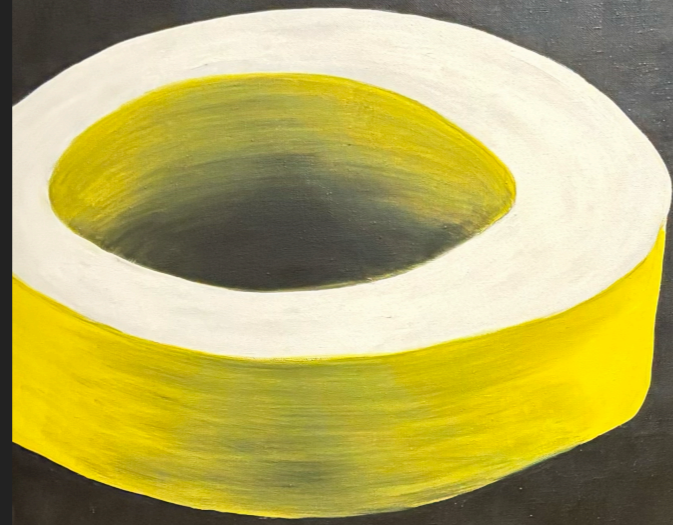
YOU

**A COMMON
GOAL**



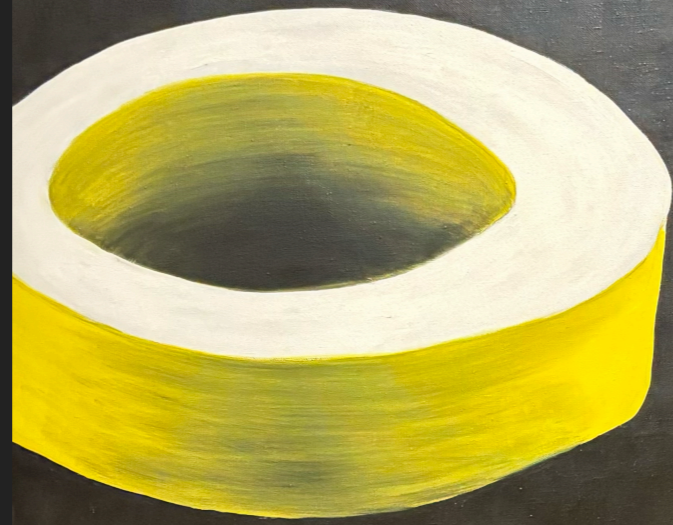
OTHER PEOPLE IN YOUR AREA

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



YOU

**THE 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

A TAXONOMY OF 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

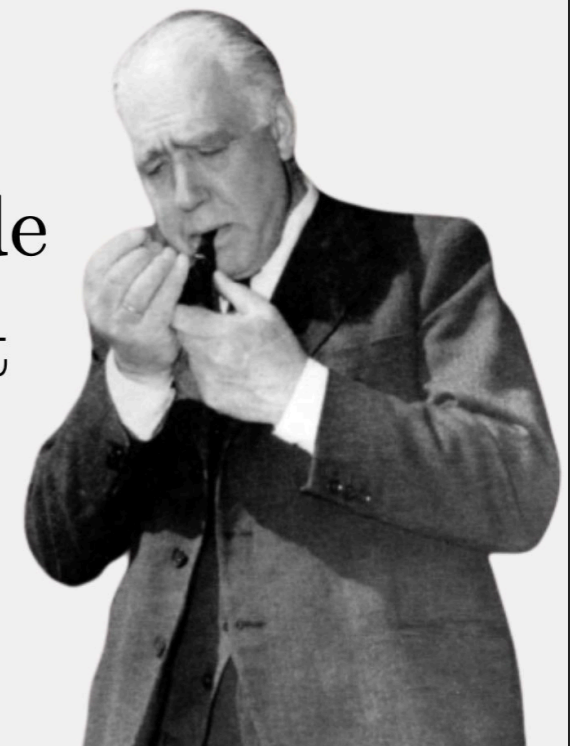


BE RESILIENT

- ▶ 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

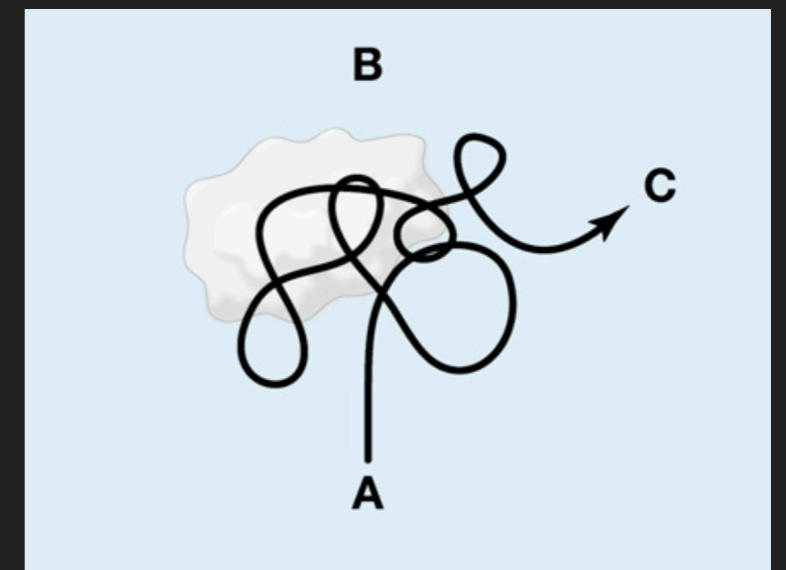
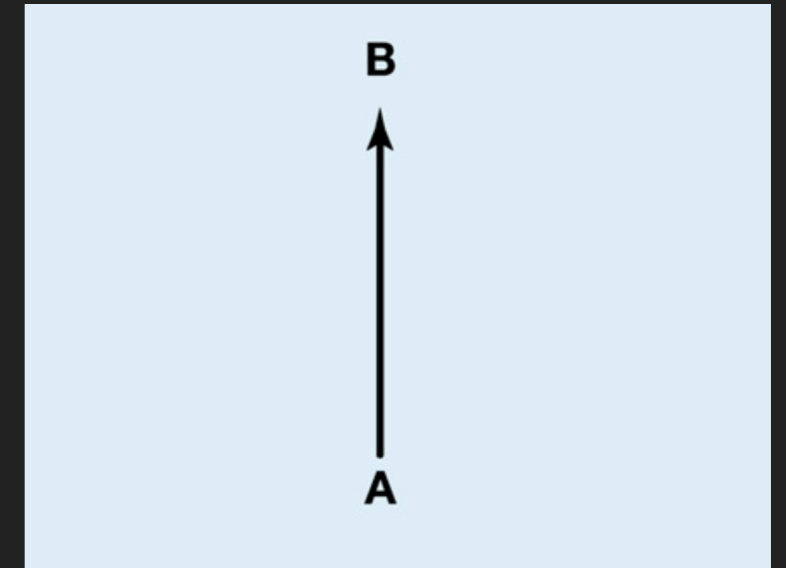
“An expert is a person who has made all the mistakes that can be made in a very narrow field”

