Methodology and Tools for Research:

Knowledge production

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Objectives of this course

- Understand several notions:
  - Knowledge production
  - Validation of claims
  - Peer assessment
  - Scientific disciplines
- And also
  - Ethics in research
  - Science and society

Outline

- Scientific knowledge
- Scientific disciplines
- Studying science
- Science and society

Outline

- **Scientific knowledge**
- Scientific disciplines
- Studying science
- Science and society

Knowledge (1)

1. facts, information, and skills acquired by a person through experience or education; the theoretical or practical understanding of a subject
   - what is known in a particular field or in total; facts and information:
   - *(philosophy)* true, justified belief; certain understanding, as opposed to opinion.
2. awareness or familiarity gained by experience of a fact or situation

Knowledge (2)

- One of the most important notion of philosophy
  - what is knowledge? what is it about? how is it possible to know something? is knowledge related to truthiness? *etc.*
- Some oppositions
  - implicit / explicit
    - *to know how to swim / to know the name of the current president of France*
  - informal / formal
    - *to know how to order in a restaurant / to know Pythagoras theorem*
  - unmethodical / systematic
    - *to know that a taxi ride is too expensive / to know the average price for a ride in a particular city*

Scientific knowledge production (1)

- Scientific knowledge = claims about reality
  - descriptive knowledge: describe (resp. explain) what happened
  - predictive knowledge: predict what will happen under certain circumstances (causes and effects)
- Empirical research
  - acquire knowledge by observation or experience that support or invalidate claims
- Use of logics and mathematics
  - assert that a reasoning is sound, check the consistency of a model, statistically evaluate experimental results with regards to claims, prove theorems, etc.

Scientific knowledge production (2)

- Scientists are in charge of producing scientific knowledge

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Validation of scientific knowledge (1)

- Scientific knowledge is more than mere individual claims
  - it should stand independently of the scientists
  - need for external validation
- Validation is based on “standardized intersubjectivity”
  - intersubjectivity: agreement between several individual on the fact that something is meaningful
  - standardized: there are rules
    - on how to reach this agreement
    - on what can be the subject of the agreement

Validation of scientific knowledge (2)

- Peer validation
  - only peers of a scientist can validate the fact that this scientist has produced valuable knowledge
  - because they also are scientists hence share the rules
- Example of validation checks
  - correction of a proof
  - reproducibility of an experiment
  - soundness of a reasoning
  - originality of the work
  - ...

Accumulation of scientific knowledge (1/2)

- Growth of scientific knowledge never stops
  - *The larger the island of knowledge, the longer the shoreline of wonder* (Ralph W. Sockman)
- Evolutions
  - incremental growth: one step after another step
  - breakthroughs: rare but happen
  - (obsolescence: something is proven false, or can be better described)

Accumulation of scientific knowledge (2/2)

- Needs
  - validation: being able to assess work originality
  - creation: being able to to build on others' works
- Growth is based on systematic accumulation of physical supports of scientific knowledge
  - mainly written supports (publications)

Socio-technical organisation for knowledge production

- Universities
  - provide places of work and discussion
- Publication processes
  - provide scientific knowledge validation workflows
- Publishers
  - provide physical supports, and diffusion through communication means
- Conferences
  - provide means for scientists to meet and discuss
- Libraries
  - support accumulation of physical supports

