Techniques and Methodology of Innovation and Research in Informatics

Masters in Innovation and Research in Informatics, FIB
Temporary Version of the Slides

José L. Balcázar

(with thanks to Fernando Orejas and Colin de la Higuera for sharing with me the contents of their slides, and to Jorge Cham for keeping online his `PhDcomics` cartoons)

Dept. CS, UPC

Spring 2016

Contents

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Personnel

- José Luis Balcázar
  - `jose.luis.balcazar@upc.edu`
  - Omega 225 (2nd floor), 93 413 7847
- Experts on scientific information management from our Library

  (Biblioteca Rector Gabriel Ferraté, BRGF);
- Other personnel on occassion:
  - Prof. Joan-Antoni Pastor, from the ESSI, UPC department, for a deeper view of Methodological Aspects of Research in Computing;
  - Other professors and some friends, for a *panel* on Innovation and the University-Industry interface.

Logistics

- Meeting about twice a week for about 14 weeks:

  Tuesdays, 12:00 – 14:00, A5 106.
  Thursdays, 12:00 – 14:00, A5 106.

  Exception: after the Easter break, several hands-on lab sessions will take place at one of the lab rooms.

  (They will be announced to the class, and a reminder will be issued a couple of weeks before through the Racó.)

- Additional personal conversations as needed:
  - I am usually available before our sessions;
  - recommended to warn me in advance by email;
  - many alternative slots for appointments, again by email.

- Slides at: `http://www.cs.upc.edu/~balqui/slides_tmiri_fall_2016.pdf`,

  undergoing substantial change along the semester.

Evaluation, I

Several separate assessments

1. One oral presentation to the rest of the class;
2. One written review for a research paper;
3. Independent, separately evaluated technological module: Tools for Research and Information Management (TRIM);
4. Almost independent, separately evaluated module on Research Methodologies:
   - most likely in teams;
   - each team prepares a written report on a research method;
   - each team prepares a presentation of their report to the rest of the class, possibly traded for the research presentation.

Evaluation, II

Sources

About the choice of the research papers

both for oral presentation and to write a review on:

- They must be different papers;
- You propose them to me: I must have a look at them before giving green light;
- Their topic must interest you and they must be published recently, e. g. at some conference this year;
- Exception: if at all possible, a paper containing your own research would be ideal for presentation.
- Still doubtful? Look at the table of contents of the last few years of the `Journal of the ACM` and/or some journal from the `ACM Transactions` (or even `IEEE Transactions`) families.

Course Contents

Subject to potential online reordering

Three main topics:

1. Research: Contents and Context;
2. The Social Side of Research;
3. The Human Side of Research.

The true implicit mission of this course:

Course Contents

Subject to potential online reordering

Three main topics:

1. Research: Contents and Context;
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The true implicit mission of this course:

To partially reduce your unavoidable future rant:

"Why nobody told me this before?"

(PhDcomics link.)

Research: Contents and Context

Forget what you saw in the movies

Admittedly subjective perspective!

- Research: what it is, what is it about;
- Research lifecycles and pathways;
- Inductive sciences versus deductive sciences:
  - formal methods,
  - data gathering,
  - modelization and design,
  - experimentation...
- The effects of research in the production sectors of modern society.

The Social Side of Research

Communication is the key

Meaningful research must live on its own!

- Research as human communication;
- Oral presentations;
- The publication process;
- Writing scientific papers;
- Reviewing and refereeing:
  - performing it,
  - suffering it;
- Getting your results trascend academia.

A researchers' life is full of quandaries!

`(PhDcomics link.)`

- Steering your research career:
  - Parallel lives,
  - Focus shifts,
  - Research funding and proposal writing;
- Ethical issues;
- Emotional issues.

Research Is Not For Everyone, I

Why are you here? Are you sure of what you are doing?

"If you are smart enough to earn a PhD, you are smart enough not to pursue one."

Lynn O'Shaughnessy, 2012

`http://www.cbsnews.com/news/12-reasons-not-to-get-a-phd`

Keep in mind:

- Some amazingly smart people get into research and just... suffer.
- Some of these quit early.

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Keep in mind:

- Some amazingly smart people get into research and just... suffer.
- Some of these quit early.
- (Maybe they are the smartest.)
- Your motivation? `(PhDcomics link.)`

Research Is Not For Everyone, II

Find out more about the rules of the game

Further, related recommended reading:

- "Dear brilliant students: Please consider not doing a PhD";
- "Graduate Study in the Computer and Mathematical Sciences: A Survival Guide"
  (and the references therein)
  by Dianne Prost O'Leary, Univ. of Maryland
  (note: very US-based).

Index

Research, I

Main definition

The main definition is not that of “research”: it is that of a

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But... truth is absolute, isn't it?

`A correlation (among many more).`

Research, II

Scientific research

“Truth” has different meanings, from the mathematical to the social.

Mathematical facts:

- their truth is time- and space-independent,

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- Higher risks for the rest.

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- Human-made artifacts are often close enough to their mental models.
- Higher risks for the rest.

Causal analysis in mental models:

the closer their modeled realities are to the mathematical, logical, linear language, the better causal analysis works.

Research, III

A social-based scale of truth: the firmer end

Maybe, some day, learn some epistemology!

(Idealism, empirism, rationalism, pragmatism, constructivism. . .)

The rough path from description to understanding

Success demonstrated by explanation and/or by prediction.

- Formal developments:
  - theoretical explanations,
  - logical consequences.

  Nonscientists may tend to give lower credibility to "theories" than we might expect.
- The inanimated physical world seems to obey laws
  - (but they may depend on the scale of the observations).

Research, IV

A social-based scale of truth: the softer end

Key observation:

Only predictions of the form “will happen here now/soon” can be actually confirmed or refuted.

- Living bodies complexity grows to the extent that absolute generalizations are hardly possible.
- And on into realms that are harder and harder to model with any success:
  - there, the support of “truths” is, often, basically social;
  - economics, medicine, sociology, psychology, naturopathy, theology, esoterism (astrology, tarot). . .

To sort out on yourself through intent meditation:

> Effect on your life as a researcher of your own faith or lack thereof.

Research, V

Socially accepted meanings

OED (Oxford):
1. Endeavour to discover new or collate old facts etc. by critical study.

Webster:
1. Diligent and systematic enquiry or investigation into a subject in order to discover or revise facts, theories, applications, etc.

Wiktionary:
1. Diligent inquiry or examination to seek or revise facts, principles, theories, applications, et cetera; laborious or continued search after truth.

DRAE (verb “investigar”, translated):
2. tr. To perform intellectual and experimental activities in a systematic manner with the aim of increasing the knowledge on a given subject.

Contemporary Research

Three motors

1. Evaluation `(PhDcomics link)`,
2. Cooperation `(PhDcomics link)`,
3. Competition `(PhDcomics link)`.

(That is: Individual, silent struggle with your own thoughts is still necessary, but far from sufficient!)

Evaluation, I

The tool to push towards relevance and scientific rigor

Is the status of my thinking ripe for communication?

Alternatively, should I keep thinking on that particular problem before starting to call attention to my progress on it?

- Informal communication with your colleagues does not count as evaluation.
- Often, what starts as informal communication will end up in cooperation, maybe the necessary cooperation to go on!
- The step forward into evaluation must be:
  - Necessarily in writing, and
  - Clearly labeled as such!

Evaluation, II

Three layers

Progressively wider public:

- Individual assessment: am I convinced that time is ripe to start communicating formally my conclusions?

  (While you are a PhD student, the individual evaluation is not performed by you, but by your advisor instead — but try to learn fast to do it well!)
- Peer feedback: first, you ask your friends for it; then, you submit to a forum to get anonymous feedback.

  (In turn, there are different forums for each level of maturity of the research.)
- Community reaction (if you are lucky and the results are actually published): takes, mainly, the form of citations.

Evaluation, III

Two roles

Consequence:

The same individuals are reviewing each others' work.

- A researcher must learn to write helpful reviews on the work of others.
- A researcher must learn to read, and profit from, reviews on his/her own work.

Believe it or not, neither is easy.

This is why this course includes practice on some of these tasks.

As we shall argue in due time, the collective quality of the reviewing process in a research topic is the major force in shaping the view of the topic from the outside researchers.

Cooperation, I

Many reasons for!

The research team:

A necessity in most fields.

- "Four eyes can see more than two".
- Explaining your thoughts to others helps you enormously to clarify them for yourself.
- Different backgrounds and skills of different persons may complement each other and lead forward faster.
- It makes it substantially easier to recover from frustration.

However, communication needs may grow quadratically; in fact, in many areas, it is unusual that efficient teams reach beyond size 4.

Cooperation, II

Many reasons for, some against!

Team-working opens the door to:

- Free-riders,
- Personality clashes

  (for instance, confrontation for alpha-male roles),
- Dilution of responsibility,
- Progress attribution conflicts...

Making progress with the wrong team is slower and more difficult than alone.

Different teams may have vastly different habits.

Competition

Research is a resource-intensive activity

Resources to commit:

- Time of the researchers:
  - Is it plainly their job?
    But such jobs are relatively scarce!
  - Are they on research in their free time?
    Verbal committments have little value against facts of life (marriage, a child, promotion at work. . .)
- Infrastructures and consumables:
  - Supercomputer cycles?
  - Kill a rat every day?

Most sources of financial support will choose very carefully which research to finance.

Entanglements in the System

The three motors interact, often unpleasantly

- Peer review is, most often, in the hands of personnel from competitor teams.
- Personnel from the same team might not provide objective evaluation.
  - “My colleague’s work is just crap, but I will evaluate it positively so that we can go on with my part which comes next”.
- Proposals of cooperation might come from spurious goals:
  - “Let’s have a team in Hawaii to organize there all our consortium workshops, even if they don’t do anything else!”
  - “Let’s include Herr Prof. Dr. M. in the consortium, because his former students are always evaluators of proposals in this field.”

After all, researchers are humans with all our human frailties like anybody else!

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After all, researchers are humans with all our human frailties like anybody else!

All in all: Welcome to research! `(PhDcomics link.)`

Research Lifecycles, I

How to start?

Researchers are scholars.

Study!,

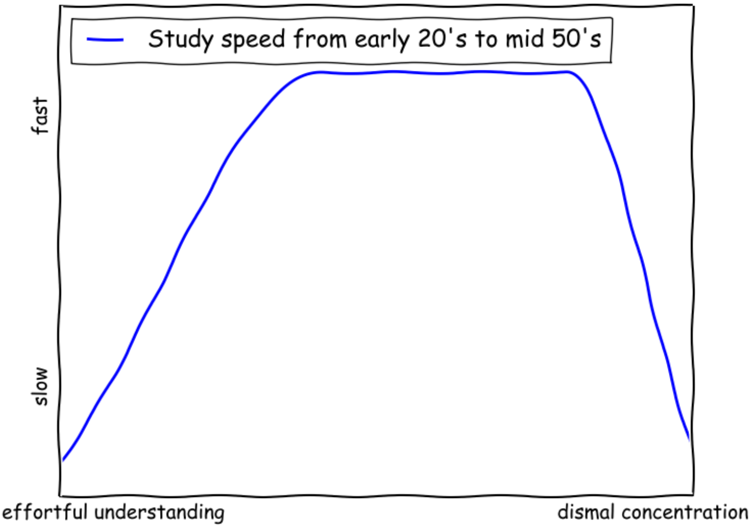
and keep learning forever.

- Books,

  but it may well happen that these days are the last epoch in your life where you read a research book end to end;
- survey papers, which can be extremely valuable,
- research papers:
  - from journals,
  - from “collected papers” books,
  - from handbooks (often consisting of survey papers),
  - from conferences (but often these are less polished),
  - or wherever you find them: arXiv and such web-based collections, internal reports of institutions. . .

Research Lifecycles, II

How fast can you study?



Research Lifecycles, III

Research documents are a graph

Use at length the lists of references!

One day must come where, as you check the list of references of the paper you just got, you know the essentials of what is inside nearly all of them.

Research Lifecycles, III

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One day must come where, as you check the list of references of the paper you just got, you know the essentials of what is inside nearly all of them.

However,

Very important piece of advice: that day is not now yet! "Before going on working on the topics of this paper, I must read its references" …

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“Before going on working on the topics of this paper, I must read its references” ...
...endless loop!

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Very important piece of advice: that day is not now yet!
"Before going on working on the topics of this paper, I must read its references" ...
...endless loop!

> Be courageus, start on, run the risk of replicating work already done, run the risk of committing gross mistakes.
>
> Sorry, there is no other way.

Research Lifecycles, IV

How to trace studying routes on the vast human knowledge map?

Some options:

- Attend talks and seminars `(PhDcomics link)`.
- Keep track of the home page of
  - prestigious authors,
  - your favorite authors.
- Keep track of the contents of
  - prestigious journals,
  - selective conferences.
- Seek advice about good papers to read (do this forever!).
- Study things related to your current main goals,
- but also unrelated ones!

  Connecting apparently unrelated ideas is a great source of scientific progress.

Research Lifecycles, V

But your mileage may vary

Main hint:

Count on making yourself unique.

Research Lifecycles, V

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You will anyhow.