Niels Bohr



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 - ▶ Often weeks with only “negative answers”
- ▶ 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



MY MAIN ADVICE

**DOON'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

DOON'T PANIC

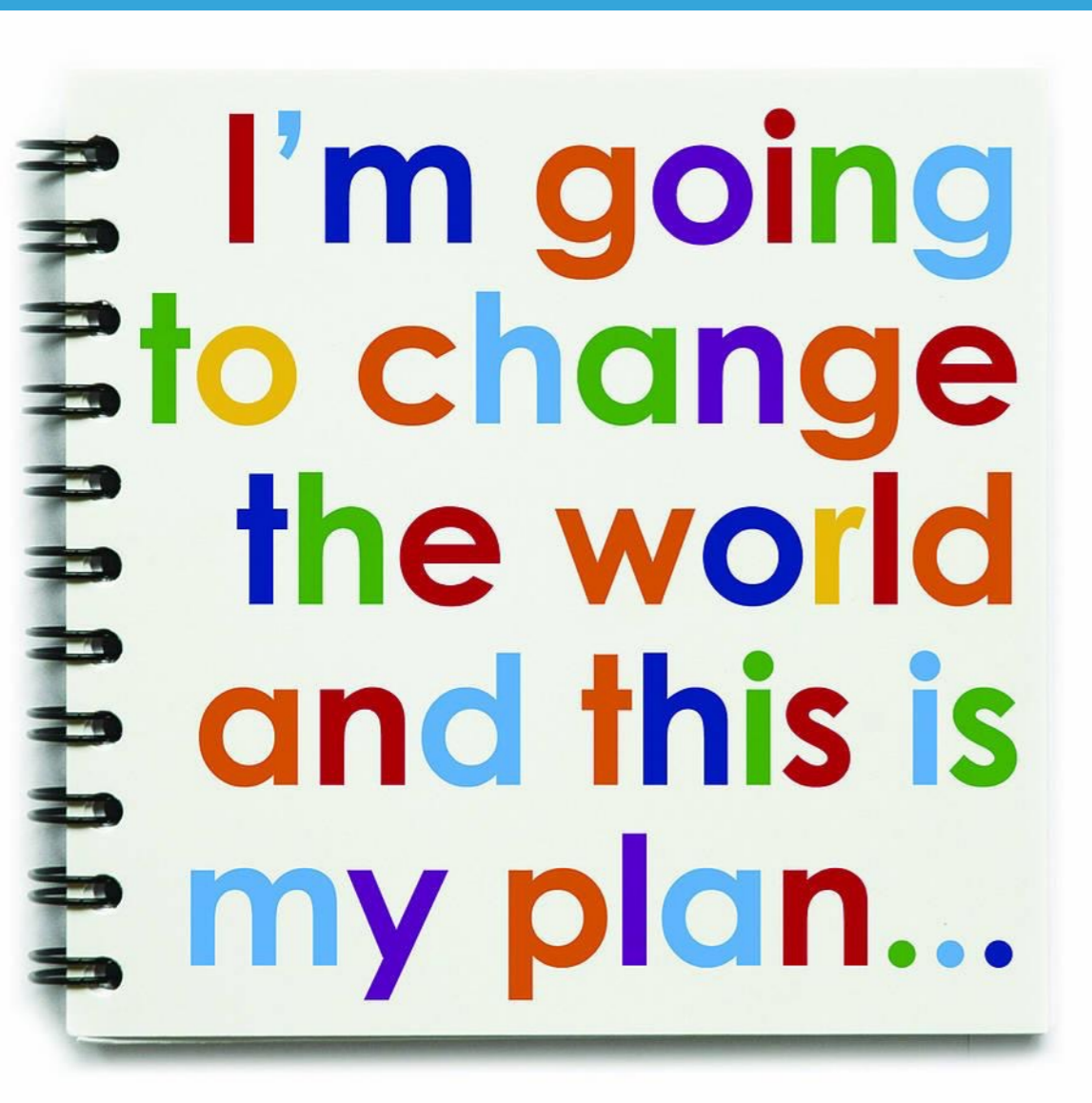
Control the process and focus on steady gains, every day.

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

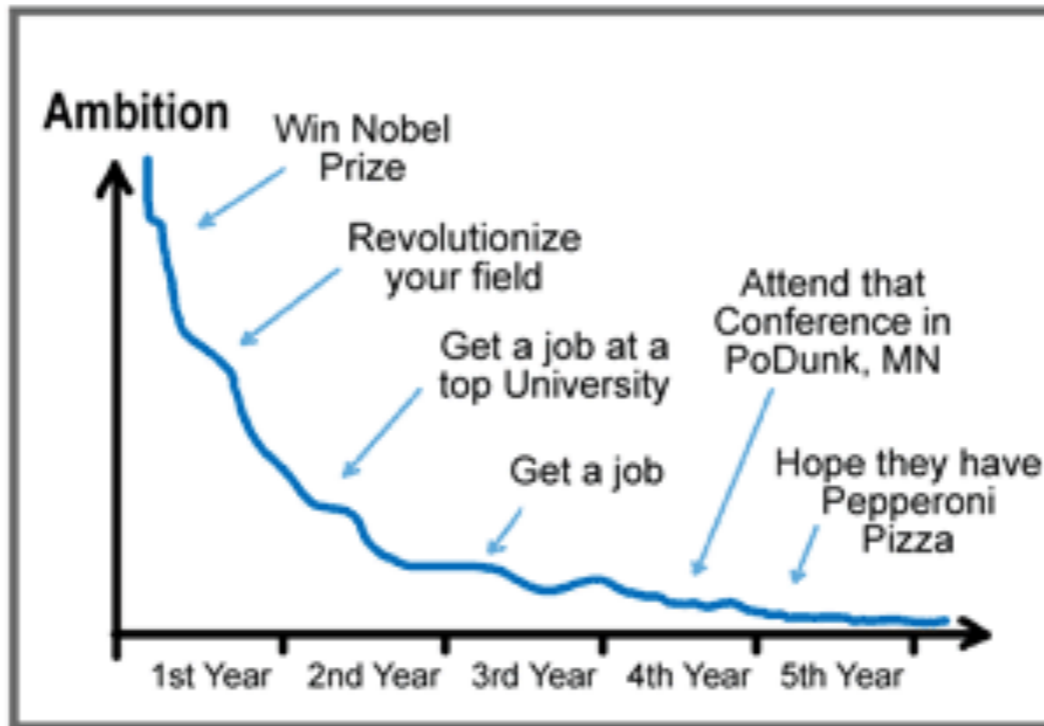
STRATEGY 1:

