Research Methodology

Lecture 2: Research

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We start from a two dimensional approach

• Depth: how deep you will go with respect to a specific aspect of a well defined problem

• Width: how broad is going to be the scientific spectra to which your contribution applies

Both dimensions need attention
Research

Personal experience

• Bachelor and Master Degree in Telecommunication Engineering
• PhD in Applied Science – ultrasound wave-propagation modelling
Research

Personal experience

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  **depth**
- PhD in Applied Science – ultrasound wave-propagation modelling  
  **width**

- Application of signal processing techniques from RADAR to ultrafast ultrasound imaging (5 proceedings and 4 journal papers)
Research

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  Depth
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  Width
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Thake home messages:

Depth gives you tools
Width gives you the chance to apply the tools
New ideas often comes from boundaries between different areas
Research

Personal experience

When I first presented this idea, the response was: “it is impossible”

It took me time and effort but I proved that it was possible and even useful
We can thus add a third dimension

How do you approach research

- **Attitude**
  - Skeptical optimism
  - Emotional detachment
  - Try to do new things
  - Have trust in your own judgment and in the scientific method (try it!)

- **Commitment**
  - Sometimes it may be frustrating
  - Sometimes it may be tedious
  - Try to always have a clear idea of what you are doing
  - Sometimes play

- **Creativity**
  - Not everyone will always welcome your creativity, since to create sometimes implies to destroy. Also remember that creation does not always comes from destruction.
Research

We can thus add a third dimension

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  • *Skeptical optimism*
  • *Emotional detachment*
  • *Try to do new things (challenge the existing)*
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What does support creativity?

• Autonomy
  • The environment
  • Knowing what you know and what you don’t know

• Flexibility and Openness
  • Challenge your understanding of things
  • Be open to different ideas, do not reject things just because you do not understand them
  • Look for contamination (Interdisciplinarity fosters innovation)

• Formulation of clear research objectives
  • Identify the problem (without problems there are no solutions)
  • Search a solution (the fact that three is a problem does not imply the existence of a solution)
  • Propose a solution (if you find one)
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• Originality
  • *It is simply new*

• Usefulness
  • *Basic vs. applied*

• Transformation property
  • *Where you see a problem I see a solution*
    e.g. speckle-noise is used for tissue characterization and motion tracking

• Condensation property
  • *At the end of a creative process it is important to answer:*
    1. *What have you done and why?*
    2. *What is the key idea?*
    3. *What characterizes the idea? (e.g. better performance)*
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- Type of research
  - Basic Research
  - Applied Research
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  • Applied Research

• Advisor
  • Collaborator type
  • Hands-off type
  • Senior scientist type
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No worries there are exceptions, remember every model is wrong
Making choices

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  • Basic Research
  • Applied Research

• Advisor
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  • Senior scientist type

Practical approach:
  • How much one publishes
  • Where one publishes
  • How much one is cited
Making choices

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  - Basic Research
  - Applied Research

- Advisor
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Practical approach:
- How much one publishes
- Where one publishes
- How much one is cited
- Accomplishments in teaching
- Enthusiasm
- Management and organization skills
- Reputation for setting high standards in a congenial atmosphere
- Compatible personality
- Ability to serve as a mentor

But also other aspects are of great importance
Programs of Study

• **Horizontal dimension:** *interdisciplinary*
  - Somewhat harder: there may be no community at all
  - Creativity may have more space to be expressed

• **Vertical dimension:** *disciplinarily*
  - Somewhat easier: there is a clear community to identify and address
  - Creativity may be more confined to a specific set of problems
Programs of Study

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Time Management

This is a key factor
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1. Set Goals
2. Make a to do list and use it
3. Beware of time wasters
Time Management

This is a key factor

1. **Set Goals:**
   1. *Passing qualifying*
   2. *Passing Exams*
   3. *Write the thesis*
   4. *Celebrate*
Time Management

This is a key factor

1. Set Goals:
   1. Passing qualifying • Improving horizontal dimension
   2. Passing Exams • Improving vertical dimension
   3. Write the thesis
   4. Celebrate
Time Management

This is a key factor

1. **Set Goals:**
   
   1. *Passing qualifying* • *Improving horizontal dimension* • *Seminars*
   
   2. *Passing Exams* • *Improving vertical dimension* • *Solve Research Problems*
   
   3. *Write the thesis* • *Publish papers*
   
   4. *Celebrate* • *Attend conferences*
   
   5. *Visit other institutions* • *Talk to people*
Time Management

This is a key factor

1. Set Goals
2. Make a to do list and use it:
   1. Prioritize your goals
   2. You can be flexible with your schedule
   3. Realize that tedious may sometimes be necessary
   4. Have deadlines and meet them
   5. Check your progresses, do not be too easy with yourself
   6. Celebrate
Time Management

This is a key factor

1. Set Goals
2. Make a to do list and use it:

1. Prioritize your goals • Focus on the result of an action
2. You can be flexible with your schedule • Talk to people
3. Realize that tedious may sometimes be necessary • Link your work to the goal
4. Have deadlines and meet them • Have a To do Book
5. Check your progresses, do not be to easy with yourself
6. Celebrate
Time Management

This is a key factor

1. Set Goals
2. Make a to do list and use it
3. Beware of time wasters:
   1. Telephone (PhD killer number one)
   2. Lack of deadlines
   3. Schedule meetings
   4. Procrastination of tedious work (I know I have to do it but I don’t do it)
   5. Over involvement with details
   6. Attempting too much
   7. Inability to say no
Time Management

This is a key factor

1. **Set Goals**
2. **Make a to do list and use it**
3. **Beware of time wasters:**
   1. **Bad planning**
   2. **Poor communication**
   3. **Lack of celebration**
Time Management

This is a key factor

1. Set Goals
2. Make a to do list and use it
3. Beware of time wasters:
   • Remember:
     • It takes time to focus into a problem
     • Interruptions makes it impossible (create a me time-zone)
Choosing a scientific problem

1. *Can it be enthusiastically pursued and interest can be sustained*
2. *Is it (partly) solvable in 3 years*
3. *Is it worth*
4. *Is it publishable work or only development*
5. *Are you competent for the task, can you become competent*
6. *Do you have what you need to solve the problem*
7. *Will the research prepare you in an area of demand or promise for the future*
8. *Is it special*
Choosing a scientific problem

1. What?
   1. Is it not solved
   2. Scenario, user case

2. Why?
   1. Is it important?

3. How?
   1. Which approach? Which idea?

4. Why me?
   1. Which competences do I have? Can I solve this problem individually?
Timing of PhD

1\textsuperscript{st} year:

- Review of the literature
- Improve on vertical dimension
- Identify problems which need a solution and structure your work
- Get experienced with public presentations
- Write and submit a (journal) paper
- Pass Qualifying exam
Timing of PhD

2nd year:

• First intuition(s) of the solution to your research problem
• Execute experiments
• Submit contribution(s) to top conferences
• Visit another institution abroad (make it worth)
• Write and submit a second journal paper
Timing of PhD

3rd year:

• Deepen your knowledge
• Disseminate your knowledge
• Expand on the previous intuition
• Submit contribution(s) to top conferences
• Write and submit a third top journal paper
• Set the basis for an extension
• Finalize your PhD Thesis
And....

There is hardly any professional growth without personal growth.

Beauty is essential.

Find motivation for what you do will be of tremendous help.
End of lecture 2