Doing a Systems PhD

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Systems Research is...

- Work in OS, file-systems, databases, networking, language run-times, system security, ...
- Not a ‘hard’ science
  - No ground truth to be discovered
    - Get to create the universe!
  - Things can be “sort of” right
    - Absolutes are rare
- Key skill: critical thinking

Critical Thinking - Reading

- Read a paper and consider:
  - Do I like it? Hate it? (opinion)
  - What problem is it trying to solve?
  - How does their approach differ from previous ones?
  - (how much previous work do I know about – read it! (reference chaining))
  - Does it work?
  - What could be improved?

Critical Thinking - Writing

- Consider a paper (or your thesis) as an *argument*
  - What is the problem?
  - If not well known, *why* is it a problem?
  - Why are all previous approaches *insufficient* (broken / wrong / stupid)?
  - What is your approach?
    - how does it work?
    - how well does it work?
    - how does it improve on previous attempts?

PhD Outcomes

- Drop out, do something else
- Finish, do something else
- Finish, join/start a start-up
  - Actual PhD work may be important
- Finish -> Academic Research
- Finish -> (good) Industrial Research
  - Last two: academic track record, references, publications important

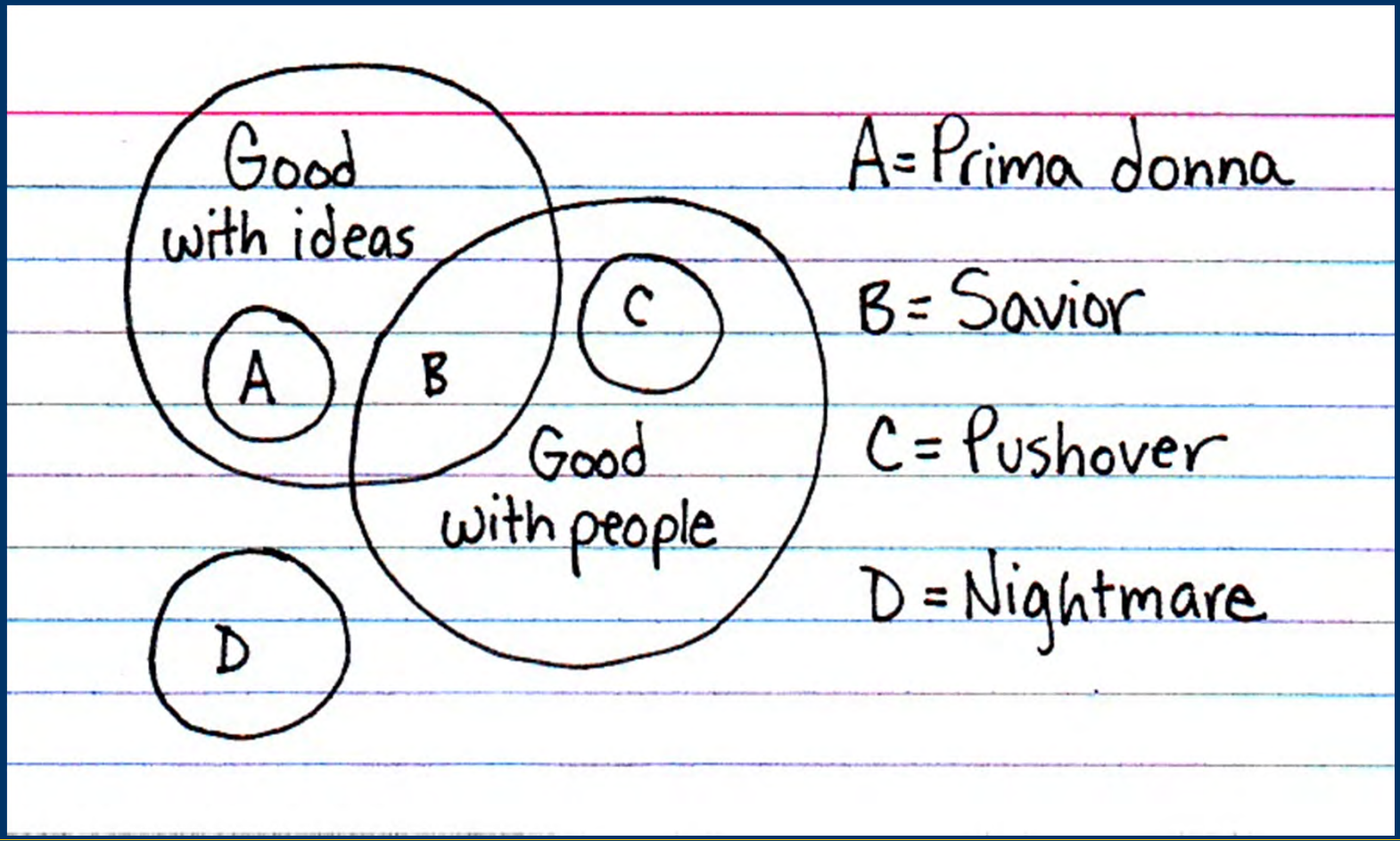
Doing a PhD: What's involved?