**MANAGING
EXPECTATIONS**

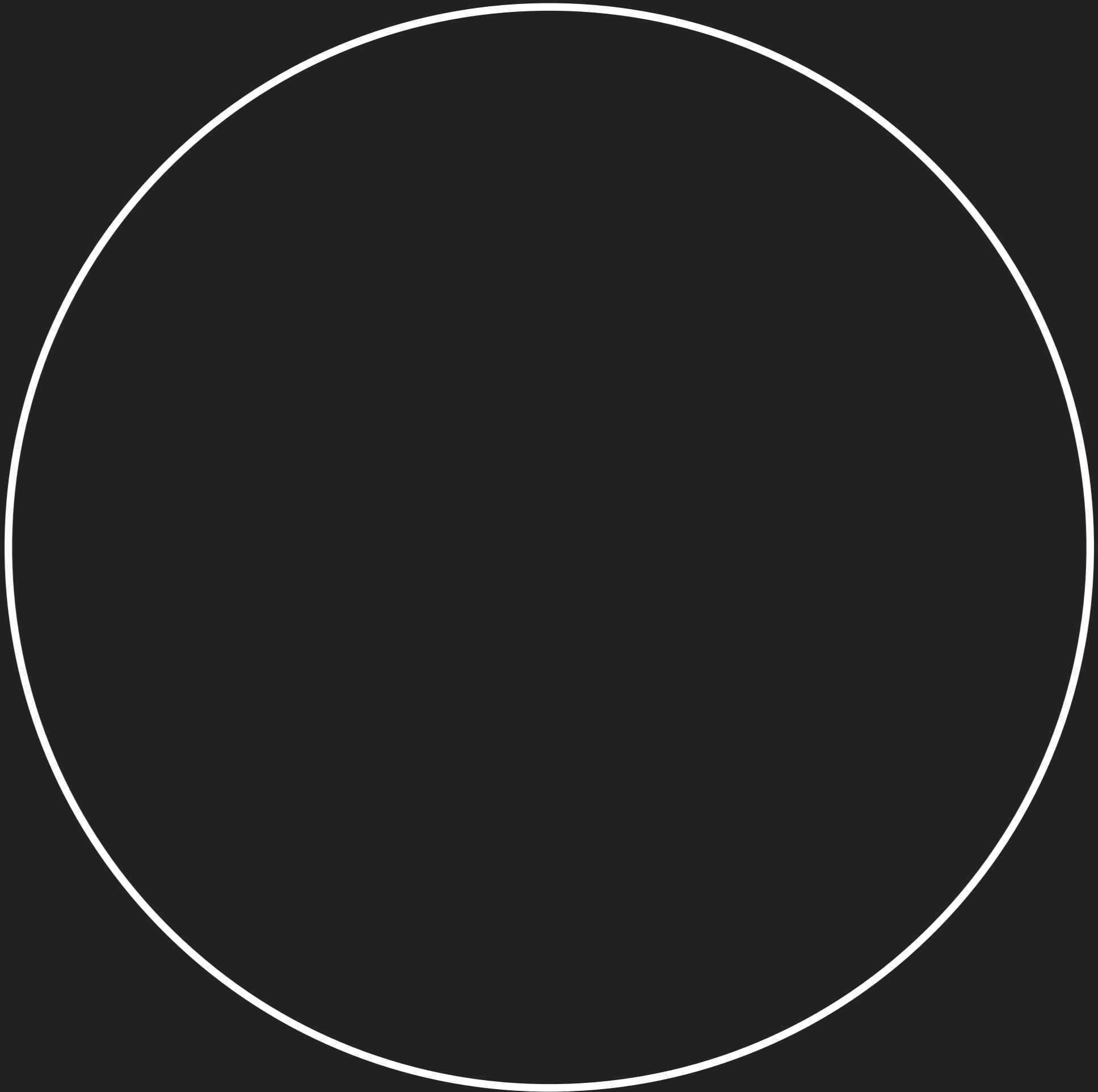


I'M GOING
TO CHANGE
THE WORLD!

YOUR LIFE AMBITION - What Happened??