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Main hint:

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- For you, “some papers are more equal than others”.
  - For some, you must get to understand up to all tiny details;
  - for many, you must work them out in some depth;
  - for many others, it will suffice to know a good approximation to what is inside.

Research Lifecycles, V

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Main hint:

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- For you, “some papers are more equal than others”.
  - For some, you must get to understand up to all tiny details;
  - for many, you must work them out in some depth;
  - for many others, it will suffice to know a good approximation to what is inside.
- Study, not only the what, but the how.
  - There is a very efficient algorithm - where is the trick?
  - A theorem guarantees that this fact holds - what makes the proof work?
  - Some nontrivial system supports a process - why is it a good idea to organize it in that way?

Research Lifecycles, VI

The turning point

Additionall skill to acquire:

detect somewhere room for further contributions.

(PhDcomics link.)

Research Lifecycles, VI

The turning point

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detect somewhere room for further contributions.

`(PhDcomics link.)` BUT... HOW?

- perspectives and future work of papers and presentations

  (but be careful not to replicate what the authors have been doing next),
- open problems in (recent!) books;
- develop a "let's do better!" attitude when reading;
- listen to everyone!, your next project might come from a conversation with a parent at your children's school door.
- But don't steal your office mate to-do list:

  at most, if you like it very much, humbly offer help.
- Initially your advisor might help, but only initially... if at all!

Research Lifecycles, VII

The rough path to progress

Magic will not be a solution: hence, the research problems you tackle should not be too difficult... but not too easy either!

Some options:

- Something admittedly does not work as desired, or there is a mistake in a published work.
- Something works as desired but it is unclear why.
- A new technique just published could be applicable to other problems.
- A new solution may exist for an already solved problem (but it must be novel enough to become interesting).
- Someone indicates a problem widely known as open.
- You identify a problem as open for the occassion (but then you have an extra difficulty in motivation).

Research Lifecycles, VIII

There is no “right” focus width

Some great researchers “wander around” open seas of knowledge and contribute far-reaching visions.

Many of us focus on a varied set of relatively small goals.

`(PhDcomics link.)`

Keep focus, but don’t be too afraid of losing focus!

1. Study;

Research Lifecycles, VIII

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Keep focus, but don’t be too afraid of losing focus!

1. Study;
2. study,
3. study!,
4. While you are at it, keep detecting somewhere room for further contributions!

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5. For instance, variations of your problem; but not only that!

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2. study,
3. study!,
4. While you are at it, keep detecting somewhere room for further contributions!
5. For instance, variations of your problem; but not only that!
6. Most researchers always have up to half a dozen different ongoing projects.

Research Lifecycles, IX

Got a problem you feel like tackling?

And, mainly,

think hard about your problem:

- talk to others about the problem and your ideas about it,
- use deadlines to put pressure on your brain,
- jot examples down on your notebook again and again:

  there will be no progress until you gain intuition about what obstacle lies behind;
- and keep thinking until
  - a/ progressing on the problem,
  - b/ giving up,
  - c/ death do you part.

Research Lifecycles, IX

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  there will be no progress until you gain intuition about what obstacle lies behind;
- and keep thinking until
  - a/ progressing on the problem,
  - b/ giving up,
  - c/ death do you part.

    The last option will be available only for a handful of problems along your lifetime.

Research Lifecycles, X

SUCCESS!

Hopefully, one day, you have an idea about (one of) your problem(s).

THAT'S IT?

Research Lifecycles, X

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SUCCESS!

Hopefully, one day, you have an idea about (one of) your problem(s).

THAT'S IT? No way! The fun is yet about to start!

1. Develop the idea,
2. go through the appropriate tests (mathematical proofs, experiments for empirical validation. . .),
3. see that the idea does not work.

Research Lifecycles, X

SUCCESS!

Hopefully, one day, you have an idea about (one of) your problem(s).

THAT'S IT? No way! The fun is yet about to start!

1. Develop the idea,
2. go through the appropriate tests (mathematical proofs, experiments for empirical validation...),
3. see that the idea does not work.
4. Don't give up, come up with another one, and yet another one...
5. ...until one "sorts of works", maybe not impressively.

Then we are talking business!

Research Lifecycles, XI

The road to publication

Development of a publishable solution

A path full of detours and backtracking.

1. Keep developing your ideas,
2. Write them up!
3. Get feedback on the write-up, find out what parts are not understandable, write it up again and again, and continue developing the ideas.

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4. STUDY!

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4. STUDY!
5. Get scientific feedback from write-ups and/or oral presentations (standard sequence: workshops, conference submissions, journal submissions), and…

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`(What exactly is a doctorate?)`

Researcher Evaluation, I

Individual!

Researchers are evaluated on the basis of their writings

and on the consequences of their writings.

Why?

Competition for resources:

- Jobs (research positions),
- Grants (research expenses coverage),
- …

How?

Serious difficulties arise:

- Identity issues,
- control of the effort spent in the evaluation.

Related memos by the CRA in

`http://cra.org/cra-best-practice-memos`.

Researcher Evaluation, II

Who am I?

Troublesome combination:

- Large set of people involved, growing daily;
- heavily interconnected networks of people and of topics.

Mechanisms to identify researchers:

- Commercial-based, mainly through publishers;
- network-based.

  UPC recommends `ORCID` (let's see an `example`).

Researcher Evaluation, III

Measurements

Goal:

Predict future Nobel award laureates and such.

- Wrong assumption that it suffices to fund the top few.
- Far too many latent variables for decent prediction.

Researcher Evaluation, III

Measurements

Goal:

Predict future Nobel award laureates and such.

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Proxies:

- Prestige and/or selectivity of conferences and journals where the papers are accepted.
- Global impact: citations received by papers globally in these conferences and journals.
- Impact: citations received by the researcher under evaluation.

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- Global impact: citations received by papers globally in these conferences and journals.
- Impact: citations received by the researcher under evaluation.
- A citation does not imply that the paper was read.
- Even if it was, does not imply that it was found interesting.

Researcher Evaluation, IV

Fashionable indices

The real impact:

How many people read the paper and found it interesting.

- Unfortunately unavailable.
- Agencies make do with plain numbers of citations.
  - "If I cannot measure what matters, I'll force what matters to be what I can measure".
- Balance between many papers with few citations each and a few papers with many citations.

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  - The *h*-`index`: N means having at least N papers published, each of which has received at least N citations.
  - Several alternatives (*g*-index, *w*-index, *i*10-index. . .)

`An opinion` by Prof. `Lance Fortnow`, `Georgia Tech`.

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A nonexisting person with high *h*-index: Ike Antkare,

`http://www.google.es/search?q=ike+antkare`.

`An example of a real person.`

Innovation, I

One possible definition

What innovation and research have in common:
you are doing something you never did before.

Innovation, I

One possible definition

What innovation and research have in common:
you are doing something you never did before.

But they differ in a couple of aspects:

Research:

- Not just you: the existing literature indicates that nobody else anywhere in the planet did it before.
- Most likely, substantial expenses were incurred.

Innovation:

- No "nearby" competitors (or "few") are doing it.
- Substantial earnings were aimed at.

Innovation, II

There are many different definitions

Innovation

A couple of further attempts at definitions:

- “Creativity is when you use money to get ideas. Innovation is when you use ideas to make money.”

  (Jatin H. DeSai)

- “Ideation is applied knowledge; creativity is applied ideation; invention is applied creativity; and innovation is the successful commercialization or adoption of radical invention.”

  (Peter Balbus)

See also:

`25 definitions of innovation` by Hutch Carpenter.

Not an absolute concept!,

but a scale with many degrees.

Innovation, III

Categorization

Several possibilities for innovation focus:

One we discuss a bit further:

- Product or service innovation (both either material or digital): if they are new or improved.

Other variants that we will not discuss:

- Process innovation: improvement in how product or service is obtained (e.g. faster, cheaper, with less defects...),
- Commercial innovation: different way of selling the same product (e.g. redesigned fares, web advertising...),
- business model innovation, and several others...

Innovation, IV

Advantages of product or service innovation

Product or service innovation

has often higher time-sustainability and is hence more profitable:

- More difficult to replicate by the competitors!
- Leverages internal knowledge.
- Intellectual Property forces a replication delay.

Also, it generates jobs more clearly than the others.

Most profitable product innovations depend on a subtle balance between marketing (the client's voice) and R+D within the company.

Innovation, V

From the perspective of impact

According to impact, an innovation can be:

- Incremental, which improves the current products, or
- disruptive, which fully changes the rules of the game.

Incremental innovation

is necessary as it benefits both companies and clients.

Disruptive innovation

- is more difficult to implement successfully but
- has more potential for growth, evolution, and job creation.

Innovation, VI

The debate about disruptive innovation

Source: `The Innovator's Dilemma` by `Clayton Christensen`, and various follow-ups (chase them on yourself if interested).

Is disruption desirable?

"Disruptive innovation" sounds so good. . .

Innovation, VI

The debate about disruptive innovation

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Is disruption desirable?

"Disruptive innovation" sounds so good...

- Consequence: the term became a highly overused cliché!
- "Everybody wants to disrupt somebody else".
- Serious debate all over. A couple of recent pointers:
  - Heavy critique of Christensen by `Jill Lepore` in The New Yorker: `The Disruption Machine: What the gospel of innovation gets wrong`.

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  - Heavy critique of Lepore by `Clark Gilbert` in Forbes: `What Jill Lepore Gets Wrong About Clayton Christensen and Disruptive Innovation`.

Innovation, VII

A glimpse of the argumentations

For instance:

“Replacing ‘progress’ with ‘innovation’ skirts the question of whether a novelty is an improvement: the world may not be getting better and better but our devices are getting newer and newer.”

Jill Lepore

`The Disruption Machine:`
`What the gospel of innovation gets wrong`

Related fallacy:

`http://en.wikipedia.org/wiki/Appeal_to_novelty`

Innovation, VIII

Choosing the concept

How to innovate?

Needs open-minded thinking, maybe as R+D within a company.

- User-centered design

  (requires deciding who your target users are).

- The blue/red ocean parable

  (an European contribution, `see Wikipedia`):

  - Red oceans: everyone else is fishing around, competing with you for catch, which is guaranteed to be there;
  - Blue oceans: you managed to navigate to a place where absolutely no one is fishing... there might be no fish either!

    You would be here after unconventional success: covering for an undetected, latent need.

How about becoming a founder instead of a PhD?

Differences between:

- Company,
- Innovative company,
- Startup

  (see also: https://en.wikipedia.org/wiki/Lean_startup).

> "A startup is a company designed to grow fast. Being newly founded does not in itself make a company a startup. [...] Everything else we associate with startups follows from growth."
>
> Paul Graham, Y-Combinator (links later on)

Innovation, X

An old pun again and again

Several application cases of the “pain/gain” joke:

- Regarding the innovation proper:
  - innovation must solve some need (pain), and/or
  - must provide some benefit (gain) that competitors don’t.

  (Is your innovation “aspirin” or “morphin”? — Steve Blank)
- Regarding the process by which an innovation would be successful:
  - how to find a client who would gain from the innovation?
  - how difficult is it for that client to actually implement the innovation, how much pain the client organization has to go through?

Innovation, XI

Crossing the chasm

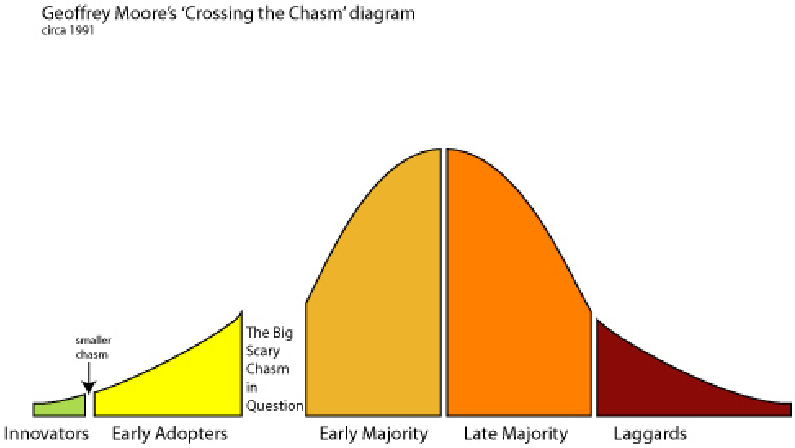

Image by Ron Mader,
Creative Commons Attribution 2.0 Generic (CC BY 2.0)

Innovation, XII

The most important step

From the idea to reality

1. Define your innovation,
2. study
   - about the context for your idea (market, competitors. . .)
   - about business model options. . .
3. set up the team,
4. find funding,
5. develop the innovation,
6. nurse and feed it to make it grow.

Which is the most crucial step?

Innovation, XII

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Which is the most crucial step?

The team!

(Why?)

Innovation, XIII

Roles in the innovation team

(Of course, each person plays several of them!)

- The revolutionary, a tsunami at brainstorms,
- the artist, knows what sort of perfection will work,
- the judge, pragmatic aware of market and resources reality,
- the magic maker, aligns all the resources and people,
- the troubleshooter, a cold-blooded Swiss army knife,
- the customer champion, can explain what the clients need,
- the conscript, prefers to focus on execution,
- the evangelist, converts the pagans into clients, and
- the connector, puts all of them together.