- Choose an advisor and a research area
- Write a research proposal, apply & get accepted
- Then do some or all of:
  - Build some stuff (e.g. new multimedia FS)
  - Measure some stuff (e.g. power use on laptop)
  - Evaluate some stuff (e.g. performance of new web server scheduling algorithm)
  - Analyze some stuff (e.g. queuing theoretic model of the Internet)
- Write a dissertation
- Submit and get viva'd – scary!

Choosing an Advisor

- How much time do they have?
- Is their technical background a good fit?
- How do they like to work?
- How do they like their students to work?
  - Ask their students!
- Do they expect you to work on ‘their’ topic (RA for N years)?
- Or do they expect you to come up with your own topic?

B > { A or C } >> D


Good with ideas
A
B
C
Good with people
D
A= Prima donna
B= Savior
C= Pushover
D= Nightmare

Choosing a Topic

- Don’t have to fix on this on day one!
  - Do some stuff, work with others, write some papers, and *then* choose
  - 6 – 18 months is fine
- How to choose something?
  - Read a paper you hate – decide to fix it
  - Read a paper you love – join effort
  - Discover a problem – aim to solve it
  - “Scrabble” – invent something

Risks – Underestimation

- Underestimate PhD
  - “Bob got a PhD for writing a web server – I’ll write a web server too!”
  - (Fail to realize Bob’s PhD was actually about techniques in zero-copy I/O)
  - Read nothing but write lots of code
  - Zero publications, zero justification
- Result:
  - Never submit (“don’t like writing”); or
  - Submit, sit back confidently, and get blown to shreds in PhD exam

Risks - Overestimation

- PhD ~= Nobel prize in Physics
  - All existing problems are simple
  - All existing solutions are stupid / trivial
  - Read everything and dismiss it
  - Invent new words or language or logic or ontology just to *express* the problem
  - Cannot explain problem (or solution) to mere mortals – stupid them!
  - Zero publications (“Not quite finished yet”)
  - Result:
    - Never submit (“No one understands me”)
    - Submit, sit back smugly, get ripped apart in PhD exam, and blame the idiocy of the world.

Risks – Awaiting Orders

- Treat PhD like high school
- Ask supervisor what to do
  - Don’t understand it
  - Don’t agree with it
  - But do it anyway
- Finish task and wait for next task
  - Play WoW or do consultancy in meantime
- Write nothing, read nothing
- Repeat until PhD deadline and realize
  - You don’t have a thesis; or
  - You have a thesis you don’t understand

Risks – Isolation

- Come up with plausible topic and reasonable approach / solution
- Start work, but don't make as much progress as you'd like
- Oh no! Other people seem to be doing fine!
  - Stop coming into department
  - Avoid supervisor
  - Avoid peers
  - Stop showering
  - Heroin
  - Death