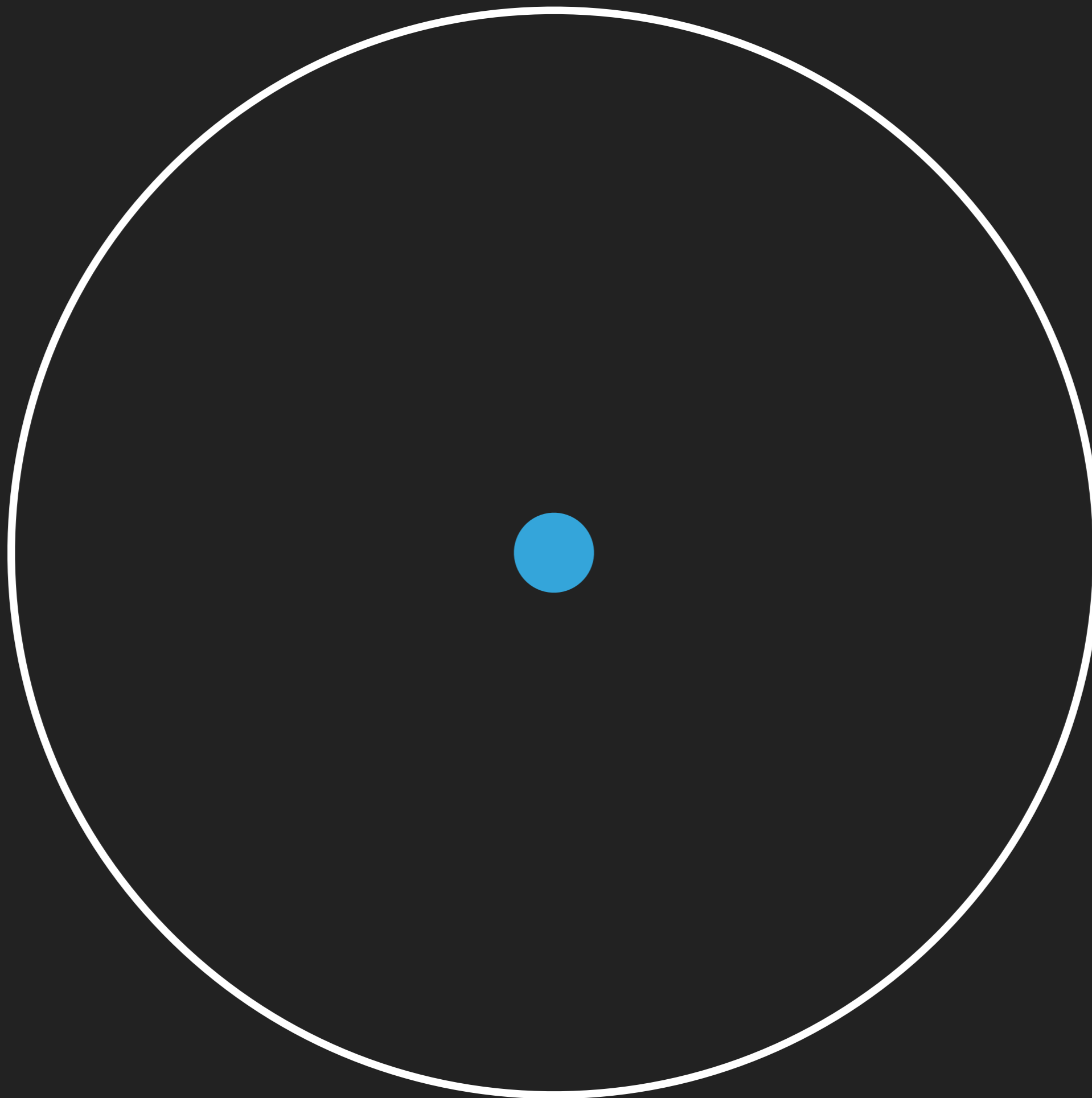


JORGE CHAM © 2008

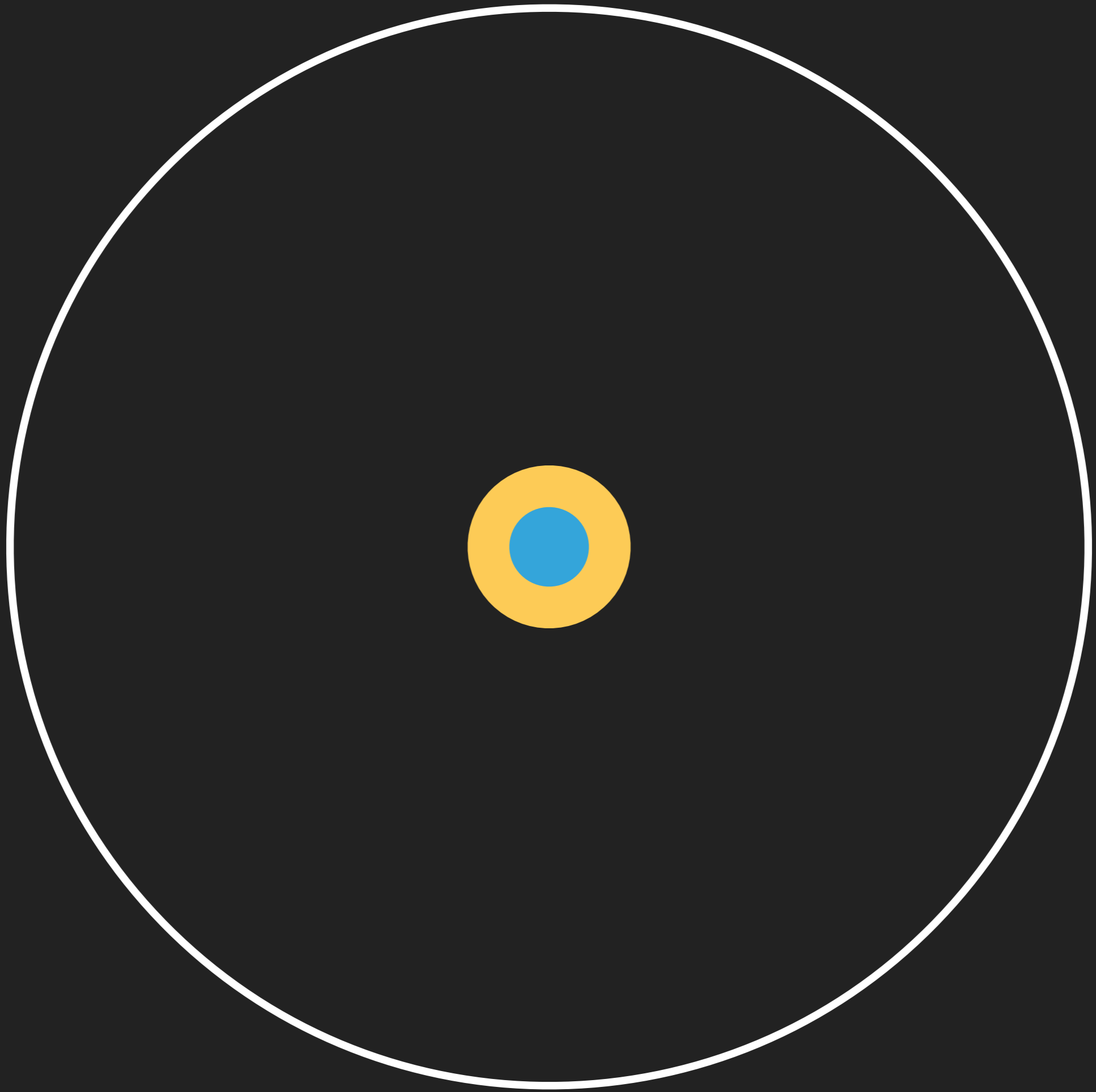


Imagine a
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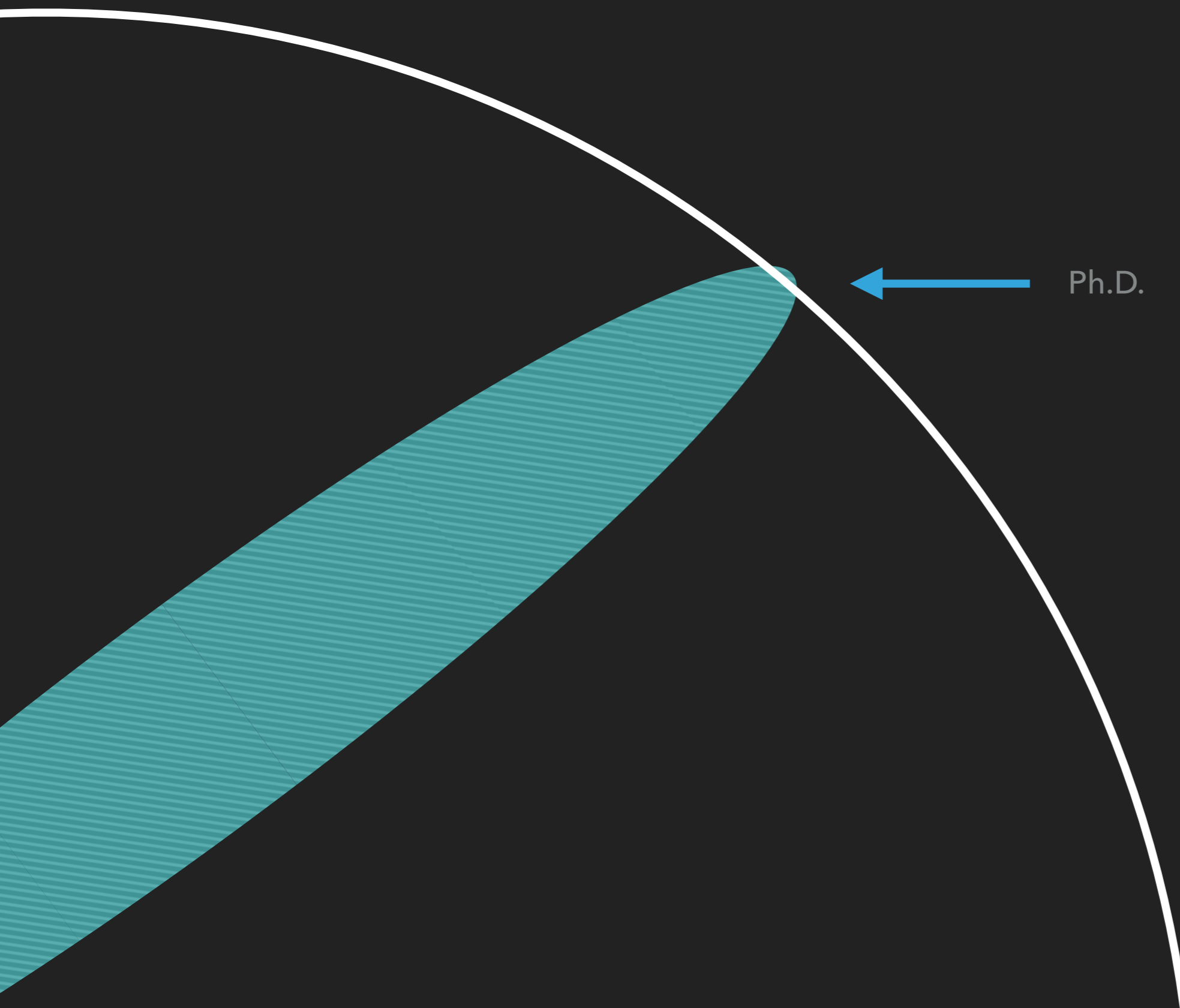
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Ph.D.