Source: `Braden Kelley`, `The Nine Innovation Roles`

Innovation, XIV

Further reflections from the same source

> "Of course, we know that people are not interchangeable, yet we continually pretend that they are anyway — to make life simpler for our reptile brain to comprehend. Deep down we know that people have different passions, skills, and potential, but even when it comes to innovation, we expect everybody to have good ideas.
>
> I'm of the opinion that all people are creative, in their own way. That is not to say that all people are creative in the sense that every single person is good at creating lots of really great ideas, nor do they have to be. I believe instead that everyone has a dominant innovation role at which they excel, and that when properly identified and channeled, the organization stands to maximize its innovation capacity."

`Braden Kelley:`

`Stoking Your Innovation Bonfire`

Innovation, XV

The educational background of the team

Little study of a few dozen very successful companies

made by T. Tunguz from Redpoint Ventures (and formerly Product Manager for Google's Social Media), taken (almost) verbatim from his blog (link later on):

- No correlation between fraction of technical founders and ultimate success: equal number of successful technical teams as non-technical teams as semi-technical teams.
- As many dropouts as MBAs among these teams.
- Slight bias towards technical teams in enterprise companies particularly where technology is the main differentiator.
- But in the consumer world and in software as a service, there seems to be no patterns.

Innovation, XVI

Quoting Tom Tunguz literally

"The magic [of Silicon Valley] is that there is no path, no formula, no stencil for how to be successful. There is no university one must attend, no incubator one must join, no technology one must master to be successful. Every entrepreneur has a different route to their successes.

But I do think there is one common element among entrepreneurs: an open mind — a mind receptive to new ideas, new people, new disruptions, new pivots and new ways of challenging commonly assumed precepts."

Tomasz Tunguz, Redpoint Ventures

Innovation, XVII

Sources from VC blogs

`http://tomtunguz.com`:

"data-driven blog posts about key questions facing startups". In particular, post cited above is: `tomtunguz.com/founders-with-cs/`

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“The way to get startup ideas is not to try to think of startup ideas. It’s to look for problems, preferably problems you have yourself.”

Methodology of Research, I

A study of debatable interest for individual researchers

Epistemology

"is the study of knowledge and justified belief. It questions what knowledge is and how it can be acquired, and the extent to which knowledge pertinent to any given subject or entity can be acquired." (`Source: Wikipedia`.)

- Research Methodology: the study of the methods employed in research.
- Not to be confused with the specific research method(s) employed in one concrete piece of work.

  (`PhDcomics link.`)

(But: who needs to study research methodology?)

(If you understand Spanish: a 5'50" `joke`.)

Methodology of Research, II

Arriving to knowledge (source: again Wikipedia!)

From potential facts to potential facts

Inferential schemes:

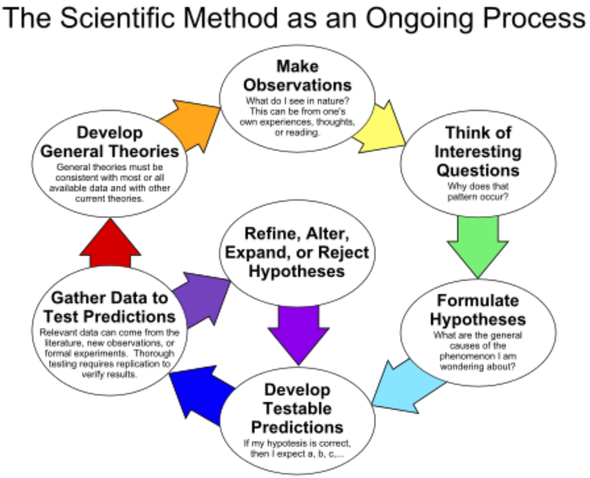
Deduction	All the beans in this bag are white, these beans are from this bag... Hence these beans are white.
Abduction	All the beans in this bag are white, these beans are white... Looks like these beans are from this bag.
Induction	These beans are from this bag, these beans are white... Maybe all the beans in this bag are white.

Only deduction is sound, but its usefulness is limited!

Variants balancing soundness and usefulness:
complete / structural induction.

Methodology of Research, III

One well-established method



`Source`: Prof. Th. Garland, UCR (and Wikipedia)

Methodology of Research, IV

Curiously, for must of us, not our cup of tea

The Scientific Method

Evolution (with considerable sophistication) of plain empiricism.

This most venerable research method, however, actually plays relatively little role in Computing. `(PhDcomics link.)`

Some areas head in that direction but are still mostly just reaching at the early (and somewhat discredited) stages of merely inductive empiricism:

- Evaluation of designs in some areas,
- Data Analysis and Machine Learning,
- a bit of Algorithmics, see e.g. `Sedgewick`,
- ...

Empiricism

The “scientific method” in current computing research: a long take-off

> “In a random sample of all the papers ACM published in 1993, the study found that 40 percent of the papers with claims that needed empirical support had none at all. In software-related journals, this fraction was 50 percent. The same study also analyzed a non-computer-science journal, Optical Engineering, and found that the fraction of papers lacking quantitative evaluation was merely 15 percent.”

Walter F. Tichy
(Karlsruhe Institute of Technology):
Should computer scientists experiment more?

(See also: Tichy, Lukowicz, Prechelt, and Heinz 1995; later improvements in some areas are described in the first session of a 2006 Dagstuhl workshop and in Tichy 2014.)

Methodology of Research, V

How to organize our views of our various research methods?

We choose 5 axes

and will later situate each research method in its corresponding zone along each axis.

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and will later situate each research method in its corresponding zone along each axis.

- **Stability:** Very stable object of study (like in Physics) / Very unstable (like in Psychology);
- **Attitude:** Descriptive / Evaluative / Formulative;
- **Measures:** Widespread measurements (quantitative methods) / Nonexistent (qualitative methods);
- **Precision:** Slightly more precise than every-day life / Inhumanly precise;
- **Values:** Intellectual / Instrumental.

Of course, each axis includes all the intermediate points.

Methodology of Research, VI

The stability axis, following Kant / Windelband / Rickert

Nomothetic thinking is based on a tendency to generalize.

- The effort is to derive laws that explain objective phenomena in general.
- Object of study is considered stable.
- Typical for the natural sciences (but not restricted to them).

Idiographic thinking is based on a tendency to specify.

- The effort is to understand the meaning of contingent, unique, and often subjective phenomena.
- Typical for the humanities (but not restricted to them).

This duality is very important in such topics as Psychology.

(See again `Wikipedia`, and the references and hyperlinks in that page, for further developments.)

Methodology of Research, VII

The attitude axis

Approaches:

- Descriptive (a system, a naturally occurring species, a body of literature...);
- Evaluative (critical, deductive...);
- Formulative:
  - Process, method, algorithm...
  - Concept, model...
  - Framework, guidelines, standards...

Methodology of Research, VIII

The intellectual process axes

Main ingredients

The “brick and mortar” of thought and communication may be:

- mainly linguistic (qualitative research),
- mainly numeric (quantitative research), most often through outcomes of measurements.

How are they used?

The level of semantical precision may be:

- human (as commonly employed by educated people, when they are careful about what they are saying),
- inhumanly precise (as in Logic and other Math fields).

The precision required in some aspects of Computing is even more inhuman than in Mathematics.

Research Methods versus Research Values, I

A view contributed from Computing

> “Each scientific discipline has two faces: An intellectual face, which corresponds to an interest in understanding a specific type of phenomena, and an instrumental face, which corresponds to an interest in using such an understanding in order to predict and/or affect (or manipulate) the environment. These two ‘faces of science’ are intimately related.”
>
> `Oded Goldreich` (`Weizmann Institute of Science`): `On Intellectual and Instrumental Values in Science`

Research Methods versus Research Values, II

From the same source

The intellectual cluster pivots at:

- understanding,
- study,
- curiosity...

The instrumental cluster pivots at:

- applicability,
- measurable achievements,
- technical competence...

Research Methods versus Research Values, III

A permanently shifting landscape

The intellectual cluster

is aligned mostly with `critical rationalism` and other classical approaches in epistemology.

The instrumental cluster

is aligned mostly with `pragmatism`, which considers thought an instrument or tool for prediction, problem solving and action.

But: Never attempt at seeing them as disjoint!

> (Then, Goldreich goes on to discuss whether a relevant landscape shift happened along the last few decades, and whether that shift requires action now.)

Methodology of Research, IX

Company along the learning path

How do researchers become researchers?

Standard path: akin to "apprenticeship":

"Learning by doing".

- Work closely with a supervisor ("PhD advisor" role);
- often, in the context of a "research group" (akin to "schools" or "workshops" in Fine Arts):
  - learning by doing with your colleague students;
  - learning by doing from your colleague students.

Methodology of Research, X

Along the way

To learn

Several aspects, all compulsory:

- "what's" (topics: hot and cold, questions: big and small,...),
- "how's" along the research task proper: research methods,
- "how's" along the whole social phenomenon surrounding research.

In most of the hows and almost all the whats, there is no substitute for the apprenticeship scheme.

Methodology of Research, X

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In most of the hows and almost all the whats, there is no substitute for the apprenticeship scheme.

Which means that this course is actually unnecessary.

Even as we cover here methodology and much more, many "fine tuning" aspects can only be grasped by apprenticeship.

Methodology of Research, XI

Most common methods in Computing

Conceptual Analysis

Mainly nomothetic, can be seen as encompassing

- Design Research (a bit more quantitative than qualitative),
- Mathematical Models and Proofs (somewhat more often qualitative).

Less common, but notably present as well:

- Survey Research (nomothetic, most often qualitative),
- In-Depth Case Study Research (mainly idiographic),
- Action Research (mainly qualitative),
- Ethnography Research (idiographic, mainly qualitative),

and many others to much lesser a degree.

(Glass, Ramesh, Vessey: `An analysis of research in computing disciplines` provides further perspective.)

Methodology of Research, XII

Methods versus values

All methods can be used both in the intellectual and in the instrumental clusters.

However, rather vaguely,

- Design Research and Action Research are somewhat closer to the instrumental values;
- Mathematical Models, Ethnography Research, and Survey Research are often closer (to various degrees) to intellectual values;
- Case Study Research is often used in research within both sets of values.

Methodology of Research, XIII

Other options

Additional feature of Computing (in general): Eclecticism.

- Did you get something interesting or something “that works”?
- Then, many colleagues would not care a dime for the methods you used.
- Risk: unreliable “results” obtained via nonscientific methods may sneak in and... remain!
- Watch out!

Often, two research methods are combined in the same study (or more, but then it risks becoming messy), in order to profit from the complementary strengths.

Eclecticism brings a bit of “identity issues”; see for instance: “`Is Computer Science science?`” by `Peter Denning`, and `additional pieces` of the same author.

Towards Design Research

Single-cycle view (insufficient)

The design cycle

1. Design and build artifacts and/or processes,
2. evaluate them,
3. return to point 1.

Key questions:

- Is it clear why to design and build the artifacts and/or processes?
- Are there difficulties in planning how to evaluate them?
- Are the design and evaluation somewhat beyond the regular abilities of professionals in the job market?

Design Research requires three positive answers.

Design Research

Three-cycle view (`Hevner`, see also the main `diagram`)

The relevance cycle

extends the design cycle into the application environment.

1. Study the interaction with the application world,
2. design and build artifacts and/or processes,
3. evaluate them,
4. return to point 1.

The rigor cycle

extends the design cycle connecting with the knowledge base.

1. Ground your knowledge on what is already known (study!),
2. design and build artifacts and/or processes,
3. evaluate them,
4. contribute to the existing knowledge,
5. return to point 1.

Mathematical Proofs, I

Variations in the concept

What does your field call “a proof”?

In practice, it is a social construct!

- Full formalization?
  - Desirable properties of reliability,
  - but unfortunately error-prone;
  - particularly useful if software support exists
    (automatic or interactive theorem provers).
  - Sometimes fun to work out completely.

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    (automatic or interactive theorem provers).
  - Sometimes fun to work out completely.
  - Sooooo boring to read.
- Semi-formalized English?
  - Most common by far.
  - Very varied degree of formalization, from sloppy narratives to texts very close to full formalization.
  - Formal fragments in the form of algebraic manipulations or calculus.

Some fields in Computing resort to no math at all, but many do.

Mathematical Proofs in Computing Research

Helping other methods, or on itself

Frequent uses:

- Direct combination with "Design Research": most often, to validate a design (prove correct an algorithm, for instance).
- Indirect combination with "Design Research": most often, identify dead alleys (e. g.: comparison-based sorting requires $O(n \log n)$ time).
- On itself:
  - Analysis of properties of notions developed in other research tasks (e. g.: important properties of existing algorithms);
  - *TST*, "Theory for the Sake of Theory", sometimes derided as not sufficiently useful, but has given us actually important progress.

Let's not miss here our "Millenium Problem"! `P=NP?`

Mathematical Sufficiency

How much math can you handle? how much do you need?

Good situations:

- Can't handle any, but do not need any.
- Barely can handle some, but do not need more.
- It's quite a bit of it that shows up at my work, but luckily I'm proficient enough for it.
- I have a mathematician as co-author.
- I am a mathematician.

