Research and How it Works

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What is Research?

- Nibble on the tree of knowledge
- Driving force: human curiosity
Knowledge Gain

- Observations, measurements, trials
- Axioms, hypotheses, models
- Validation, verification, falsification
  - Proof (theoretical sciences)
  - Experiment (applied sciences)
  - Empirical study, survey (social sciences)
Research Aspects (1)

- Objectifiable, rational
- Reproducible, verifiable
- Principle of causality
- Reductionism - holism
- Paradigm shift
Spurious Correlations

US spending on science, space, and technology correlates with Suicides by hanging, strangulation and suffocation

http://www.tylervigen.com/

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Research Aspects (2)

- Society and Science
  - Scientism
  - Anti-scientism
- Science – research - development
- Basic research – applied research
- Research is very costly (even more costly is not doing research)
Research Aspects (3)

- Very strong differentiation

- Exponential data growth

Diagram:

- technical sciences
- computer science (cs)
  - theoretical cs
  - practical cs
  - technical cs
- computer graphics
  - visualization
  - volume visualization
Research Paradigms

- Experimental sciences (observations, experiments)
- Theoretical sciences (modelling to describe and explain natural phenomena)
- Scientific computing (computer simulation of mathematical models)
- Data science (big data, smart data)
Where does Research happen?

- Universities: “Unity of Teaching and Research” [https://www.bmbwf.gv.at/]
- Extra-mural research institutes
  - IST Austria, AIT, Joanneum Research, Oefai
- Academy of sciences
- Public – private research partnerships
  - K+ Centres (VRVis, http://www.vrvis.at/)
- Commercial companies
  - typically in large companies
  - (Research and) development
What is a university teacher doing?
- He/she is teaching (4 - 12 weekly hours each term)
- He/she is doing administrative work (study curriculum, ...)

What is he/she doing during the breaks?
- He/she is going on vacation

And then he/she is doing research
Research Groups

- Institute subdivided into several research groups
- Joint research interests
  - VC&HCT: CV, CG, Prip, ...
- Members of a research group
  - University teachers
  - Research associates, PhD students
  - Master students, interested students
- Carrying out research projects
Research Projects (1)

- Single projects – joint projects
- Problem, goal, approach, outcome, costs
- Processing in several phases (milestones)
- In each phase defined
  - Desired goals and results
  - Actions, implementation measures
  - Evaluation
  - Duration
Research Career

- Professional career
  - Tutor (teaching/research assistant)
  - Doctorate (university assistant, research assistant, ...)
  - PostDoc
  - Habilitation (tenured position), Professorship

- Qualities of a good scientist
  - Curiosity (why, why, why, ...)
  - Creativity
  - Excellent command of tools
  - Analytical thinking
  - Perseverance, tenacity, thoroughness, frustration tolerance
Research Projects - Milestones

- Project start
- State-of-the-art survey
- Formulation of ideas and goals
- Implementation, realization
- Testing, evaluation
- Publishing (write a scientific paper)
- Project end with debriefing
Research Project - Example

CT - Angiography
Research Results

- Master theses
- PhD theses
- Publications (https://www.cg.tuwien.ac.at/research/publications/)
  - At conferences
  - In scientific journals
- Software prototypes
- Patents, licenses
- Spin-off companies
Research Groups (1)

- Internal Communication
  - Individual meetings
  - Organisational meeting
  - Scientific meeting
  - Colloquy cycle
  - Yearly closed meetings
  - Social interaction
Research Groups (2)

- External Communication
  - Colloquy cycle, guest lecturer
  - Guest researcher
  - External research stays
  - Conference attendance
- Publications (papers, posters)
  - Scientific
  - Popular science
- Trade fairs
Organized by scientific associations
Local organizers
Conference chair, program committee
Call-for-papers
Submission of scientific papers (technical reports)
Peer reviewing
Conference attendance, giving a talk
Article published in conference proceedings
- Published by commercial publisher or scientific association
- Editor-in-chief, editorial board
- Submission of scientific papers (technical reports)
- Peer reviewing
- Major revision with second review cycle
- Article published in journal
- Duration: half a year and longer
Scientific Associations

- Advancement of scientific area, members
- Ethical guidelines
- Publishing of journals
- Organization of scientific events

Examples of scientific associations
- OCG (http://www.ocg.at/)
- GI (http://www.gi-ev.de/),
- Eurographics (http://www.eg.org/)
- IEEE (http://www.ieee.org/)
- ACM (http://www.acm.org/)
Journals on Academic Establishment

- Austrian University Journal
- German University Journal
Research Activities - Evaluation

- #Publications
- #Patents
- #Talks
- Acquired research fundings
- #PhD students, #Master students
- Member in scientific associations
- Member in program committees
- Member in editorial boards
- #citations
  - Science Citation Index
  - http://scholar.google.com/
  - http://citeseer.ist.psu.edu/
  - http://www.scopus.com/scopus/home.url
  - http://www.vs.inf.ethz.ch/publ/slides/Citation-Index-Unsinn.pdf

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Research Funding

- University, science funds, company funding

- Science funds
  - FWF – basic research fund (http://www.fwf.ac.at/)
  - FFG – applied research fund (http://www.ffg.at/)

- EU – funding programs
  - Horizon 2020
  - ERC grants
How to Run a Successful Research Group?

https://www.cg.tuwien.ac.at/research/publications/2021/wu-2021-vi/
Study and Research

- Unity of teaching and research
- Scientific topics dealt with in
  - Proseminars, Seminars
  - Programming assignments, computer science projects
  - Bachelor thesis
  - Master thesis
  - PhD thesis

Research is fascinating
Join in nibbling!
References

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