RIGHT AND WRONG EXPECTATIONS

WHY YOU PROBABLY WON'T CHANGE THE WORLD

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
- ▶ 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!
 - ▶ Aim to become the best expert in a very narrow area

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!



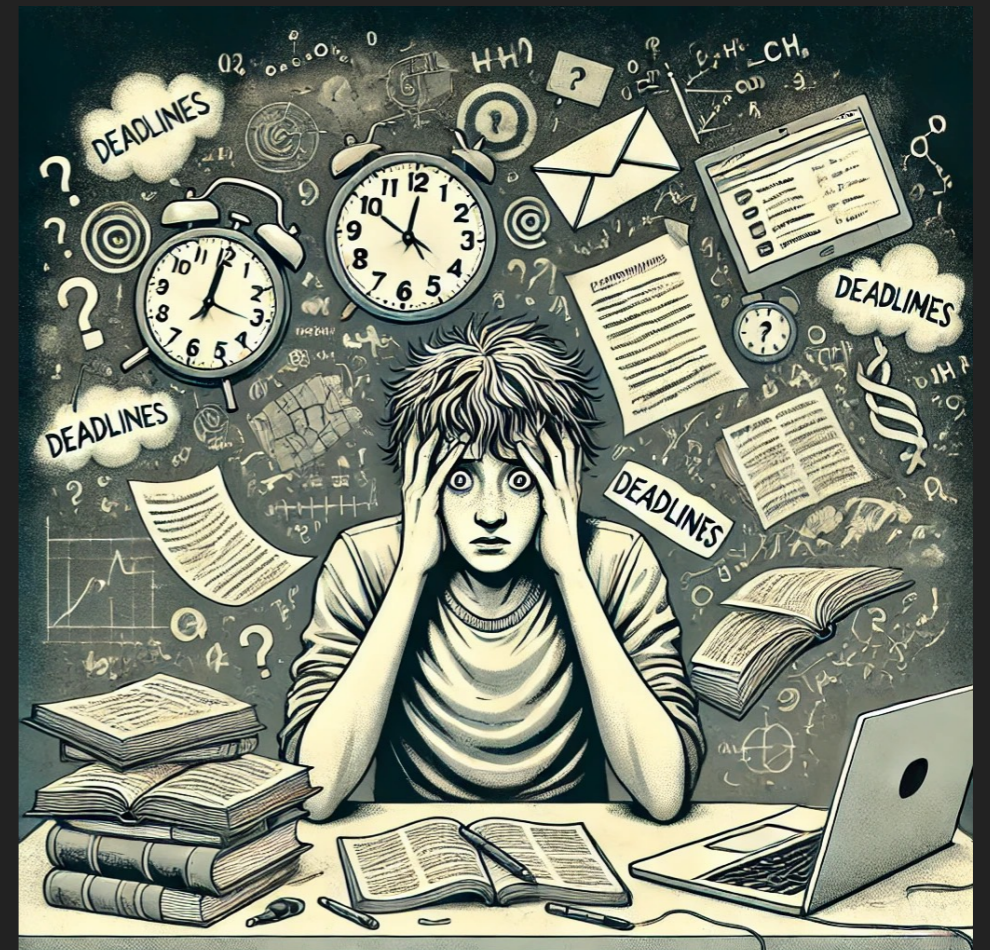
STRATEGY 3:

**CONTROLLING THE
PROCESS**

WHAT YOU
CAN (NOT)
CONTROL

MANY THINGS ARE OUT OF YOUR CONTROL

- ▶ Whether you solve the problem you work on
- ▶ Whether your paper gets accepted or rejected
- ▶ Whether you get a lot of citations
- ▶ Focussing on outcomes can make you very unhappy very quickly
 - ▶ **Outcomes**
= paper accepted or rejected, problem solved or not, your paper got cited or not, ...
- ▶ **“Out of your 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