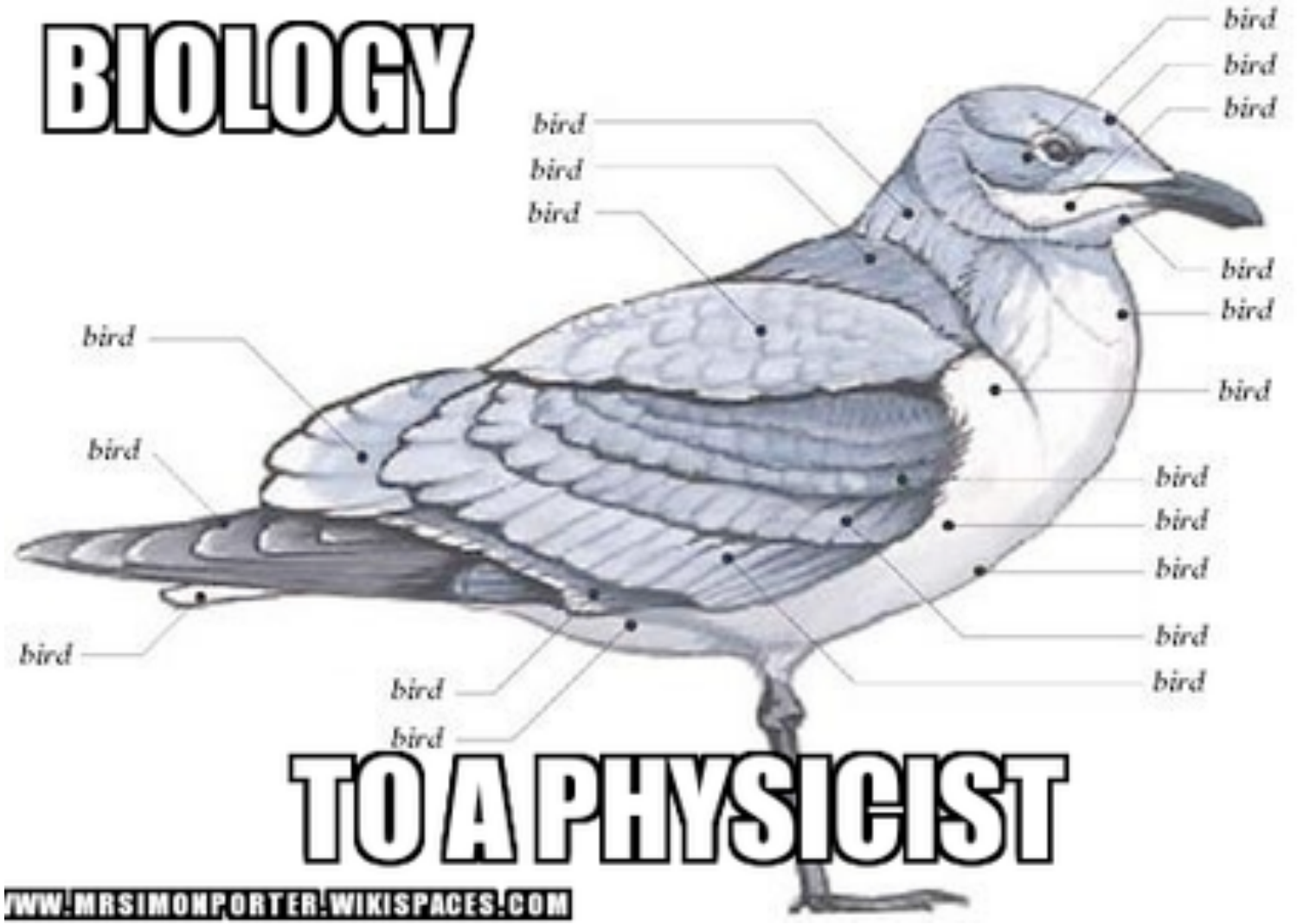
Scientific ethics

- Scientists are committed to the functioning of science, mainly regarding evaluation
  - accepting peer evaluation
  - honesty for evaluating others' works
  - citing others' works
  - not stealing others' works
  - honesty with one's actual results
  - *etc.*
- Science would not work without ethics…
  …but of course it is not as simple
  - see later

Outline

- Scientific knowledge
- **Scientific disciplines**
- Studying science
- Science and society

This is not a bird



Validation and "standardized intersubjectivity"

- All the researchers adhere to a set of general rules
  - peer assessment, ethics, logical reasoning, etc.
- Not all the researchers work on the same domain
  - e.g. sociology, biology, philosophy, computer science
- Not all the researchers agree with each other on
  - means of validations, what is an experiment, what is "good" science, etc.

Distinctions amid Science

- Natural science
  - universal laws, natural objects
- Cultural science
  - contingent laws, cultural objects

Ernst Cassirer
is Public Domain

- Hard science *vs* soft science
  - not only methods, but also perceived *legitimacy* (rigor, mathematics, predictions, experiments)
  - Physics/Chemistry > Biology > Psychology > Social sciences
    - Exercise: where is computer science?