But: just in case you do not find a mathematician you can work with, and your work suddenly acquires a formal facet, you should keep improving your math abilities!

`(PhDcomics link.)`

Mathematical Proofs, II

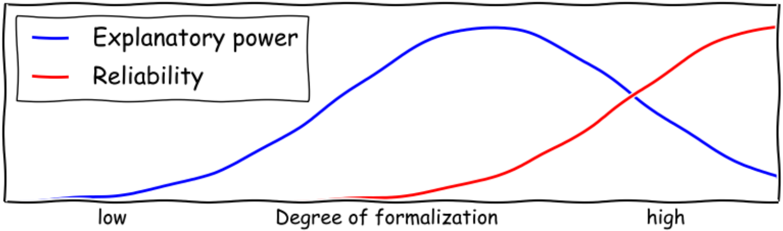
Intrinsic conflict

Why different habits?

Proofs are expected to serve a dual purpose!

- Ensuring the truth of statements,
- explaining the reasons why statements are true.

    The second purpose is much more common in Computing than it was in traditional Mathematics.



Mathematical Proofs, III

The fully formalized case

Proofs under full formalization

Only one case is actually pretty common:

Sequences of algebraic (in)equalities or calculus, e.g.,

If $sup(Z) \leq mxs_\tau(X) = \gamma * c_1$ and $c_1 < sup(X_0) \leq sup(Y)$,

$$\frac{sup(Z)}{sup(Y)} \leq \frac{mxs_\tau(X)}{sup(Y)} \leq \frac{mxs_\tau(X)}{sup(X_0)} = \frac{\gamma * c_1}{sup(X_0)} < \gamma$$

Quite infrequent usage beyond this:

- effortful to write;
- effortful to read with, often, little gain in understanding;
- usage widening slowly but steadily.

Many aspects still live in narrative, semiformalized proofs:

- like contrapositives ($A \Rightarrow B$ versus $\neg B \Rightarrow \neg A$), proofs by distinguishing cases...

Potential advantage of full formalization

Support from automated or interactive theorem-proving programs:

- State-space exhaustive exploration for models like transition systems, Petri nets...
- Constraint solvers (SAT, SMT...);
- Rewrite systems, Model checkers, and other interactive theorem provers for formal logics;
- Custom programs (e.g. for the proof of the 4-color theorem).

Slowly converging syntax proposals are leading to proof repositories.

Mathematical Proofs, V

A more common case

Narrative proofs

Relatively informal descriptions of how one would construct the formal proof.

- Text, often liberally interspersed with mathematical expressions.
- Attempt at being useful for understanding why the argued facts hold, besides proving them.
- Sometimes, supported by visual illustrations (like diagrams):
  - extremely instructive if the author invests effort in their design and creation,
  - but occassionally dangerous!

Mathematical Proofs, VI

Tasks for PhD students in Computing

To develop:

a knack for the sort of mathematical proof expected in your area.

- Community-defined! (Social construct alluded to above.)
- Mostly on your own!
- Advice: Construct for yourself proofs as formalized as you can; but publish narrative, explanatory versions.
- Try to distinguish in your texts the parts that explain how the proof works, from the proof proper.
- Risk: it is nontrivial to distinguish an acceptable narrative proof from a bunch of “prove-babble” sentences that do not support the intended conclusion.

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- Risk: it is nontrivial to distinguish an acceptable narrative proof from a bunch of "prove-babble" sentences that do not support the intended conclusion.
- Even worse risk: it is nontrivial to distinguish an acceptable narrative or formal proof from an almost acceptable, but subtly erroneous, narrative or formal proof.

Mathematical Proofs, VII

"Proofs without words" or their modern version, "proofs by YouTube"

Risk:

Nice and clear diagrams may suggest that a property holds in general, when it might only happen to hold for particular cases.

- If well-designed, wonderful for explanation.
- Helpful to follow up the proof without getting lost.
- Definitely insufficient as proofs, properly speaking.
- Some examples:
  - The `Difference of Squares identity.`
  - The `Mutilated chessboard problem.`
  - The `Pythagorean Theorem` (lots of alternatives, e. g. `http://www.youtube.com/watch?v=pVo6szYE13Y`).
  - `The curious identity` $64 = 65$.
  - `"A collection of beautiful proofs"`, by Edsger W. Dijkstra.

Mathematical Proofs as Adversaries, I

Where is the difficulty?

Potential hurdles

Any of these may turn out to be difficult, or next to impossible (or, bad luck, maybe impossible altogether!):

- Understanding why what you claim is actually true.
- Identifying the conceptual constructs that allow you to express that understanding.
- Characterizing the relevant properties of these constructs.
- Arguing convincingly that actually your constructs do enjoy these properties.
- Arguing convincingly that all the ingredients you came up with entail whatever is your claim.
- Explaining the whole thing, complete and without holes, in a clear and enlightening manner.

Mathematical Proofs as Adversaries, II

Some of the dangers

Very incomplete list of famous causes of errors:

- Stated some expression with "dots":

  $$1 + (-1) + 1 + (-1) + 1 + \cdots;$$

- Forgot to check truth of some intermediate statement

  (for instance, proved set inclusion or implication in one direction and forgot that the other was also needed);

- Forgot to test divisor $\neq 0$;
- Multiplied or divided by a negative number inadvertently, and hence forgot to reverse the inequality;
- Misunderstood how a variable was quantified;
- Mixed up the ordering in which quantifiers were to apply;
- …

Quantification, I

Frequent source of errors

Many assertions are either

- universal, $\forall x\, P(x)$, or
- existential, $\exists x\, P(x)$.
  - A single example suffices to prove an existential assertion;
  - or, if reasoning by cases, one per case.
  - Proving universal statements is often more difficult.
  - One useful approach is induction.
  - The negation of a universal assertion is existential: therefore, a single counterexample suffices to disprove a universal assertion.

Understand and be careful with the difference between

$$\forall x\, \exists y\, P(x, y) \qquad \text{and} \qquad \exists x\, \forall y\, P(x, y).$$

In narrative proofs, it is often difficult to see exactly how each variable is quantified.

Quantification, II

A quote from Mathematics that definitely applies as well to Computing

"As has been occasionally remarked, the human mind seems limited in its ability to understand and visualize beyond four or five alternations of quantifier. Indeed, it can be argued that the inventions, subtheories, and central lemmas of various parts of mathematics are devices for assisting the mind in dealing with one or two additional alternations of quantifier."

Hartley Rogers, Jr. (1967)

Key question:

What is the reader of the proof supposed to know beforehand?
While keeping that question in mind, try your hand at:

- There are irrationals a and b such that a^b is rational.
- Parity of $a + b$, $a * b$, a^2 in relation to the parity of a, b.
- For consecutive naturals a, b: $a^2 + b^2 - 1$ is divisible by 4.
- If $n = 2k$, then $n!$ is divisible by 2^k.
- For every $n \in I\!N$ with $n \geq 14$, there are x, y such that $n = 3 * x + 8 * y$.
- For $x \in I\!N$ and $y \in I\!N$, if $x * y = 0$ then $x = 0$ or $y = 0$.
- Let $f : I\!N \to I\!N$ be such that always $f(x + y) = f(x) + f(y)$. Then, for all $x \in I\!N$, $f(x) = f(1) * x$.
- The mutilated chessboard problem, for different board shapes and different mutilation procedures.

Index

Scientific Communication Channels, I

Principal axis: expected author-reader time scale

Two goals

(sometimes conflicting):

- dissemination of results so that other researchers can pick them up and weave them into their work,
- archive of results so that we can trace the existing knowledge no matter how long back (in principle at least).

Scientific Communication Channels, II

A source of difficulty

Good archival versions are not easy to write!

Potentially, they are to be read years later: topics and notation may have changed, readers may have completely different education and priorities.

- High completeness degree,
- utmost clarity in explanations,
- less assumptions about what is to be known beforehand,

all require to insist in rewriting and gradually improving the text further and further: a slow process.

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- less assumptions about what is to be known beforehand,

all require to insist in rewriting and gradually improving the text further and further: a slow process.

Hard to conciliate with rapid dissemination!

Scientific Communication Channels, III

Secondary axis: information vehicle

Complementary approaches:

- Written: able to provide a good level of detail.
  - Immediate dissemination: preliminary reports, workshop and conference proceedings, (modern) author homepages. . . ;
  - archival versions: journal articles, book chapters, survey texts, books. . .
- Oral: good for transmitting key intuitions and advertising.
  - Immediate dissemination: workshop and conference presentations;
  - archival versions (very modern): video recordings (TED, videolectures.net. . .).

Few people are very good at both ways of communicating!

Oral Presentations, I

Visual support in oral communication

In some research areas, oral communication has a tradition of employing joint visual support.

- Often "slides",
- sometimes video.

Why?

- Very good if done well,
- but a bit difficult to do well.

Oral Presentations, II

Advantages of using slides at talks

What the visual support is for:

- Provides a guideline of the contents, useful both for speaker and listeners.
- Gives you an approach to the task of preparing the talk.
- Helps in maintaining the attention of the audience:
  - (Always a challenge!)
  - May augment variety of form in conveying the message;
  - may help distracted listeners to get back in track.
- Is capable of supporting communication of graphical information.
- Some people are better at understanding what they hear, some at what they read: combining both may be helpful.
- However: be aware that no one does both at once.

Oral Presentations, III

Dangers of using slides at talks

What the visual support is not for:

- Covering for your shortcomings:

  A good talk is a talk that could be given with little or no visual support.

- Reading the slides aloud.

Oral Presentations, III

Dangers of using slides at talks

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  A good talk is a talk that could be given with little or no visual support.

- Reading the slides aloud.

  It won't work!,

  Most listeners will process both sources,
  reading and hearing:
  if they are identical, attention is lost, and is hard to recover.

  Memorizing the talk won't work either:

  you must definitely work out your command of the language of presentation.

Oral Presentations, IV

Similar considerations for several different contexts

Research talk opportunities:

- Presentations at conferences;
- seminars at your own group;
- seminars at other places,
  - traveling, or
  - in the same region but to a different group;
- the PhD defense!

Each type has some distinctive trait, but we can discuss some comments of general applicability.

Oral Presentations, V

Should be's and shouldn't be's

When you start performing your presentation, you are not

- a teacher,
- a priest,
- a clown.

But: you are a bit of each!

Oral Presentations, V

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When you start performing your presentation, you are not

- a teacher,
- a priest,
- a clown.

But: you are a bit of each!

Please: only a bit!

Advertising is a better referent. Why?

Oral Presentations, VI

Sometimes we openly speak about how to sell our research

Goal:
To convince the audience that they want to read the paper.

Intermediate need: to keep the attention of the audience.

- No universally valid advice: each person must develop his/her own strategies;
- judicious use of humor may be helpful;
- analogy may be helpful ("parabolas");
- but both ingredients are difficult to handle well! Some say:
  - humor is like salt,
  - parabolas are like pepper.

Preparation of a Presentation, I

First: choose an imaginary audience

You must definitely know

- which audience you have in mind as you prepare the talk;
  - what can be assumed known?

    Very little!
- what do you want them to remember from your talk;
  - take-home message:

    A single sentence, if possible!

Preparation of a Presentation, II

Second: structure your talk

Usually in 3 parts

but feel free to break the rules if you feel you will communicate better: listen to your intuition!

- Introduction:
  - 5–10 minutes that everybody must be able to follow!
  - Focus clearly the main thrust of your contribution;
  - provide motivation!
- Technical body:
  - A representative selection of the main results.
- Conclusion:
  - Summarize your main message,
  - discuss the results,
  - possibly, propose future work.

Preparation of a Presentation, III

Consequences of earlier statements

The technical body:

Be very careful with the technical level:

- Try to motivate all the choices.
- Try to explain everything through simple examples.
- A bit of technicalities to satisfy a small portion of the audience may be OK, BUT:
  - announce them as such!
  - It is far too easy to add too much technicality,
  - avoid that trap.
- Consider using images, but think thoroughly, before adding each one, whether they actually suggest what you intend.
- Insist on the main message!
  - It is unlikely that you can present all your main results.

Preparation of a Presentation, IV

Wisdom of traditions

Mathematicians of old, whose talks explained theorems on a blackboard with white chalk, used to say:

Every talk must contain

- a mathematical proof, and
- a joke,

Preparation of a Presentation, IV

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. . . and they must be disjoint.

Preparation of a Presentation, V

Don't improvise, ever

1. Design a written plan of contents;
2. trim down the plan (for sure you plan to cover too much);
3. design a set of slides,
   - after designing the plan for the whole presentation;
   - one by one, not necessarily in their order;
   - in each:
     - either one image plus a couple of lines of text, or
     - 3 to 15 lines of text;
   - An old strategy:

     write normal size letters on an A4 paper folded 4 times.
4. Overlays work well but are not easy to design.
5. Evaluate the slides against the available time, and

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5. Evaluate the slides against the available time, and
6. Return to point 2.

   Adding more and more text to the slides won't work.