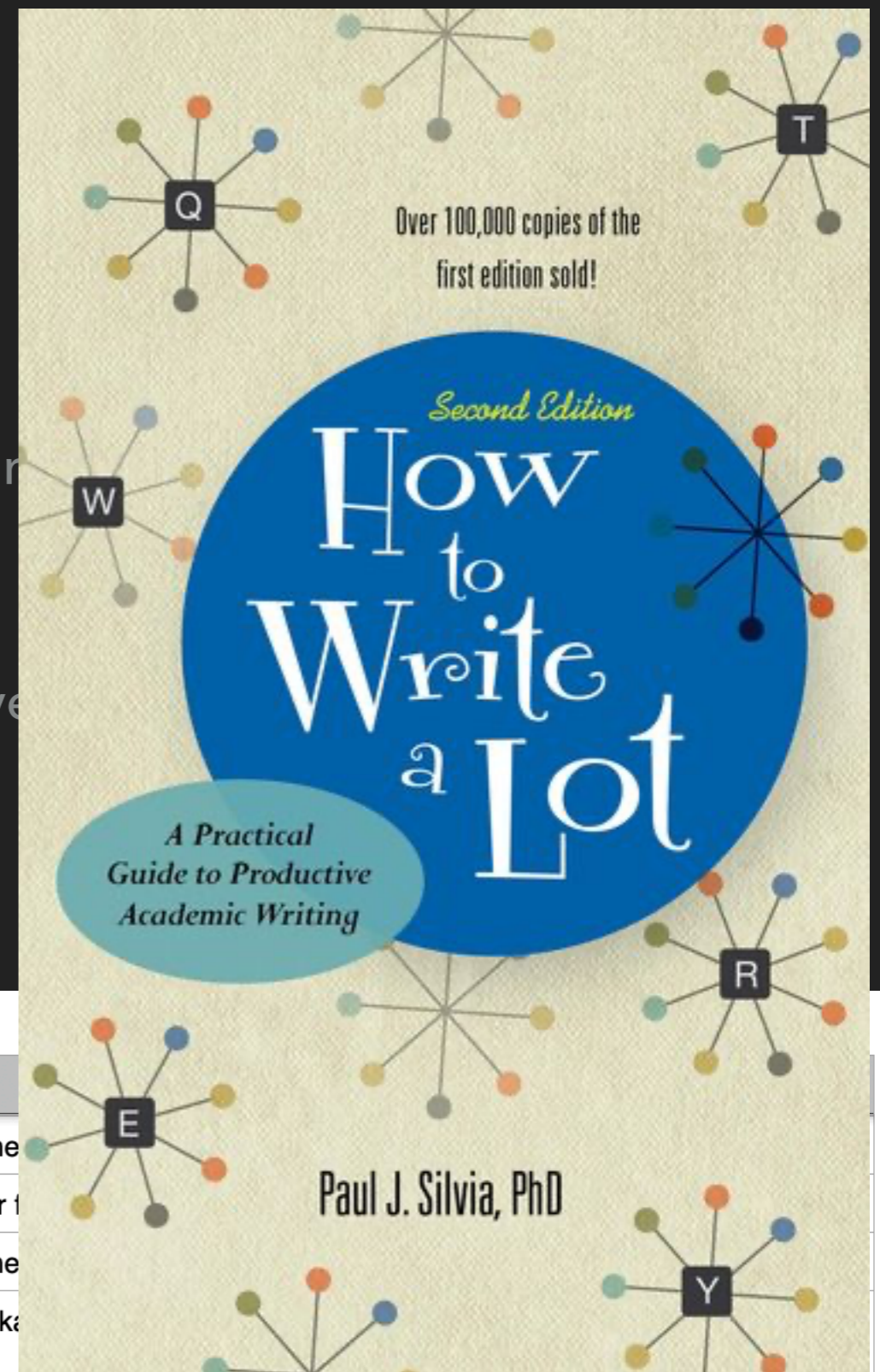
- ▶ Maintain a writing schedule
 - ▶ Helps you stay organized and keep track of your progress
 - ▶ Plan one week ahead
 - ▶ Each day ε progress \implies 200ε progress after 1 year!
 - ▶ In the real world, constants matter!
 - ▶ Forces you to be honest with yourself

Writing Schedule

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

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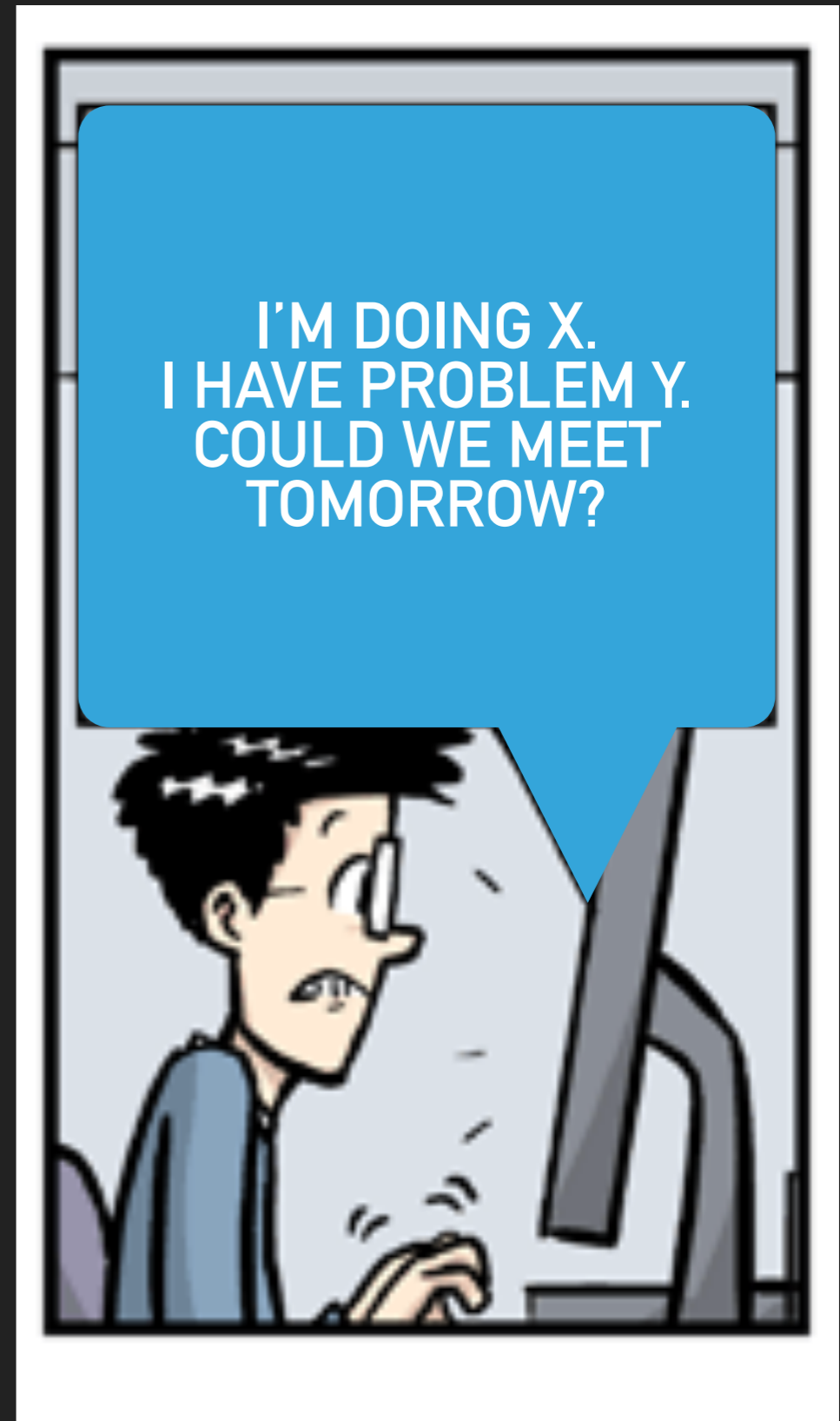
DEALING WITH YOUR ADVISOR

- ▶ 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**

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 it is 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