Scientific disciplines (1)

- Community of researchers, characterised by
  - a common object (research domain): e.g. life, law, matter, information, etc.
  - the associated scientific practices : community of practice
    - commons means of validation, methods, ways of apprehending the world, etc.
  - the associated body of knowledge
    - corpus of scientific material

Scientific disciplines (2)

- Belonging to a discipline:
  - agreeing to its object, methods, limits of body of knowledge
  - participating to the growth of that body of knowledge
- Hence being recognized as a peer by the others members of the community

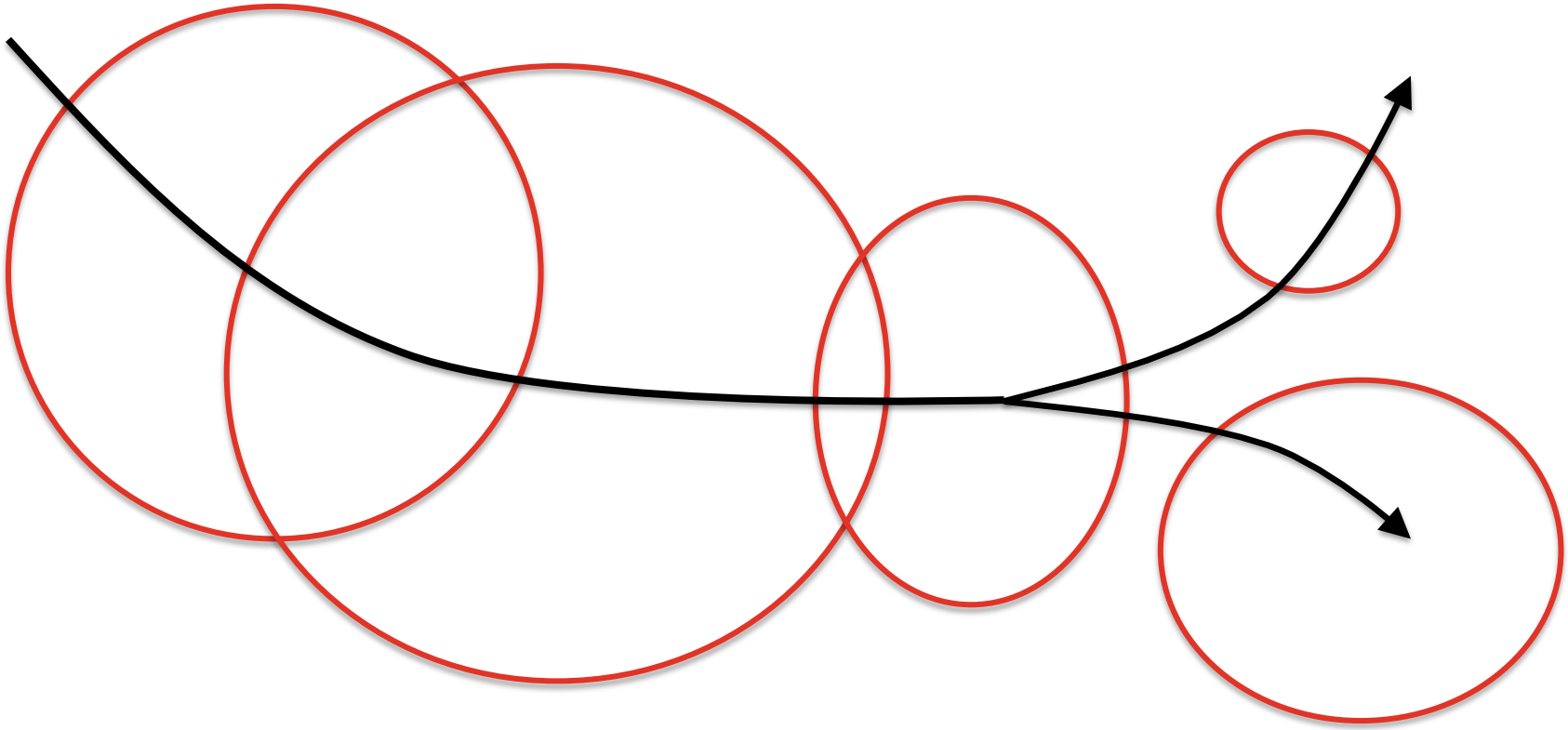
  « a sociologist is a guy who is considered a sociologist by sociologists »

Sub-disciplines

- Scientists from the same discipline are supposed to be able to talk to each other
  - but disciplines are huge with several thousands of researchers, all hyper-specialised
- There are many sub-disciplines
  - Chemistry (wk): Analytical chemistry, Biochemistry, Inorganic chemistry, Materials chemistry, Neurochemistry, Nuclear chemistry , Organic chemistry, Physical chemistry, Theoretical chemistry
  - Computer science: networking, HCI, Language theory, Pattern recognition, Databases, Image processing…
- Not mentioning sub-sub-disciplines !