Preparation of a Presentation, VI

Packed-up slides don't work

Slides should not include too much text

If a slide includes too much text, then the audience will try to read it, instead of listening to what you are saying, since it has been proved that no one can listen and read simultaneously. The consequence will be that no one will pay attention to you for a while and, hence, they will stop following you. Moreover, given that probably you speak faster than they can read, when you move on to display the following slide the audience is likely to have two kinds of feeling. On the one hand, they will feel frustrated, because they did not have enough time to read the slide. On the other, whey will notice that they have lost connection to your verbal communication, so they will stop paying attention to the talk.

Preparation of a Presentation, VII

Practice!

`(PhDcomics link.)`

Don't even dream

of walking into your presentation slot without previous rehearsal.

- Summon colleagues, friends, and relatives to listen to you for at least one dry run;
- try to plan for several practice dry runs;
- ask for explicit feedback after each practice talk.
- You may want to change the slides after each dry run:
  - if the change is nontrivial, you will need further practice;
  - the "real thing" must be with slides almost identical to one of the practice talks.
- As you get old, you start relaxing all this a bit.

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  Then, you will learn to prepare the slides the night before.

Preparation of a Presentation, VIII

Additional observations

Some further issues about contents

- Care for the details: no typos, correct punctuation. . .
- Is the person doing the presentation an author?
- Additional annotations?
- Include an index? Keep returning to it?

  Some people love it, some people hate it.
- Inserting side material: risk of distraction!
  - Animations? videos? software demos?

    Often, all these work best just before the conclusions.
- Learn to reuse slides:
  - Reuse must be designed from the start!
  - Make (some of) the slides equally valid if parts of the talk are skipped or added.
  - End up with several versions of the same talk, with different lengths and levels of detail.

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DE CATALUNYA
BARCELONATECH

The slides

- Maximize the information/noise ratio

Giving a Presentation, I

Your scheduled session

Don’t be late!

- Double-check the session you are scheduled in.
- Double-check the room in which your session takes place.
- Show up there 5 to 10 minutes before the session starts,
  - NOT a few minutes before your talk is scheduled to start,

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  - even less a few minutes after your talk is scheduled to start.
- Find the chairperson in charge of the session.
- Identify yourself to her/him as a speaker.
  - Important: who is the speaker in multi-author papers.
  - Important: who is the speaker when no author is present.
  - Help the chairperson learn to correctly pronounce your name.
- Test the equipment!

  `(PhDcomics link.)`

Giving a Presentation, II

The talk!

`(PhDcomics link.)`

- Starting: *Good morning* and such – read title only if the session chair has not announced it, or if there are changes.

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- Risk #2: Timing! – the situation is complicated enough, and yet you must remember to watch your watch!
- Risk #3: Obstructing! – depending on the room and where you stand, part of the audience may not see the slides.

Giving a Presentation, III

Some lesser risks

Take into account as well

(although these issues are a bit less important than the previous ones):

- You might mistake your audience for a much cleverer one.

  `(PhDcomics link.)`
- Gadgets in your slides may act improperly.
- You may forget to look at the audience –

  remember that the whole game is a game of communication!

Giving a Presentation, IV

Ooops, it is not over yet!

And then… the questions!

Main attitude: don't be afraid!, most people are not smarter than you are.

    (PhDcomics link.)

Several types of questions:

- Kind – someone gives you a chance of showing off.
- Interested – someone wants to know some omitted detail.
- Pedantic – someone wants to show off.
- Aggressive – someone wants to attack your work.
  - An attack on your work (infrequent) is not an attack on you: do not take anything personally.
  - An attack on you (very infrequent) is to be heard and forgotten promptly: don't react. They have some sort of personal problem, and it is not your problem.

Giving a Presentation, V

Striking back. . .

Always: answer honestly and kindly!

- Show interest.
- If you do not know the answer, say so.
- Do not get into discussions: if necessary, propose to continue the discussion off-line.
- Never attack back.
- If you need to blame your supervisor, do it kindly and in positive terms.

Don't undervalue the importance of

- the contents of the talk, and
- your attitude when you are answering questions.

Posters, I

A hybrid sort of communication

Conferences have several forms of participation:

- Mere registration and attendance (always!);
- Important "sexy" talks by "stars" in the field (very often):
  - Plenary sessions,
  - Invited speakers,
  - Keynote speaker(s)...
- Regular presentations (always! possibly, scheduled into parallel sessions);
- Short presentations (sometimes);
- Posters (sometimes);
- Occassional variant:

  Parallel sessions plus a poster for every paper
  (allows attendees to catch up with papers missed).

Posters, II

What, and what for

Literally: a poster you will hang on provided places, where a description of your contribution is presented.

Not extremely common option

Allows the conference to accept more papers (and get additional attendance) whereas the proceedings size is maintained.

- Very short (2 to 5 minutes) “advertising” presentations
- plus separate event where posters are put up to display;
- at that event, further explanations are offered individually to the interested persons.
- Usually in the afternoon or evening, and nothing (except perhaps a very relevant social event) after it.

Posters, III

Creating the poster

- Design is far from trivial.
- Plan to invest a good number of hours in creating it.
- Find out from organizers whether portrait or landscape format is expected.
- In any case, portrait format has a couple of advantages.
- A0 size advisable; A1 barely OK but much less impressive.
- In an emergency, paper copies of the slides spread out on the wall may do, but much much less impressive.

Written Research Communication Venues, I

Three main sorts, but this is changing substantially these days

We communicate in writing

our findings among researchers through:

- Books,
- journal articles,
- workshop and conference proceedings.

For the coming years, keep an eye on the joint evolution of journals and conferences in your field of speciality.

Written Research Communication Venues, II

Objective and subjective motivations

Why do we do it?

- Unreported research dies with the researcher.

Written Research Communication Venues, II

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  This is not necessarily bad.
- Researchers are evaluated according to their publication record

  (and this fact distorts heavily the whole process).
- Harmless forms of “ego boost”,

  “pills” for the self-esteem (or vanity);
  e.g., the day you are denied a grant, you look up your CV on DBLP or Google Scholar and feel a bit better. . .

Books

Writing a book is a long-term, labor-intensive project

Let’s write a book explaining together all these results!

- Don’t let me scare you away, go ahead!

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- Don't let me scare you away, go ahead!
- But, be aware:
  - For a noticeable period of time, like at least one year and easily three to five years, you will do little else, if at all.
  - Writing a book jointly with co-authors is a good idea:

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      and not shorter as one might expect.
  - After you have gone through the text one thousand times, you still spot mistakes in the one-thousand-first.
- To consider:
  - Degree of completeness?
  - Usability for teaching?

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- To consider:
  - Degree of completeness?
  - Usability for teaching?
  - Do books still make sense?

    `(A related report in The Guardian.)`

Journals, I

The central channel of research communications

The traditional form for archival versions

of research articles, with some distinctive traditional advantages:

- Generous page limits, if at all:
  - (main, longish) articles,
  - (shorter) “letters”, “notes”, or “correspondences” (not many journals target both);
- wide and long-term readership and impact,
- preferred reference,
- often better rated in evaluation.

But: their golden age was before Internet.

Journals, II

Who is behind?

Main players:

- An Editor-in-Chief or Managing Editor,
- often, an Advisory Board,
- an Editorial Board consisting of a list of Editors, sometimes structured by areas with corresponding Area Chairs,
- authors, and...
- a publishing house.

Scientific publishers

- Publishing houses of (mostly US-based) large professional associations (ACM, SIAM, IEEE, the IEEE Societies...);
- Established commercial publishing houses:

  Elsevier, Springer, Wiley, Academic Press...
  (They keep buying each other: difficult to keep track!)
- Other commercial publishers.

Journals, III

But the times they are a-changing…

The subscription prices of scientific journals went up along the last couple of decades, probably excessively.

- Additionally, new journals kept, and keep, appearing.
- Researchers started looking for alternatives

  (`link to a 1994 example` in Mathematics).
- Websites providing links (often admittedly unrefereed):
  - author homepages,
  - `http://arxiv.org/`, ECCC...
- Some venues use the word "journal", prominently displayed in their name, to advertise (or pretend) a serious reviewing pattern.

  Some very reliable examples:

  `http://jmlr.org`,
  `http://jair.org`,
  `http://www.jucs.org`...

Journals, IV

Publishers are hardly needed anymore!

Business here!

Scientific publication has been a flourishing business:

- Most of the added value contributed with no monetary cost!
- It still is a good business, but a bit less every year.
- The move to web support:
  - Mid 1990's: birth of the open access serious journals.
  - Publishing by (networks of) institutions that try to push towards a system that is more fair and less fraud-prone:
    - MIT Press,
    - J.UCS consortium...
  - Subsequent open access option of "traditional" journals.

    Warning: no agreement yet about what exactly Open Access means!
  - "Traditional" journals "become electronic" as well.
  - Birth of the open access bogus journals.

Bogus Venues, I

Earning money from conferences and journals

Risk of suffering unprofessional actions as there is some money involved!

Bogus journals!

- "Predatory scholarly open access".
- Joining the bogus conferences, a notion that has been around for many years now.
- Common trait: actual business model is sale of CV lines.
- Unfortunately, whether electronic or in paper, we cannot simply trust the journal (nor the journal's organization!) for scientific seriousness.

Bogus Venues, II

Science 342, 6154 (2013), 60–65, DOI: 10.1126/science.342.6154.60 (link)

“Who’s Afraid of Peer Review?” by John Bohannon

“On 4 July, good news arrived in the inbox of Ocorrafoo Cobange, a biologist at the Wassee Institute of Medicine in Asmara. It was the official letter of acceptance for a paper he had submitted 2 months earlier to the Journal of Natural Pharmaceuticals [...] In fact, it should have been promptly rejected. [...] Its experiments are so hopelessly flawed that the results are meaningless.

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I know because I wrote the paper. Ocorrafoo Cobange does not exist, nor does the Wassee Institute of Medicine. Over the past 10 months, I have submitted 304 versions of the wonder drug paper to open-access journals. More than half of the journals accepted the paper, failing to notice its fatal flaws. [...]
From humble and idealistic beginnings a decade ago, open-access scientific journals have mushroomed into a global industry, driven by author publication fees [...]"

Bogus Venues, III

Be very careful!

How to choose a journal for your paper?

- Telling apart the bogus subset may prove difficult.
- Try hard to identify them: falling once for them is admissible (barely), falling twice is not.
- Impact factor won't work: there are bogus "impact factor measuring" companies as well!
- Three tests: money, colleagues, and initiative.

  Unfortunately, all three have many false positives.

Money: Do they ask authors to pay for publication?

Colleagues: Ask your supervisors and their peers!
Also: compilations of suspect journals and/or organizations guilty of "potential, possible, or probable predatory scholarly open-access":
`http://scholarlyoa.com`

Bogus Venues, IV

Who takes the initiative for the publication?

Cut&paste from my own inbox:

Invitation for Free Article Publication

Dear jose.luis.balcazar@upc.edu,

Public Science Framework is a leading platform offering journal articles from 39 journals. All of the journals are peer-reviewed, open-access and dedicated to the latest advancement of all theoretical and scientific aspects. We invite scholars to submit recent research works to these journals.

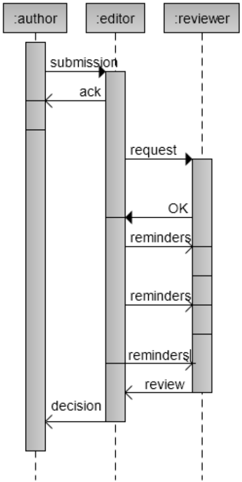
From July 11, 2015 to September 17, 2015, promotional activities are offered for all authors:

No Publication Fee in 7 Journals

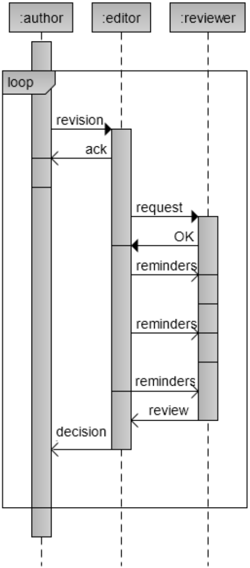
Articles submitted to 7 journals presented on the rightside will be published for free.

Journals, V

The journal reviewing pattern for regular papers



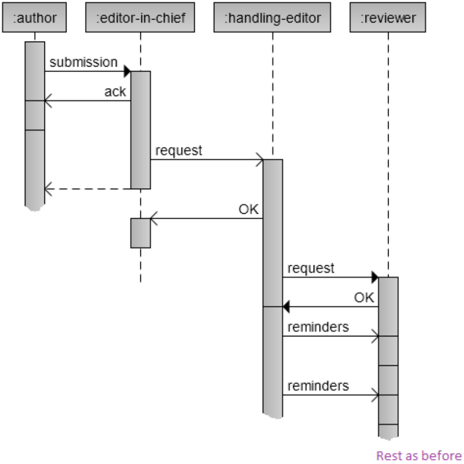
if decision != REJECT then



Journals, VI

The journal reviewing pattern: variant

In some journals, the Editor in Chief appoints a handling editor for each submission.



Journals, VII

Regular issues and special issues

Special issues of journals

under a submission deadline, usually firm.

Two major sorts:

- "Selected" (or "best") papers from a conference,
- topical issues.