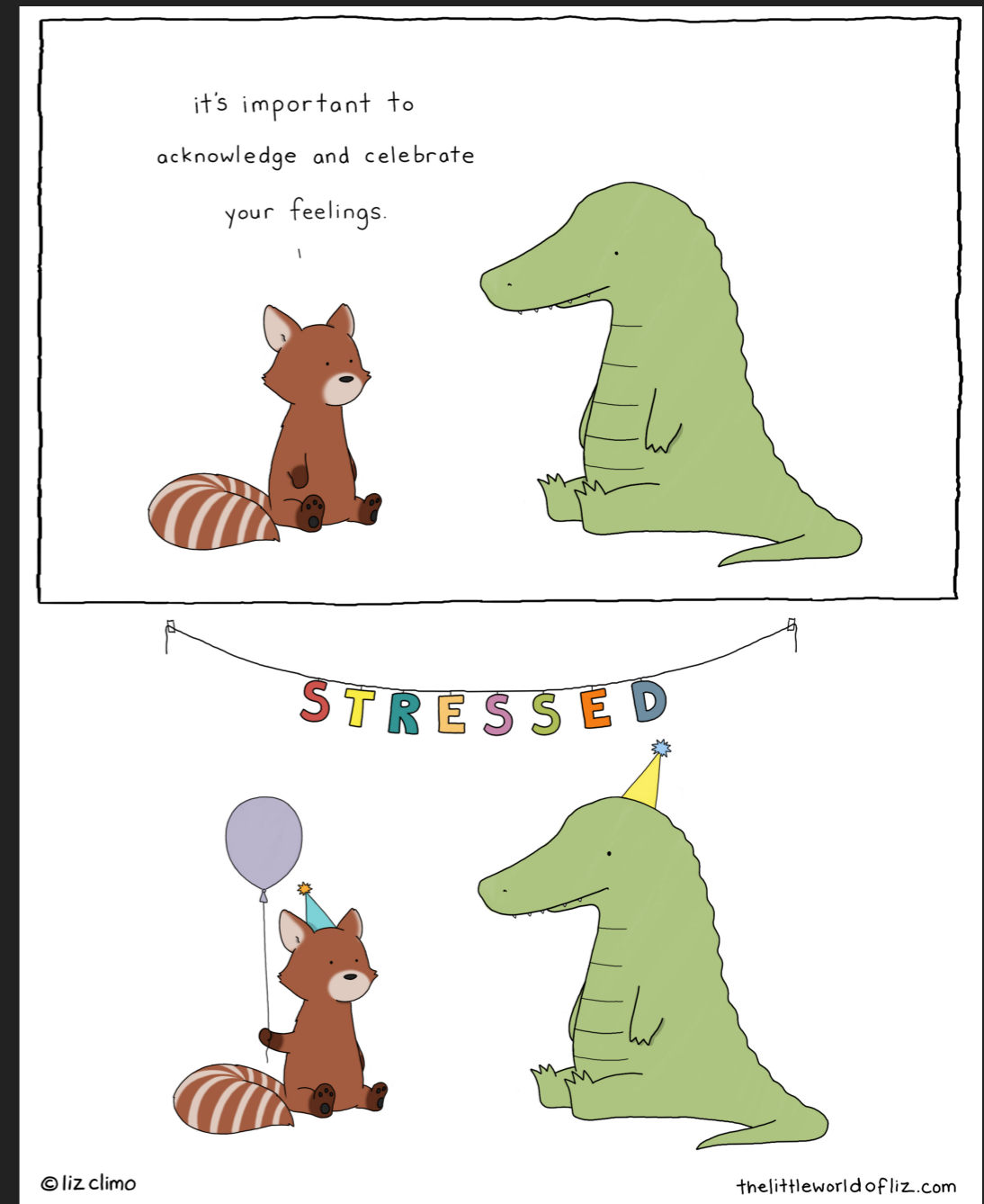
- ▶ Ask your advisor
- ▶ Ask your friend
- ▶ Keep banging your head against the wall
- ▶ Sometimes
- ▶ Sometimes
- ▶ keep your
- ▶ Who knows



No need to call it a day. that way.