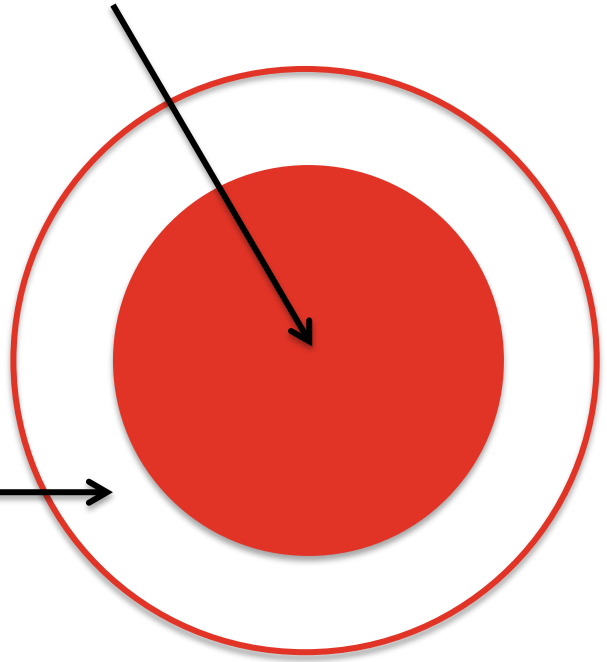
Evolution of disciplines

- Scientific knowledge evolve…
- … so do disciplines



Frontiers of disciplines

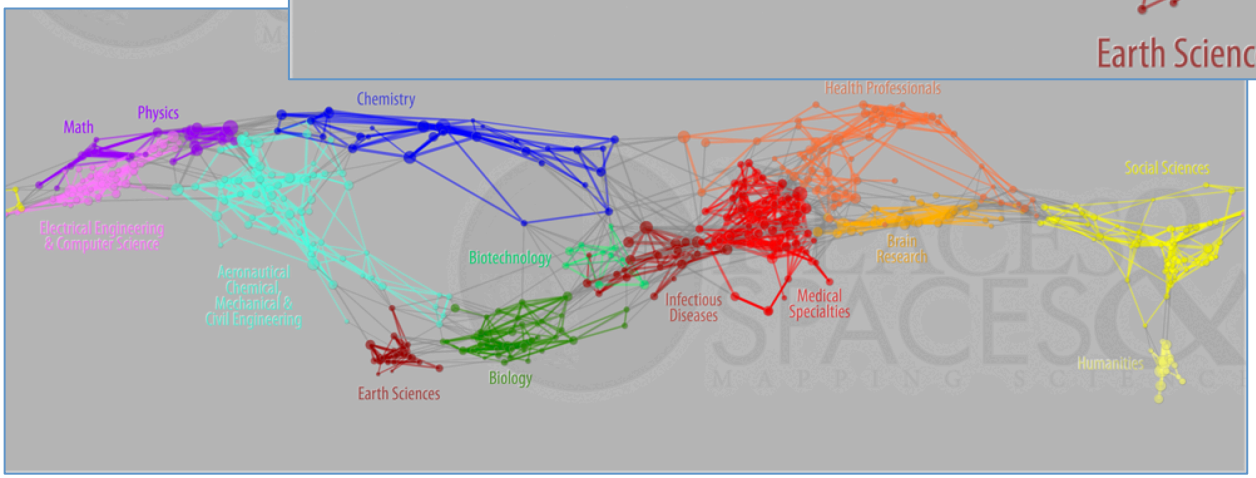
- The frontiers of disciplines are always challenged
- Quite comfortable to be at the core of the discipline
  - quite stable
  - full agreement with the values of the community
- Not so comfortable to be at the edge
  - more rapid evolution
  - more criticisable



[pluri-| inter-| trans-]disciplinary practices (1)

- Pluri-disciplinarity (or multi): several disciplines within a same team to build something in common
  - variety of approaches, innovation
- Inter-disciplinarily: using approaches from another discipline, enhancing one's method with others'
  - synthesis of approaches
- Trans-disciplinarily: building a common approach, with belongs neither to a discipline nor to the other
  - common object, common approach

Mapping science



http://scimaps.org/maps/map/maps_of_science_fore_50/detail- © Cyberinfrastructure for Network Science Center

[pluri-| inter-| trans-]disciplinary practices (2)