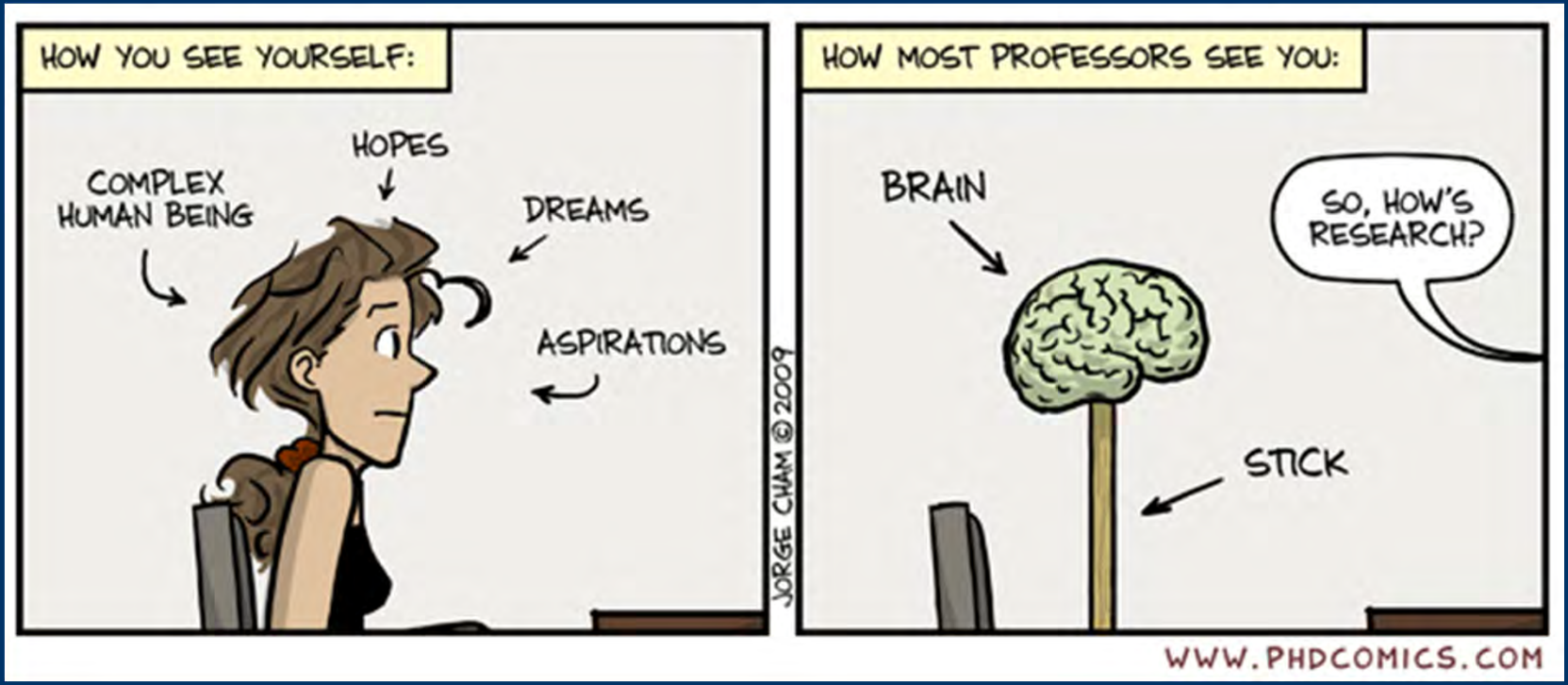
Better Strategies

- Work with others from day one
- From 1 year in, aim to have a current "draft" of your PhD in your head
- Do *something* every month
  - Read + critique a bunch of papers
  - Write some code
  - Do some measurements
  - Write down results, designs, ideas, …
- Dual-task if at all possible: left brain / right brain parallelism

Aside: Breadth is Important!

- PhD itself typically in-depth:
  - You become the expert at something
- But your time on the PhD program should cover more than this:
  - Work with others (& in other areas)
  - Internships particularly valuable
- Post doctoral jobs typically favor a broader outlook (too narrow == bad!)

