STEFAN NEUMANN

WHAT IT'S LIKE DOING RESEARCH

EXPLAINED VIA 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

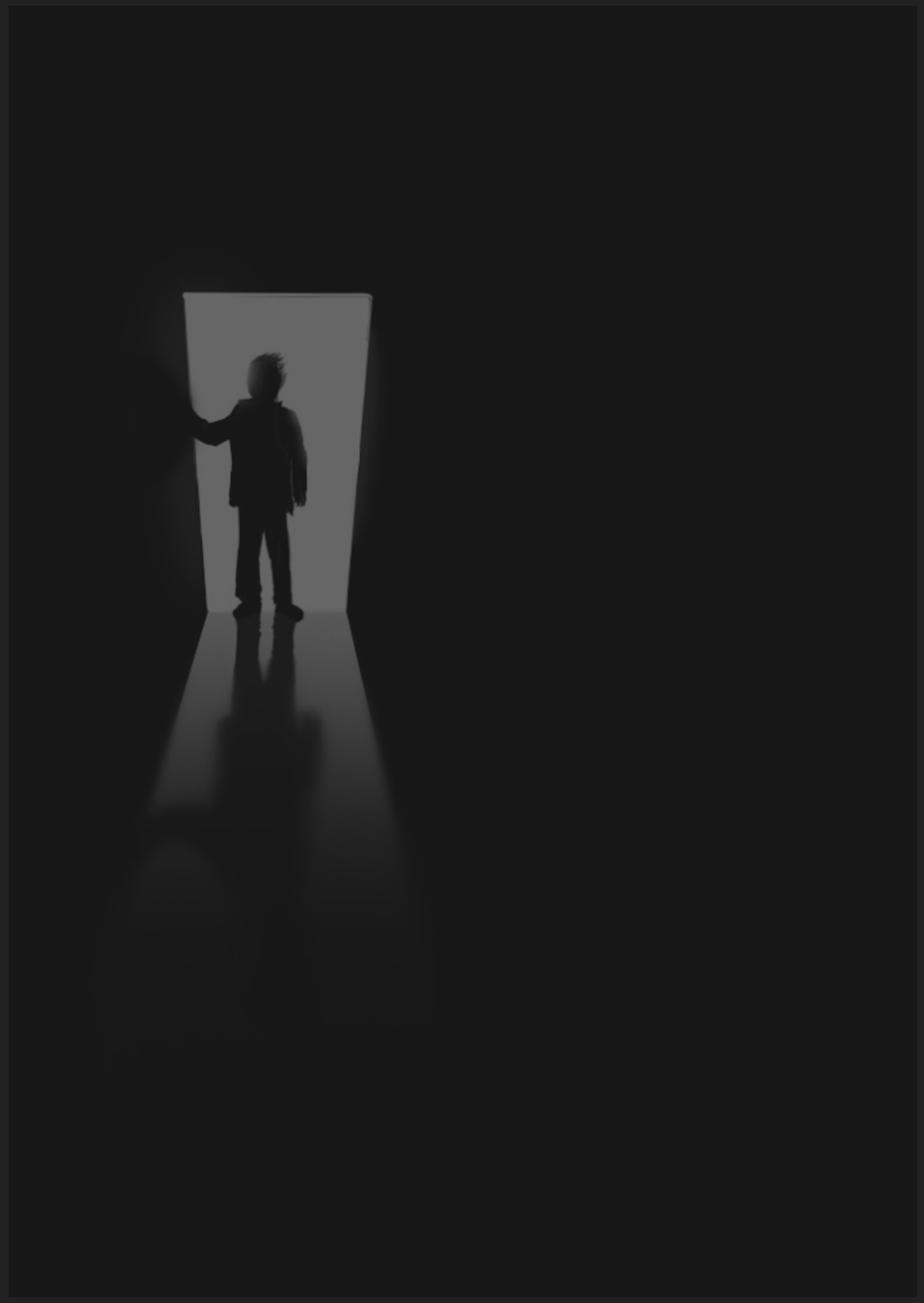
THE RESULT

YOU WANT

BUT HAVEN'T

ARE YOU AFRAID OF THE DARK?

- To do science is to be in the dark
  - We may strike gold
  - Or we find dirt, dirt, and more dirt
- We don’t know the answers we’re looking for
  - We don’t know if the answers even exist
  - Heck, we don’t even know the correct questions
- **Very exciting when you find the right problem and answer**
  - Be the first to solve a problem, the (research) world will remember you



NAVIGATING THE DARK

- The problems you work on will be hard
  - Often you work on them for weeks and still cannot solve them
  - This is different from being good in courses
- 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

MOTIVATIONS TO DO RESEARCH

- There are many different reasons to do research
  - When I was a young Ph.D. student, I would go around asking senior people:

    What do motivates you to do research?
- Quite diverse answers, different research philosophies
- I recommend you do the same

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 critics”:**
  Reflect upon impact of trends and technologies; critique developments and fix biases

➡ None of these research types is better or worse, you just have to find out what drives you (that will take some time and experience)