- It is difficult
  - not getting (publishable) results easily
  - understanding another discipline (objects, methods, body of work)
- Some qualities are needed
  - deep respect of the point of view of the other
  - confidence that an agreement will eventually be reached
  - patience and hard work to be able to build that agreement
- But it is rewarding
  - revolutionary ideas often come from inter- or trans-disciplinary work
  - new disciplines emerge from trans-disciplinary work
    - e.g. bio-informatics

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Taking science as the object of science

- Epistemology
  - *Epistēmē*: science, knowledge - *Logos*: discourse
  - *Meaning 1:* Theory of knowledge
  - *Meaning 2:* Philosophy of science
    - Study of how knowledge is produced, in general or considering particular disciplines
    - Thomas Kühn: notion of paradigm
- Sociology of science
  - Studying science as a social activity

Science and writing

Edmund Husserl
is Public Domain

- For creating knowledge
  - Husserl's *Origin of geometry*:
    - no geometry, no mathematics possible without writing
  - need for "externalising ideas" so as to be able to consider them, verify reasoning, etc.
- For evaluating knowledge
  - only externalised written scientific knowledge can be evaluated
- For spreading knowledge
  - written scientific knowledge can circulate

Science and Janus

- Latour *Laboratory Life: The Construction of Scientific Facts*:
  - Scientific activity has two faces like Janus

Bruno Latour in Gothenburg by Jerzy Kociatkiewicz is *CC BY SA 2.0*

Day to day laboratory life: humans, multiple goals, various experiments, strange phenomena, luck, etc.

Janus coin is Public Domain

External presentation of scientific work: unique direction (from hypothesis to validation to conclusion), non-importance of scientists, etc.

- See for instance recent (jan 2013) twitter hashtag #overlyhonestmethods

Science and scientists

- Scientific activity involves lots of sub-activities not directly related to scientific production
  - management, getting funds, etc.
- Researchers are humans too
  - they have strategies of power
    - for science / for career (hopefully connected :-)
  - they can cheat
    - certainly a minority
  - …

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Peer validation ≠ market or society "validation"

- Internal to science
  - *new* knowledge is acquired, the world changes because we think it differently
    - *new* concepts: e.g. ecology
    - *new* objects: e.g. quasars
  - criteria = actual knowledge *production*
- External to science
  - knowledge discovery has consequences on society
    - new technical tools and industrial development
    - new ways of thinking society
  - criteria = impact on society, "usefulness"

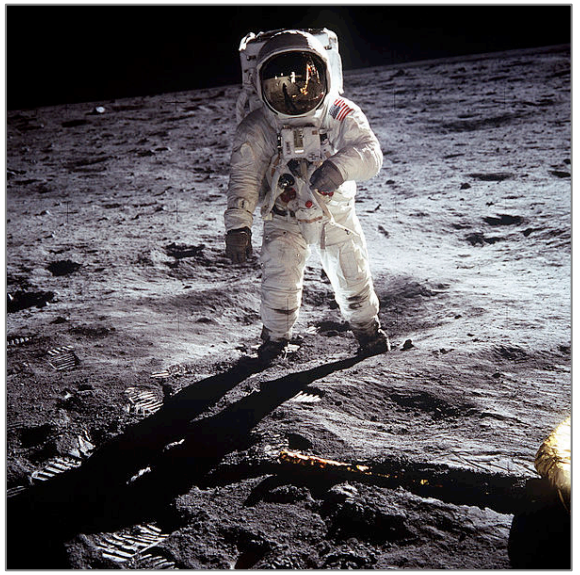
Science and society (1)

- Scientists are appointed by society to produce scientific knowledge, they need support for
  - doing research
  - accumulating knowledge
- Social organisations are devoted to providing such support
  - universities, laboratories
  - libraries
  - funding bodies
  - scientific publishers
  - ...
- Most are publicly funded

Scientist Looking Thorugh Microscope
by anonymous is Public Domain

Science and society (2)

- Society is conscious that research is very important for its development
  - put not always for the sake of knowledge creation…
- Utilitarian view on science
  - produce wealth!
    - we need growth
  - produce prestige!
    - big equipment, Nobels
  - produce ROI!
    - funding only “useful” research
  - meet my timescale!
    - few years vs several decades (long term research)
  - produce certainty!
- sometimes contradictory with what science is



Astronaut Buzz Aldrin on the moon by NASA is Public Domain

Scientist (2013)

- Scientists are in charge of producing scientific knowledge

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Scientist (2012)

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