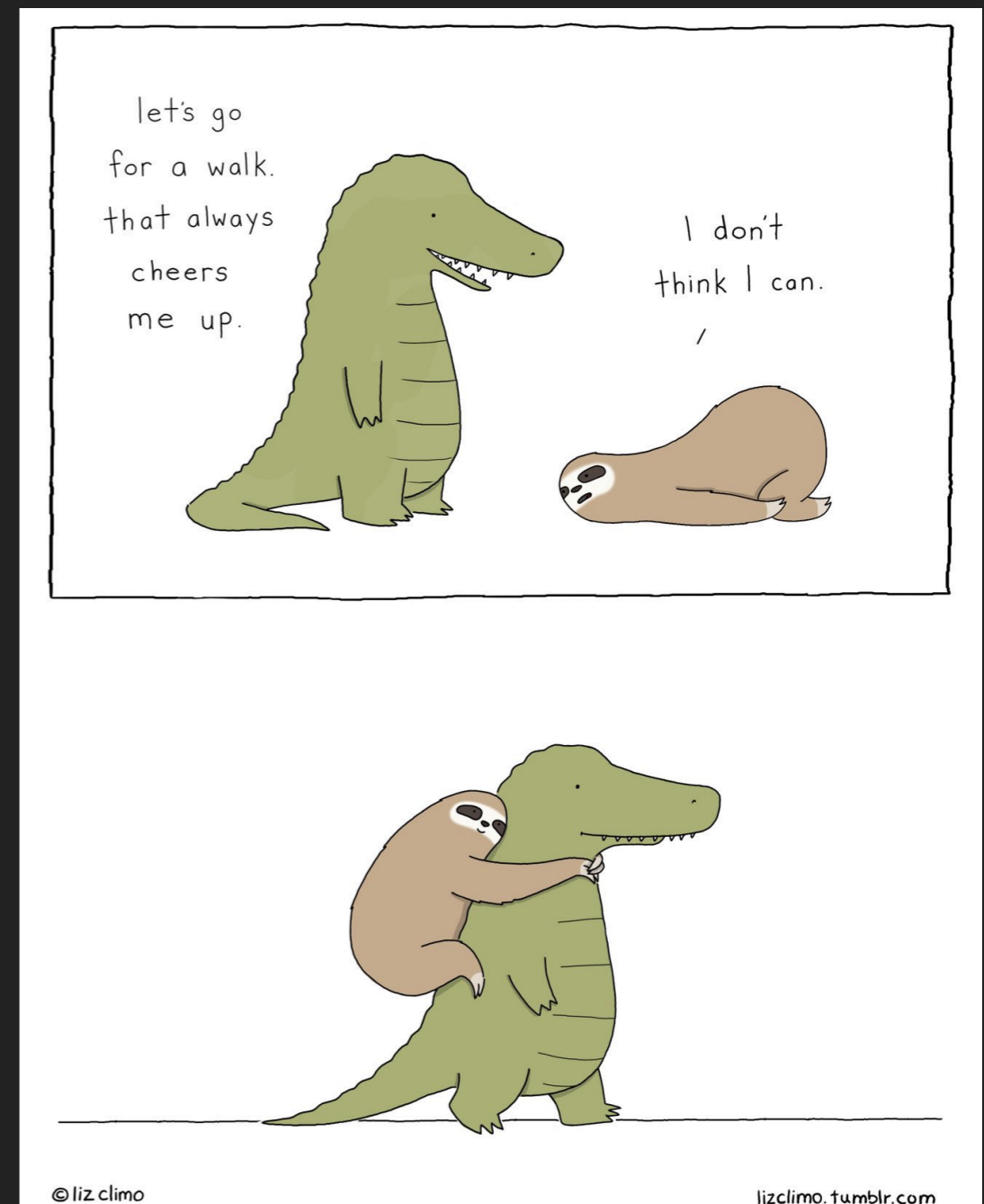
DEALING WITH STRESS

- ▶ 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



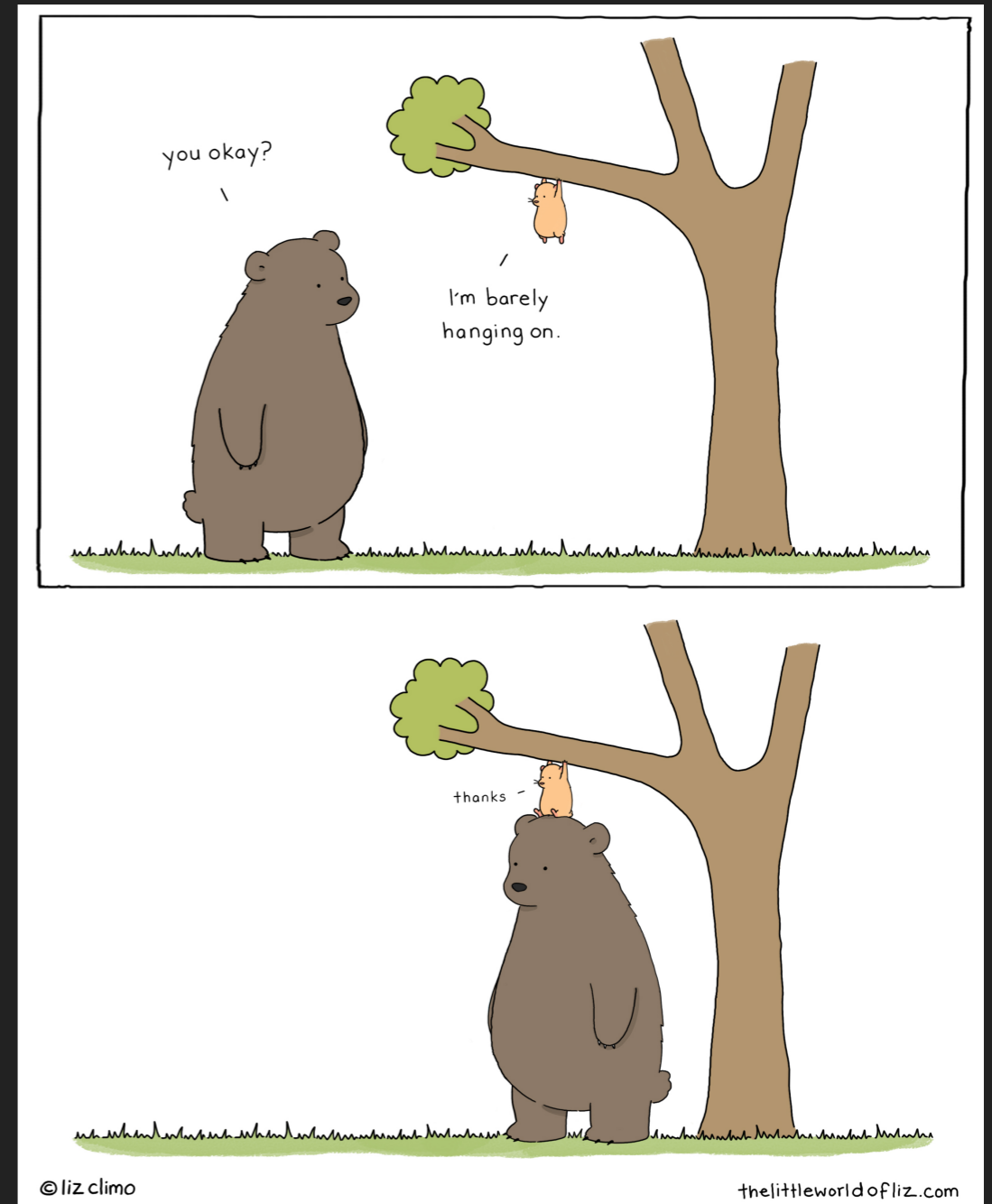
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 - ▶ Many of you even live in a new country
- ▶ Find some friends inside and outside of academia
- ▶ Meditate if that's your thing



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

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

(Work in progress)

HOW TO STAY CALM

WHILE AI IS TRANSFORMING COMPUTER SCIENCE

AI IS CHANGING COMPUTER SCIENCE RAPIDLY

- ▶ Very exciting
 - ▶ Lots of new technology to try out and to integrate in different domains
- ▶ Frightening
 - ▶ What will be left of your research fields when you graduate?
 - ▶ How will this transform the economy?
 - ▶ Lots of **uncertainty**

HOW TO NAVIGATE THIS UNCERTAINTY?

- ▶ Same as before: You need to control the process
- ▶ Checking social media every couple of minutes or hours, and having FOMO will not help you calm down
- ▶ Set up a process that works for you:
 - ▶ Define which developments are relevant for you
 - ▶ Define how you keep track of these developments
 - ▶ E.g., every 2 weeks you spend 1 day reading and experimenting
 - ▶ Discuss with your advisor and your group how to do this best

HOW TO MAKE SURE YOUR PAPERS WILL STAY RELEVANT?

- ▶ Your paper will definitely stay relevant, if
 - ▶ You make progress on fundamental and long-standing problems
 - ▶ You can demonstrate very clear real-world impact
 - could be societal or in application domains
 - ▶ Such papers were always hard to write, they will always be hard to write
- ▶ What is at risk:
 - ▶ Papers that take an existing result and just apply a little twist

YOU NEED TO MASTER THE NEW TOOLS

- ▶ You must learn to master these new tools
 - ▶ Coding agents, which proofs can be outsourced to LLMs, etc.
 - ▶ Everyone is using this now (or will be soon), you must not be left behind
- ▶ Discuss with your peers *and your advisor* how to do this best
 - ▶ You are now the supervisor of these tools, being a good supervisor is tough

THE MOST IMPORTANT RULE



Andrej Karpathy ✓

@karpathy



This is the the quote I've been citing a lot recently.



kache ✓ @yacineMTB · Feb 4

you can outsource your thinking
but you cannot outsource your understanding

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

CONCLUSION

DOON'T PANIC

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

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/essai-phd.pdf

can I see
the map?



sure.
/

we still
have a long
way to go.



don't worry,
I packed
snacks.

© liz climo

thelittleworldofliz.com



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



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”