Journals, VIII

Selected papers

Special issues of selected papers from a conference:

- Usually a long-term agreement for conference and journal.
- Program Committee Chairs invite papers from the conference after attending the oral presentation.
  - This often gives extra prestige to the journal paper.
  - They must make sure that the reviewing process and quality control is kept at the journal's standard.
  - Papers should be deep revisions and/or extensions of the text published in the conference proceedings.
- Sometimes the whole conference proceedings are the journal issue (no particular prestige in this case).

Journals, IX

Topical special issues

Issues specifically targeted to a key research topic

- A small group of prestigious researchers proposes to the Editor In Chief of the journal
  - a topic,
  - a submission deadline, and
  - a plan for a timeline up to publication.
- If accepted, proponents are appointed Invited Editors.
- Calls are issued.
- The invited editors handle the reviewing process as with regular papers, except that they try hard to get all deadlines strictly enforced.

It is unusual (but does happen) that a single journal issue contains both a special issue, or part of it, plus regular papers.

Journals, X

Journal publication may take looooong

Always:

Read carefully and follow closely the instructions that the journal itself gives for prospective authors.

- Getting OK from two or three reviewers may take time.
- Reviewers may take time to react.
- Authors only in exceptional cases send a reminder to the editor.
- If reviews do not agree about the decision, the editor may look for additional reviewers.
- It is unusual that a paper is accepted right away

  (but it is not unusual that a paper is rejected right away).
- A first revision may lead to acceptance, but often a second and even a third revision takes place

  `(PhDcomics link).`

Journals, XI

Additional letters involved

Old-style protocols:

(But corresponding items also for submissions via web.)

- Submission:

  a cover letter explaining that the paper is a submission, and to what journal. Include title and authors, and specify who acts as the contact author.

- Revision:

  a rebuttal letter explaining how all criticisms raised by the reviewers have been addressed, or, if they have not, why.

- Often, the editor adds a cover letter to the reviewer indicating what sort of recommendation is desired.

  A typical set of recommendations to choose from is:

  Reject,
  Reconsider after major revision,
  Accept after minor revision,
  Accept.

Conferences, I

The case for timeliness

Conference papers

- Hard, tight page limit.
- Timeliness relies on strict deadlines:
  - for abstracts and for complete submissions,
    - hard
    - firm, or
    - soft

    `(PhDcomics link);`
  - for revised final versions in case of acceptance.
- Hence: fast publication process.
- Extra visibility due to the oral presentation.
- Direct contact and fast feedback.
- Last but not least, and even first: networking!

Conferences, II

(PhDcomics link.)

Conferences, II

`(PhDcomics link.)`

("Drinking the Kool-Aid" is a metaphor commonly used in the United States that refers to a person or group holding an unquestioned belief, argument, or philosophy without critical examination. It could also refer to knowingly going along with a doomed or dangerous idea because of peer pressure. The phrase typically carries a negative connotation when applied to an individual or group.)

Source: Wikipedia.

Conferences, III

Forums for all stages of research

Researchers love to travel

(particularly with paid expenses, but not only).

We are permanently organizing meetings.

- Informal workshops: no formal proceedings;
  - little or no filtering of submissions (or plainly by invitation),
  - may have "informal proceedings" or lead to "post-proceedings".
- Established workshops: most often, co-located with a major conference,
  - almost all have proceedings, occassionally formal ones,
  - sometimes become a bit selective.
- Small, focused, fully refereed conferences,
  - with formal proceedings (ISBN, found on Amazon. . .),
  - usually noticeably selective.
- Large, prestigious, extremely selective conferences.

Publication Process, I

A standard pathway, with all sorts of variations

Got results?

Keep writing successively better text versions.

1. Present them in a couple of informal workshops, gather feedback, rewrite,
2. submit them to some established workshop, gather feedback, rewrite,
3. try a few major conferences (in turn!, not at once) until acceptance (or nausea), gather feedback, keep rewriting,
4. work out loose ends, simple extensions, variations, present them at informal or established workshops, gather feedback, rewrite,
5. sit down and write the complete journal submission.

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5. sit down and write the complete journal submission.

   By then you are sick of it... and yet, all the interactions with the journal reviewers remain ahead: you will rewrite further!

Publication Process, II

Related considerations

Where to submit it?

- Advertised topic close enough?
- Presence of respected names among the evaluators?
- Convenient deadline?

  `(PhDcomics link, another PhDcomics link.)`
- Again: make sure to read and follow the instructions.

Never step ahead without explicit consent of all authors and of all their supervisors (if they have them).

Often some of the steps in the previous slide are skipped:

- the paper gets invited to a journal special issue of a conference,
- or you dare to submit to the great, selective conference straight away…

Publication Process, III

Multiple publication policy

Easy: DON'T!

Preliminary paragraphs of motivation, notation, and related work may be the same in several consecutive papers, but

- the technical contribution to each formally published item should be different;
- only exception: material accepted for a conference, if worked out in sufficiently improved form, may be submitted to a journal as archival version.

Material submitted to a conference should not be submitted to another one, or to a journal, until receiving a decision (unless the conference explicitly permits it in the call for papers).

(But workshops with informal or no proceedings are OK.)

Conferences, IV

Who is behind?

Get involved!,

as soon as you have the opportunity.

- Steering committee (senior researchers),
- Program committee chairs (senior researchers),
- Area chairs (senior researchers),
- Program committee members (senior, tenure-track, or postdoc researchers),
- Reviewers (all researchers),
- Local organization committee chairs (senior or tenure-track researchers),
- Local organization committee (researchers):
  - Other organization roles (financial, tutorials, workshops, publicity, sponsorship, webmaster. . .),
  - an army of young, energetic, sleepless PhD students.

Conferences, V

Who is not behind?

Not all roles are necessary

- Some conferences manage without steering committee.
- Many conferences do not need area chairs.
- Really large, complex conferences outsource most of the local organization to professional companies

  (at a high financial cost to be defrayed by the participants).

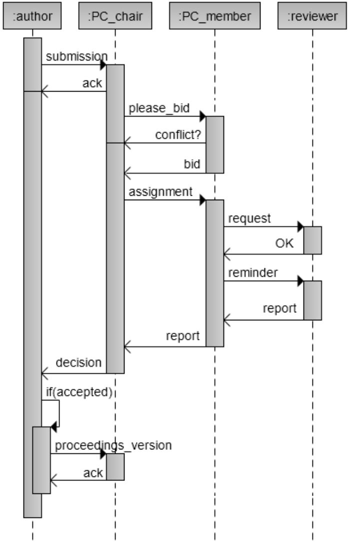
Financial balance

is a must for successful conferences.

- Sponsorship from institutions and companies,
- registration fees must cover the rest of the expenses,
- risk of suffering unprofessional actions as there is some money involved: bogus conferences.

Conferences, VI

The conference reviewing pattern



Conferences, VII

The program committee

Arriving at decisions:

- Reports from reviewers are the responsibility of the corresponding PC member,
  often the same person;
  if not, the PC member may modify the report or the recommendation.
- Reviews are necessarily less detailed than for journals.
- Clear rejections and very clear acceptances are processed readily.
- Considerable discussions may be spent on each of the remaining papers.
- Final decisions are taken.
- PC chair listens patiently to complaints.

Conferences, VIII

Awerbuch's Maxim

The decision of a PC is a random variable with an expectation determined by the submissions' quality and a variance determined by the PC's quality.

Baruch Awerbuch

`http://www.cs.jhu.edu/~baruch/home.html`

Conferences, IX

Thanks to the agility of the web

Recent variants:

- rebuttal phase, where authors respond to reviews
- shepherding, where authors of weak papers with valuable contributions are helped off individually,
- Area Chairs may be there to consolidate reports of sets of related papers and help with final Program Chairs decisions,
- Doctoral Consortia, separate track, oriented to PhD students…
- A potential shift coming!
  - Lately, some communities are steering towards a merge of journal and conference publishing.
  - See, for instance, the last few VLDB and the recent experiments at ECML PKDD. Watch out!

The Task of the Referee, I

Rather: Your task as a referee

Refereeing:

Creating a

- written,
- substantiated,
- helpful

opinion on the adequacy of a research article for its potential publication in a given forum.

`(PhDcomics link.)`

The word “review” has several different semantics,

be careful!

- A “referee report” (our meaning here),
- a “literature review section” of a paper,
- a survey paper,
- a `brief description of a published paper...`

The Task of the Referee, II

A very important task for the community

A service to our fellow researchers:

We all must be willing to contribute!

- We all submit papers and, hence, we all are asking the same service from the community.
- At certain times, we must contribute more than we receive,

    to cover for people who engage in research, start publishing, and then leave.

- Relatively easy to do,
- somewhat difficult to do well:
    - Depth of argumentation?
    - Usefulness for the decision as to whether to accept for publication?
    - Usefulness for the authors?

  Superficial factors have limited convincing power.

The Task of the Referee, III

A very important task for you

Try your best to do it well!

- Whomever asked you to write a referee report is showing appreciation for your work!
- Take it as a honor!
- That person will receive, from your report, also information about yourself: your own reputation is also at stake.
- Your opinion will be affecting both
  - the career of a collegue, and
  - the development of the field.
- Being asked to perform referee reviews provides you with useful early glimpses of what is going on.

The Task of the Referee, IV

Quality is subjective!

A good referee report tries to tell not only what is to be changed to improve the communication, but also how.

Need to straddle a middle ground:

- If reviewing in an area is too strict, good researchers will abandon it.
- If reviewing in an area is too loose, the area will lose respectability.

Luckily, the outcome is, essentially, a social process;

but imitation creates risk.

We can propose some guidelines, but:

- Do not trust them too much,
- they should not be interpreted in merely syntactic terms!

The Task of the Referee, V

How to prepare a review?

Four clearly delimited parts

- A recommendation (may come either first or last).
- A brief description of the contribution of the work under review, in your own words.

  You are not expected to copy the abstract.
- An assessment that substantiates the recommendation.

  Both, positive aspects and negative aspects.
- As much constructive feedback as feasible,
  - from objections to the whole approach,
  - through comments on structure or clarity,
  - down to pointing out typos and small mistakes.

  Often, this part is separated in “major issues” and “minor observations”.

The Task of the Referee, VI

How to decide a recommendation?

To take into account:

- Importance of the problem attacked,
- relevance of the results,
- novelty and instructiveness of the approach.

Always in reference to the forum to which the submission was sent:

> the Journal of the ACM is very different from the local workshop organized next door.

The Task of the Referee, VII

Quality is very subjective!

Guidelines suggested:

- Is the progress made well-motivated?
- What level of difficulty was confronted?
  - 20-year-old open problem?
  - Exercise for grad school?
- Appropriate methodologies and working hypotheses for an acceptable solution?
  - Soundness of the approach?
  - Correctness of all the steps?
- Is communication effective?
  - Precision in the use of language?
  - Clarity? Elegance? Reasonably easy to read?
  - Is the structure of the paper optimal for understanding?

The Task of the Referee, VIII

Depending on the sign of the review

Dependence on the recommendation

- If the recommendation is positive, make sure to distinguish
  - suggested changes for improvement and
  - mandatory corrections that must be performed for acceptance.
- If the recommendation is negative, you must choose:
  - If the work has value, how can the author deeply rewrite the paper so that it reaches a publishability threshold?
  - Otherwise, a short report may suffice.

And always: with utmost politeness, never be insulting, never resort to sarcasm.

The Task of the Referee, VIII

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And always: with utmost politeness, never be insulting, never resort to sarcasm.

(There will be a place for being more aggressive in private communication with the decision maker.)

The Task of the Referee, IX

Some typical cases of firm negative review

Clear rejections

One or more of:

- Out of scope,
- so badly written that assessment is impossible,
- work not original,
- work contains important errors or unsubstantiated claims,
- level of difficulty is grad school exercise.

The Task of the Referee, X

Some typical cases of potentially negative review

Possible rejections

One or more of:

- Results of minor relevance,
- misses key published results that must be considered,
- elegant and correct, but useless (note that this objection is not easy at all to substantiate),
- publication attempt is premature,
- "boring" or "too incremental".

This outcome must take into account how selective the journal or conference is.

A submission to a selective journal or conference, rejected on these grounds, may well become accepted in a decent, serious forum of lesser selectivity.

The Task of the Referee, XI

Some typical cases of potentially positive review

Possible acceptances:

- Relevant results for an interesting problem,
- extends known results in a non-obvious way,
- provides new insights, acts as an eye opener,
- lays foundations to open a new research area.

The Task of the Referee, XII

Who is the reviewer?

Who is who?

The reviewer might not be such an expert!

- Am I knowledgeable of the topic and fully understood the contribution?,
- Am I familiar with the topic and understood the key points of the contribution?,
- Am I an informed outsider and got just the main thrust of the paper?
- Other worries:
  - I am a friend / foe of (one of) the author(s)
    (conflict of interest).
  - I work on exactly the same topic (so what?).
  - I already filled way more than my share of reviewing the last couple of years.

The Task of the Referee, XIII

Who is the author?

Who is who?

- Authoring team includes a well-known star in the field?
- Authors unknown or of lesser fame but the writing and the references show expertise?
- Obvious newcomers?

Make explicit this bias you might have!