Managing your Supervisor…



Managing your Supervisor (1)

- Extreme #1: “The Gauleiter”
  - He or she has an idea and/or plan
  - Your job is to carry this out
- Pros:
  - Should be clear what to do
  - Can make progress from day 1
- Cons:
  - Little opportunity for creative thought
  - May feel lack of control or ownership
  - Potential outcomes: frustration, or apathy
- Strategy: read, think & *argue*

Managing your Supervisor (2)

- Extreme #2: “The Don”
  - Vaguely interested in everything
  - Expects you to come up with an idea, and then go off and do something good (but may not mention this)
- Pros:
  - Lots of flexibility and options
  - Lots of positive feedback from supervisor
- Cons:
  - Easy to get stuck, or lost
  - Feedback may be vague or esoteric (low usefulness)
- Strategy:
  - Attempt to engage him/her concretely in your work
  - Impress with your own erudition / intelligence

Managing your Supervisor (3)

- Most supervisors not at extremes, but will have different pros and cons
- Key point: it is *your* responsibility to make your supervisor work for you
  - You're the one who wants to get the PhD
- General Strategies:
  - Have relatively frequent meetings
  - Aim for concrete deliverables (e.g. whiteboard design, or draft paper)
  - Educate: be[come] the expert on your topic
  - Learn to argue/discuss/explain

Aim to Publish

- Writing a thesis with several publications under your belt is a lot easier than doing it from scratch!
  - Plus a good way to exercise your possibly atrophied ‘writing muscles’
- Work with others:
  - E.g. three 3-author papers a year for the same price as one single author paper
- Get feedback:
  - Reviewers are often smart and dedicated
  - And even if they’re not, they’re representative of the research community (i.e. your examiners)

How to Publish (1)

- Start by writing down *something*
  - Hard to publish if don't have a paper :-)
- Starting point usually either "stuff I've done" or "thing I believe"
  - "Stuff I've done" – first write a tech report which just describes it
  - Add `blank' related work section
  - Retro-fit argument of some sort
  - Give to peers / supervisor / others, get feedback, modify, repeat, ...
  - Submit to appropriate workshop / conference (with proximate deadline)

How to Publish (2)

- Or start with an idea / belief
  - Write out skeleton argument
  - Critique related work
  - Work out what you need to actually *do* to back up your argument, and then
    - Sketch out solution in paper, run past peers / supervisor / others, submit position paper
    - And/or start to do actual work
      - Add details / results etc as you go

In Both Cases: Use Others

- Come up with an outline argument
  - Run past peers / supervisor / others
  - Objectively consider feedback
  - Tweak / vastly rework argument
  - Repeat until fixpoint
- Write a position paper or short paper
  - Run past peers / supervisor / others
  - Objectively consider feedback
  - Tweak / vastly rework paper
  - Repeat until deadline

Reasons for Paper Rejection

1. Paper not clearly written (at a word / sentence / paragraph level)
2. Paper not clearly written (at a structural / argument level)
3. Paper clearly written, but:
    1. argument is weak / false; or
    2. solution is obvious / incorrect; or
    3. experiments (or analysis) are poor
4. PC are biased idiots

Writing up

- Need to write a *dissertation* which supports your PhD *thesis*
- Typically 30-60K words:
  - Longest document you'll have ever written
  - Hard to ensure a single "story" throughout
  - Core ("meat") usually 1—3 chapters
    - E.g. design, implementation, eval
    - E.g. technique1, technique2, technique3
  - Produce drafts and get frequent feedback
- Expect 6-12 months just for write-up!
- Day after submission: best day of your life

Summary

- Systems Research is (or can be) fun
  - Can have “real world” impact, or make a fundamental contribution (or both?)
- Keys to success are
  - Engage critical thinking – read a lot
  - Make everything an argument – use your colleagues and supervisor for feedback
  - Be proactive – educate your supervisor
  - Publish (or at least submit) papers

Questions?

- or why not just chat to me over a beer?