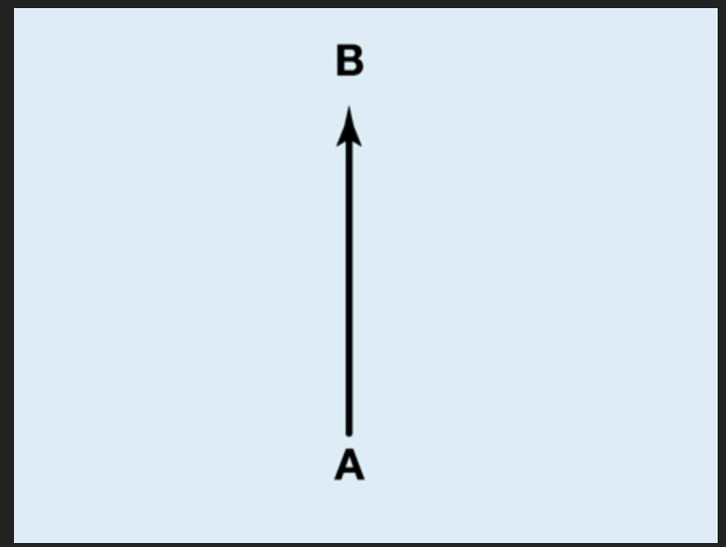
SOME TIPS FOR YOUR START IN RESEARCH

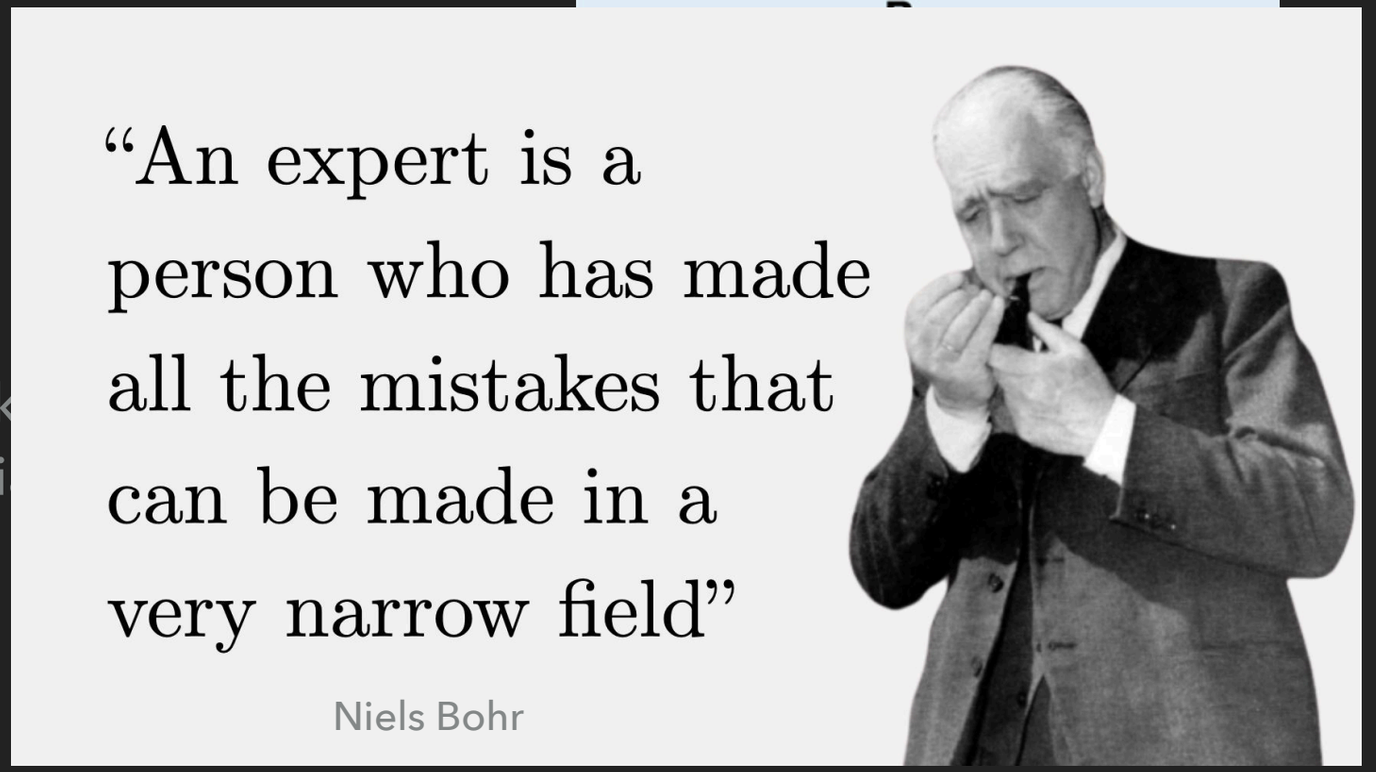
BE PATIENT

- 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 new things 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
  - Research is not like that
- Often there are weeks with “only negative answers”
- Allow yourself to make mistakes
- Failure is learning opportunity
- Often you reach an alternative goal
  - ➡ Reaching goals after long time of work them feels much sweeter than immedi





FOCUS ON YOUR DEVELOPMENT

- Ph.D. students must publish papers to get their degree
  - ➡ You don’t have to do that
- Focus on **learning** things that **excite you**
- Strive to learn interesting, foundational techniques
  - ➡ With a good foundation 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)

YOUR COMPETITIVE ADVANTAGE

- After a while, almost all researchers are completely embedded in “their field”
  - They work on important problems in their own area
  - They have relatively less stimulation from other areas
  - To a degree they are also “stuck” in their own area
- In some sense, you have a broader view than many professors
  - You are exposed to quite diverse courses, researchers, etc.
- Make use of this!
  - Try bringing together ideas from different courses or fields
  - Be curious, approach professors with “wild” ideas
    - But don’t be surprised when they reject them

THE PERKS OF DOING RESEARCH

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 and researchers
  - Fascinated by the quasi-polynomial time graph isomorphism algorithm? You'll never walk alone!


YOU
OTHER PEOPLE IN YOUR AREA

HAVE FUN DOING RESEARCH

- Doing research in CS is inevitable
- Doing research can be a lot of fun
  - Find a goal/project that excites you
  - Find out what type of researcher (and person) you are
- This is your chance to do what excites **you**
- **Be curious and shoot for the stars**

- Slides available online: neumannstefan.com/files/doing-research.pdf

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