- Try to compensate for it.
- Some venues try to avoid that bias by anonimization of the submitted papers (double-blind reviewing).

  Sometimes this works,
  but in many cases it does not.

Written Research Communication

Effort easy to underestimate

Who do we write for?

This should guide how we write.

- Main readership aimed at, to keep in mind: future researchers interested in progressing on the same or related topics.
- (Maybe somebody like yourself!)
- Precondition: getting published!
- Key readership aimed at, to focus permamently on: the reviewers.
- (Maybe somebody like yourself... or maybe not at all.)

Considerations about Writing

Why is it so difficult?

`(PhDcomics link.)`

Goals might not be well-alineated

The future reader you imagine may be very different from the evaluator.

- Long term goal: future readers be well-served if they spend their valuable time reading your paper.
- Short term goal: current reviewers are to be convinced that the long term goal will be attained.
  - Writing is difficult,
  - writing clearly for the readers is more difficult, and
  - writing convincingly for the reviewers is very, very difficult.

(Write what the reviewers expect?)

General Guidelines, I

Your helper thoughts

For your paper to be useful

to future readers, you want to attain some features:

- Interest: to entice them not only to start reading your paper, but also to keep reading it.
- Correctness: whatever they learn by reading your paper should not disappoint them later on by turning out false.
- Readability: readers should feel that the paper was "well-written"... easier said than done; but this is the way you will gain further readers.
- Originality: no alternative, current reference will allow the reader to learn the same things.
- Non-Triviality: many readers must have an easier time by reading your paper than by reconstructing its main messages on their own.

General Guidelines, II

How to make your paper interesting?

Interest

in scientific work is never attained through “suspense”.

> Sorry, friend, but Agatha Christie and all other “whodunnit” book authors can beat you up blindfold.

Instead, invest thinking in how to structure your paper, and explain:

- why your results are significant?
- why the problem tackled is worth thinking about?
- why did you string together all of the parts of your article?

General Guidelines, III

How to ensure that your contribution is correct?

Correctness

is a key property of scholarly work.

- Careful justification of every nonobvious claim or opinion.

  An item obvious to you may be far from obvious for the reader — yet, it is the readers' perspective what counts!

- Honest discussion of the means used to reach your conclusions.
- Honest discussion of the limitations and drawbacks of your contribution.
- Show care for the details: avoid typos and silly errors, give complete references.

(PhDcomics link.)

General Guidelines, IV

How to write a really readable paper?

Readability

involves clarity and "self-containedness" of the text.
In turn, self-containedness relies on hitting right a few guesses:

- A decently correct guess of what the reader knew before starting to read:

  everything else must be explained;

- A decently correct guess of what notation and terminology the reader is used to:

  it is to be followed with care.

Strategies for clarity are much more difficult to transmit. But:

- Try hard not to set the reader astray (e.g. keep consistent notation);
- Try hard to make correct the first meaning the reader understands from each sentence.

General Guidelines, V

Your contribution must be an original, nontrivial piece of research work

Originality and nontriviality are very important.

Publication of trivial or redundant research is negative:
it eats up journal pages, disk space, and, most importantly, researcher time.

- Instant understanding does not leave footprints.
- It will be always better if the reader re-does everything you did on his/her own. The only reason to publish is if re-doing is slower than reading.
- Good reference lists and good comparison with the state-of-the-art are a must to convince the reviewers of originality.

General Guidelines, VI

Timing

Before starting

- Sure you have a number of paragraphs jotted down, that were needed along the way for the research.

  Maybe addressed to other members of your research team.

General Guidelines, VI

Timing

Before starting

- Sure you have a number of paragraphs jotted down, that were needed along the way for the research.

    Maybe addressed to other members of your research team.

- Do not re-use them (do not even look at them).
- Plan before you start writing!
- Motivation first,
- then structure,
- then contents.

    Think carefully about what examples would be best.

General Guidelines, VII

Generalities on the structure

We can describe a suggested structure

of a standard research paper, but:

- no article structure is general enough to ensure that it will always work;
- hence, you will be deviating slightly from the standard structure in almost all cases;
- occassionally, you will be deviating considerably from the standard structure.

Let's move on into the finer details of the suggested structure of a paper.

Structure, I

How to structure a research article?

Standard structure:

1. "Front page": Title, authors, affiliations, abstract, keywords. . .
2. Introduction and preliminaries
3. Technical body,
4. Conclusions and acknowledgements,
5. References,
6. Occassionally, Appendices for very technical material.

A subsection "Related Work" comparing with the state-of-the-art is a must, but may come either before or after the technical body.

Structure, II

How to pick the title of your paper?

The title

is one of the most difficult choices.

- Clear, to the point, short — as feasible.
- As attractive and enticing as possible — within common sense.
- The "colon" trick: two sentences for the price of one.
- Occassionally, it can be funny but: be extremely cautious with funny ideas for the title.
  - `Google query: "mick gets some".`
  - `News in The Guardian (2014) about Bob Dylan lyrics in scientific papers.`

Structure, III

Rest of the front page

Authors (PhDcomics link):

- Ordering? Careful at the family names.
- Affiliations?
- Acknowledgements of research grants and funding sources?

Abstract and keywords (PhDcomics link):

No such thing as "too much thinking invested".

- Never start with "In this paper,…"
- Must be standalone plain text: no formulas, no references…
- Precision and concision: Can you find a shorter way? And yet another one, even shorter? (An extreme case.)
- Inspirational analogy: "On the phone", or "On the elevator".

Structure, IV

How does it start?

Introduction

- Presentation and motivation of the problem tackled.
- Related work:
  - either a whole subsection of literature review here,
  - or a brief context of references here and a full section on "Related Work" somewhere else.
  - Either way, the critical comparison must be somewhere.
- Approach taken and intuitive explanation of results obtained.
- Conceptual and notational preliminaries as subsection or as a separate section.
- "Table-of-contents paragraph" at the end of the Introduction?

  `(PhDcomics link.)`

Structure, V

Why it starts in that way?

Considerations about the Introduction

- The first paragraph is the main opportunity to "sell" your work.
- Many people will read only the introduction.
- Explain and clarify: interest, originality, difficulty.
- Avoid:
  - jargon,
  - overspecialized issues and points of view,
  - vacuity, hype, overselling.
- Notational and conceptual preliminaries: picture in your mind the desired reader (take other papers as examples).

Structure, VI

The technical body: very little to say in general

One or more technical sections

(as many as convenient):

- Each must have “topical” personality.
- Internal structure: local, motivating introduction (usually unlabeled); subsections.

Structure, VII

How does it end?

Conclusion

Or “Conclusions”? Or “Discussion”? Or “Perspectives”?

- Write the Conclusions section and wait for one day.
- Read it and identify what is there that was not said before.
- If nothing found, remove the section; if something found, consider moving it somewhere else in order to remove the section.
- Leave the section only if it passes this test.
- Consider a subsection of “Future Work” — but clarify which parts of it you plan to tackle in the immediate future and which parts you are offering for others to continue.

Structure, VIII

Additional sections

Acknowledgements

- People that somehow helped in the research or in the write-up.
- Maybe the reviewers of previous versions?
- Research funding in case it does not appear in the front page.

References

Also known as “Bibliography” `(PhDcomics link)`.

- Double-check each reference: do not rely on your memory.
- Fight for completeness.
- Never copy directly references from other papers without checking them out: if you should not rely on your memory, even less on somebody else’s.

Structure, IX

Generalities about contents

About the text proper:

Always must have a clear mind of what are you developing exactly at each particular point.

- Avoid “shopping lists”.
- Balance between avoiding unnecessary repetitions and insisting on the main message of the paper.
- Well-planned figures are very good, improvised ones are often useless.
- Work out running examples and examples with surprising properties.
- Justify everything, in particular opinions, and especially criticisms.

Structure, X

Further considerations

Other issues

- Be very careful with the level of detail!
- Consider postponing to the appendices:
  - specific, technical, well-isolated developments,
  - complementary developments,
  - introductions to side topics,
  - anything else that does not fit well (either thematically or due to the detail level).
- “I” or “We” or impersonal or passive?
- References are not nouns.
- The “et al.” abbreviation: “al.” is abbreviation (of “alii”) and has a dot; “et” is not, so it does not have a dot.
- Other features (quotations, footnotes. . .)

Computer Infrastructure for Writing, I

LaTeX

(PhDcomics link)

De facto standard

There is a "before" and an "after" Knuth's TeX.

- Earlier systems were fantastic compared to having nothing, but very limited compared to TeX.
- Knuth's perfectionism must be acknowledged as doing the rest of us a great service.
- Writing for TeX is akin to programming:
  - Conceptually subtle processes, nontrivial to steer;
  - Separate phases of "writing" and "seeing the result", uncomfortable to very visually-oriented minds.
- Lamport's LaTeX:
  - Simplifies the concepts to be taken care of while writing.
  - Very good results unless you are as perfectionist as Knuth.
  - Still separate phases.

Markup not in the SGML family

- Needs training.
- Familiarizing yourself also with TeX may be helpful to understand error messages from LaTeX.
- Allows publishers to ensure that all papers of the same journal look alike by offering the LaTeX setup on their website (old "style" files or newer "class" files).
- It might happen that, some day, a new system takes over…
  - But: it is not going to happen anytime soon.
  - Beating the current de facto standard is very difficult.
  - Count on LaTeX being likely to become the second most frequent program you interact with, only below your favorite text editor, and possibly above the web browser.

Computer Infrastructure for Writing, III

Interfaces for $\LaTeX$

Aim:

Simplify a bit the usage for visually oriented minds.

- IDEs, like TeXMaker: useful for those who use IDEs for programming (e.g. Eclipse) — one more text editor to command…
- But learn to run it from command line windows as well!
- Most modern text editors have "latex modes".
- Standard process has three steps: from source to `.dvi`, then to PostScript, then to either printer or PDF.
- Many current interfaces offer a direct, source to PDF process.
- Get on your laptop more than one $\LaTeX$ installations and more than one PDF viewer. (I assume you already have more than one text editor.)

Related systems:

- Beamer: LaTeX for presentations. Forget about all competitors and focus on this one.
- "Document classes" for poster presentations.
- BibTeX: helps you inmensely to handle the references, provided you are willing to organize them as it requires — Internet sources like DBLP help.
- TikZ: the best way I know to add internally-constructed diagrams. It still allows you to import external graphic files. Very powerful yet reasonably easy to use.

Sorry if it sounds menacing, but: refusing to join the LaTeX users will definitely harm your scientific productivity.

Research Papers versus Research Proposals

Grant proposals are a must

So far you surely already wrote some grant request.

- As you progress along your scientific career, this acquires more importance.
- At some point, researchers become so busy asking for money to do research, that we do not have time for research.
  - Nonsense? YES!

Research Papers versus Research Proposals

Can you write out your research before performing it?

Grant proposals are a must

So far you surely already wrote some grant request.

- As you progress along your scientific career, this acquires more importance.
- At some point, researchers become so busy asking for money to do research, that we do not have time for research.
  - Nonsense? YES!
  - So what?
    (This is why I require from myself a single-authored paper every now and then.)

Grant Proposals, I

A mismatch

If communicating your research results after obtaining them is difficult, imagine doing so before!

- Yet, you will need to go through it!
- One common way out, causing quite some difficulties between researchers and funding bodies:

  `PhDcomics link.`

Make sure to find out, for each call, the odds of each outcome (`PhDcomics link`).

Grant Proposals, II

General observations

As in the case of research papers:

- Read and understand the call;
- Plan before starting to write;
- Try and understand the review criteria:

  you must address them all!
- The state-of-the-art section is even more crucial than in papers:

  you must convince evaluators that you will do better!
- The explanation of the interest is even more crucial than in papers:

  you must convince evaluators that you will do a more relevant research than some of the competing proposals!

Often, competition for grant money is even more fierce than competition to get published.

Grant Proposals, III

New-looking idea necessary, but not sufficient

Besides explaining why

it is possible and desirable to improve substantially on the state-of-the-art of your problem, you must as well

- show that you have the expertise and know-how to obtain the improvement, and
- show that you are able to handle the project and its resources to indeed get there.
- In principle, you are not expected to know how to get there.
- Catch:
  - if the details on how to get there are missing, the evaluators may declare themselves unconvinced;
  - if they are, and clearly lead to the result, then it is development, not research.
- The balance between them is very difficult. There is a high sheer luck factor.

Grant Proposals, IV

Expected structure

Research plan:

must look feasible and clear; it is expected to

- break down the whole project into “workpackages”;
- break down each workpackage into “tasks”,
  - not too big,
  - not too small;
- assign “milestones” and “deliverables” to the workpackages and tasks.
- relate tasks via a dependence relation: which task needs to be completed before starting which other (PERT diagram);
  - keep dependencies simple;
  - no loops!
- plan these tasks in time (Gantt chart);
- assign person-power to each task, often under constraints.

Grant Proposals, V

Budget

Several aspects need money

and all of them must be duly justified by the end of the project.

- Direct costs:
  - Existing personnel hired by the institution, who will work in the project — need an estimate of hours devoted;
  - Personnel hired newly to work only in the project;
  - travel and subsistence costs for coordination meetings and dissemination;
  - equipment and inventory items (e.g. books);
  - consumables.
- Indirect costs, a.k.a. overheads: not all expenses are authorized as direct costs. Indirect costs cover them (e.g. electricity in your office) usually as a fixed fraction of the direct costs. Often, the researcher does not see these funds at all.

Grant Proposals, VI

Budget models

Several financial models exist

Find out which ones apply!

- Marginal direct costs: grant does not cover main personnel costs like people already working for the institution.
  - May cover personnel hired newly to work only in the project and the other direct costs.
- Full direct costs: time of people who is already working for the institution is also budgeted, but the support received is often only a fixed fraction of the full costs.

Whatever the model, the budget must be credible and aligned with the granting entity expectations.

Some entities expect researchers to raise part of the funding elsewhere.

Grant Proposals, VII

Equipment

Budgeting for equipment may be tricky

Equipment comes labeled with an "amortization" period along which it is expected to be fully functional. This period is tabulated, often on the basis of price.

If the amortization period is longer than the expected length of the project, the grant may cover only the corresponding fraction of the price.

Rental may be an option, but may not be always valid, and not always better.

Grant Proposals, VIII

Other aspects

Proposals must address many other topics

- Dissemination: how will the project influence others?
  - Scientific publications in journals and/or conferences?
  - Tutorials? Summer schools? Websites? Software?
  - Other events addressed to other target groups?
- Scientific coordination: How is teamwork organized?
- Management: How is decision-making organized for running the project smoothly? What are the main risks? How to handle them? How to solve conflicts? How are Intellectual Property rights handled?
- Responsibility: Who is to be chased after to make sure each deliverable is indeed delivered? Who is to write each promised report? Who is to organize each event?

Often, boards are set up for each of these facets.

Finishing the PhD

One very special document and one very special talk

"Fast forward" to a remote future scenario:

After several years of research, the research community has already accepted you as one of their members.

But humans need rites of passage to internalize change!

- Deliver a document: your PhD thesis.
- Deliver a further ritualized talk: the PhD defense.
- It is not a "defense" anymore, actually:
  - If there was something really worth attack, your advisor would not let you proceed

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    (unless you insist too much — don't!).

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- It is not a "defense" anymore, actually:
  - If there was something really worth attack, your advisor would not let you proceed
    (unless you insist too much — don't!).
  - Yet, please try do to your best, even if there is no risk in the event!
- If you are lucky, everything will run very smoothly: here we will consider the case where things go wrong.

Milestones

So far we already covered the initial ones

There are a few milestones in the life of a PhD student.

Some of them may pass unnoticed — you might only realize you have passed them later on, upon talking to others or upon further reflection on your life.

Initial milestones:

1. The idea you come up with and propose to the rest of the team actually works;
2. you gain coauthorship;
3. you get your first acceptance;
4. you want to write the first draft of a joint paper yourself;
5. you give your first serious research talk...

The Thesis, I

When to start writing it? And how to start writing it?

Key milestones:

6. You start considering a change of advisor because you feel you are not learning anything from him/her anymore…

   but don't!, this just means you are actually progressing!

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7. you realize (possibly in shock) that your advisor actually never had the slightest idea of what your PhD document was to contain `(PhDcomics link)`;
8. you realize that you actually do! Time to start writing!
9. First step, most likely wrong (but not always):

   ```
   cat mypapers/*.tex > thesis/draft0.tex
   ```

   `(PhDcomics link...)`

The Thesis, II

Phases and structure

The interaction with your advisor fully changes now!

- Prepare drafts of index and structure: chapter titles, contents of each. . .
- Interact about it with your advisor, for several rounds.
- Identify fragments of papers that help start fleshing out each chapter.
- Structure can be inspired in the structure of a paper we already discussed, but is likely to suffer substantial deviations along the writing process.
- Get courage and start! (Somebody around you might help with a good push. . . `PhDcomics link.`)
- Don't bother to interact heavily with advisor along the writing process: it is likely to have limited efficacy. `(PhDcomics link.)`

The Thesis, III

A book?

In a sense it looks like writing a book

but in other senses it does not... Fortunately!

- Uniform notation across the whole document

  (maybe difficult, because, so far, notation was uniform only within each paper, and they were written at different times).
- Similar problem with references.
- State of the art chapter becomes surprisingly difficult.
- Surveying together all your contributions is also difficult.
- Fortunately, motivation chapter flows more smoothly than ever — not the least because you write it last.
- Resist the temptation of adding exercises to each chapter.

Maybe it will make sense, afterwards, to work on evolving your PhD document into a book.

The Thesis, IV

The last year: a journey through the desert... Careful! Danger!

The last year is surprisingly hard to go through!

Getting satisfactory text becomes difficult, desperatingly slow.

- Alone! Not part of a team anymore. It is your thesis.
- No interaction with advisor needed at all — like, "no water" through the desert.
- Big risk: you start seeing mirages!

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  Namely: seemingly useful detours! `(PhDcomics link.)`
  - To round it up, actually, I should get this or that additional algorithm / feature / theorem / extension…
  - That particular problem in the "Future Work", I know well how to solve it, and, see, there is this great opportunity of a conference in Hawaii…
  - Time to finally join the Movement for Human Progress on X and help organizing the great event they plan now…

Many PhD's have failed at this stage! `(PhDcomics link...)`

The Thesis, V

Don’t listen too much to your perception

One day, suddenly, you realize in horror...

that your PhD thesis does not look like a PhD thesis at all...!

> It is just a big brick full to the brim of trivialities!
>
> You want (or even need!) to dead-stop working on it.

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You want (or even need!) to dead-stop working on it.

- The more you go through the text, the more depressing it is.
- Yet, stopping working on it for a few days does not lead to better breathing.
- And, as you get back to working on the text after a few days of not looking at it, the feeling of depression is even higher!

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There are reasons!: your contributions must look trivial to you, as, otherwise, you would not have been able to reach them — besides, you are sick of writing them out.

Help: if your advisor tells you it is a thesis, then it *is* a thesis: force yourself into believing him/her.

The Thesis, VI

Once you complete your document, if at all...

The first draft

after having been approved by your supervisor, is... well...
just a draft. `(PhDcomics link.)`

- External anonymous reviewers?
- Department authorization?
- Reviewing and authorization by jury members?

Work on the second draft begins — and then, on the third...

The Thesis, VI

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Work on the second draft begins — and then, on the third...

Good news: once you are here, it is guaranteed to finish.

The Thesis, VII

The defense!

The most unusual of your oral presentations!

- No such thing as “too many practice talks”.
- No less than three or four.
  - The real one will not be as good as the best dry run.
  - More like the second or third best.
- Constructing the committee and finding a date and time may prove to be a complicated task.
- The jury will ask questions, preceded by (possibly long) explanations of their individual connection to your topic. `(PhDcomics link.)`
- Possibly one of them may get you into trouble, maybe unintended.
- Simply work your way out; try not to be alarmed.
- Upon answering, act bold (within reason): they may wish to know your courage at long range guesses.

Index

A Very Old (African?) Adage

Plus a personal precision

If you want to travel fast, go alone; but, if you want to reach far away, go in company.

A Very Old (African?) Adage

Plus a personal precision

If you want to travel fast, go alone; but, if you want to reach far away, go in company.

Only that, in the second case, make sure that your company wants to go to the same place as you.

Ethical Issues, I

Human frailties

Are there cases of unacceptable behavior?

In all scientific endeavors,

nearly everyone,

nearly all the time,

acts correctly.

There are extremely infrequent cases of doubtful, or plainly unacceptable, behavior:

- with respect to the scientific community, or
- with respect to the society at large.

Ethical Issues, II

Result quality issues

All humans commit miskates

but science aims at reliability, therefore

- everyone is to watch out for potential errors in the literature;
- refereeing processes reduce published errors.

The individual performance evaluation distorts!

> Thought experiment: find a mistake in the paper you are submitting today; send it in yet, and later publish a correction and get two publications instead of none?

Ethical Issues, III

The problem worsens in certain areas

Experimental sciences

like Biology or Medicine, where experiments may require almost inhuman care and effort, raise other issues:

- Errors cannot be detected just by reading the paper.
- Extreme case: outright fraud,

  e.g. fabricated experimental outcomes.
- Some areas establish reproducibility protocols.

Social sciences work

is often ideologically tainted, which makes peer reviewing difficult and sometimes altogether omitted (have a look at `en.wikipedia.org/wiki/Sokal_affair`).

Ethical Issues, IV

Be strict with your own behavior, yet a bit wary of others

Most likely,

the results you are reading have been worked out thoroughly and you can rely on them.

- But you are painfully learning, or will learn soon, how difficult it is to obtain reliable research results.
- The possibility of an oversight always remains.
- Use your own reading to double-check the results you are learning about.
- A correction of a published result is a publication opportunity.
- Even if you are very careful with your publications, every now and then somebody will show you wrong and correct (or disprove) your results. This is part of the game.

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- (Just do not let it happen too often.)

Ethical Issues, V

Attribution issues

Who was first to obtain a scientific advance?

How to credit properly earlier work?

- Even if you worked it out yourself, if it is published, you must acknowledge the right source.
- Again individual performance evaluation distorts.
- The very first time the advance was obtained,
  - was it duly published?
  - was it in an equivalent but seemingly different form?
  - was it really exactly the same result?
  - Identical? "Essentially" identical? "Similar" yet slightly different?
- Previous work by yourself?
  - Self-plagiarism, LPU/MPU (least/minimal publishable unit, a.k.a. "salami publishing").

Extreme case: outright plagiarism.

Human Interaction, I

Most modern research is team-made

Human relationship with your team

Source of both greatest joys and greatest difficulties. . .

- Make sure you contribute, on average, at least as much as your coauthorships are worth.
- But don't be too picky; respect the decisions of the moral authority: advisors, seniors, or the person who did most of the job.
- The team are your coworkers: it is not necessary to develop friendship, but it is positive in case it develops.
- At some point, the task ahead is your thesis, and the team becomes a single person, with highly variable expectations of how much help will come from your advisor.

Human Interaction, II

The advisor-advisee relationship does not compare to any other

Asymmetry:

- The success of your PhD is 95 % your success and 5 % your advisor's.

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- Only second to (but quite different from) that of your most significant one.
- PhD advisors may become close friends or terrible foes, with emotional relationship in all ranges from fully neutral to deep haters or… lovers.

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- PhD advisors may become close friends or terrible foes, with emotional relationship in all ranges from fully neutral to deep haters or… lovers.
- If your advisor and you become lovers before the end of the PhD, keep the lover, but change advisor.

Human Interaction, III

The weirdest time along

The last year!

Already possibly difficult to go through, and, additionally, your advisor and you are feeling weird.

- You might be behind your duties in learning how to let yourself ask and receive help.
- You may plan to finish the subsequent draft along the next couple of weeks before your next interview with your advisor. . .

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- (Time for an overdose of `PhDcomics`! `Link`, `link`, and `link...`)

The 3 Golden Rules of Successful Scientific Research

According to Edsger W Dijkstra

- Internal:

  Work always at or near the limits of your own ability.
  (It is the only way to push them!)

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  (EWD omitted the word “alone”.)

(Link.)

Emotional Issues, I

Research is for the bipolar :-)

Research is a wonderful job!

- Can you imagine the first time you get news back from the Journal of the ACM starting "We are happy to inform you…"

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Research is a depressing job!

- Easily it happens that, along one solid year, only one single advance is obtained,
- and, moreover, it says that the previous year advances were all wrong.

  (`PhDcomics link`.)

Emotional Issues, II

Rather, research is for the anankastic (obsessive-compulsive) personality disorder ;-)

`PhDcomics link.`

Research is very difficult!

There will be periods where

- you were at that key conference and understood essentially nothing,
- you feel not clever enough or not prepared enough,
- your partial results turn out to be consistently wrong,
- nothing works as you expect it to,
- your paper gets rejected…

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- nothing works as you expect it to,
- your paper gets rejected... again!,
- your results are clearly pointless or useless.

Emotional Issues, III

What to do?

How to handle your emotions?

No universally valid advice.

- Wait patiently, euphoria will arrive in one form or another!

  (Does not work well with the impatient.) `(PhDcomics link.)`
- Relativize: with very few exceptions, nobody's life is at stake, and everything else can be remedied.

  (Does not work well with the enthusiastic — and it could eventually block you.) `(PhDcomics link.)`
- Talk to others about it: you will find everybody goes through all this.

Emotional Issues, IV

The euphoria instants

At some point, you will reach very satisfying feelings!

- Wonderfully looking results,
- enjoying conferences and learning at them,
- paper accepted,
- recognition arrives (a famous researcher cites you)...

Treasure these instants!
Go back to remember them whenever necessary.

Emotional Issues, V

Keep in mind

Some observations might be useful:

- “Fast-minded” and “clever” are different qualities.
- No one ever had the needed preparation right from the start.
- No one is a fair judge of him/herself: rely on external opinions, discuss permanently with others what you are working on.
- Every failure contains an opportunity to learn.

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- Try to get yourself in your best and most productive position.

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- Try to get yourself in your best and most productive position.
- Keep working continuously, beware of procrastination!
- Enjoy working!