From Ontology-based Data Management to Reforming Research Evaluation: challenges and perspectives ahead

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Short CV of Cinzia Daraio

Cinzia Daraio is a full professor at the Department of Computer, Control and Management Engineering "A. Ruberti" of Sapienza University of Rome (Italy) where she teaches Quantitative Models for Economic Analysis and Management, Productivity and Efficiency Analysis and Economics and Industrial Organization.

She is specialized in science and technology indicators, data quality and data integration, higher education microdata, methodological and empirical studies in productivity and efficiency analysis. Over the years, she participated in several international and national research projects and expert groups at the European Commission and OECD on these subjects. She is member of the Editorial Board of Journal of Productivity Analysis, International Transactions in Operational Research, Scientometrics, Journal of Informetrics, Journal of Data and Information Science, Quantitative Science Studies, Scholarly Metrics and Analytics and others.

She is in the list of the World top 2% scientists in the field of Social Sciences (Baas, Jeroen; Boyack, Kevin; Ioannidis, John P.A. (2021), “August 2021 data-update for <<Updated science-wide author databases of standardized citation indicators>>”, Mendeley Data, V3, doi: 10.17632/btchxktzyw.3).

She authored more than 200 publications including a monograph two edited books, many articles in international peer-reviewed journals, several chapters and papers presented at conferences and in proceedings. Additional information are available on her website: https://sites.google.com/diag.uniroma1.it/prof-cinzia-daraio/home-page-of-cinzia-daraio

Research topics and some projects

Research topics

- Data integration and data quality
- Efficiency and productivity analysis
- Research evaluation

Some projects

- Do we have the right metrics? How Virtue Ethics, Accounting, Efficiency Analysis and Machine Learning can help
- Evaluating Evaluations by Including Normative Ethics, Management Science and Artificial Intelligence in a Visual Analytics Environment
- Research infrastructures for the assessment of science, technology and innovation policy

Outline: a Journey from Data Integration to the Reform of Research Evaluation Systems

I. Recent trends in research assessment:
   I. Computerization of bibliometrics
   II. altmetrics
   III. complexity of research assessment
   IV. granularity and increasingly demang policy needs
   V. need to reform current research evaluation systems

II. Need for a Framework

III. Crucial role of Data and Challenges in Data Integration

IV. Sapientia: the Ontology of Multi-Dimensional Research Assessment

V. Combining Ontology-based Data Management and Visual Analytics

VI. An Ontology-Based Semantic Design for Good Evaluations of Research Practices

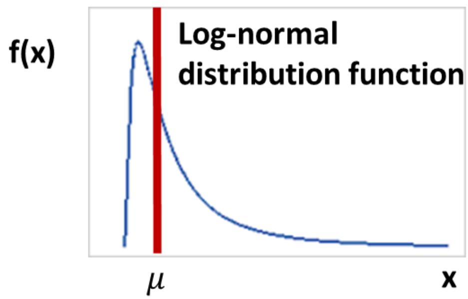
I. Recent trends in Research Assessment

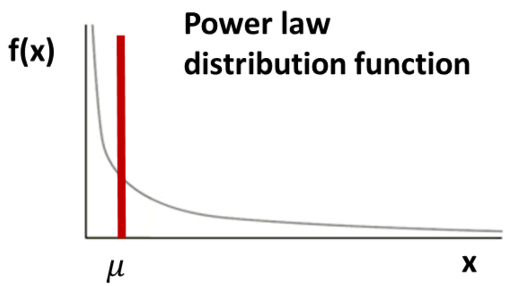
Recent trends in research assessment

Category	Description
Changes	Has changed the way in which the knowledge is produced, the dynamics of science and its interactions with society: *postacademic science* [24.49, 50]
	There is a crisis of *technoscience* (scientific research and technological innovation, focused on applications [24.51]) and science identified [24.52] in reproducibility, peer-review, publication metrics, scientific leadership, scientific integrity and the use of science for policy
	Advent of the big data era and its technological developments in research assessment (the *computerization of evaluative informetrics*) [24.10]
	Has changed the way in which science is communicated [24.53]
Consequences or effects	*On the demand side* (those that ask for research assessment): changes of the requests and the ways in which the assessment is carried out (has to be done): 1. Extension to societal value and value for money (*evaluation society*) [24.54, 55] 2. Performance-based funding [24.56, 57] 3. Requests for new and timely indicators in response to changing needs [24.58] 4. Increase of institutional and internal assessments.
	On the supply side (those that offer research assessment): proliferation of rankings (among many others [24.59]), development of Altmetrics [24.60, 61], open-access repositories [24.62, 63], new assessment tools—both commercial (InCites and Sci-Val) and freely available (Google Scholar citation), desktop bibliometrics ([24.64]; Publish or Perish software)
	On scholars: the increase of *publish or perish* pressure, impact on the incentives, behavior and misconduct, and increasing critics against traditional bibliometric indicators [24.65–73]
	On the assessment process: Increasing *complexity of the research assessment* linked to the *implementation problem* [24.2]; multidimensionality of the assessment of the research [24.74]; problems of data quantification, harmonization and standardization for different evaluation and assessment purposes [24.75–77]
	On the measurement of productivity/efficiency within an assessment process: The increasing complexity of the research assessment and the extension of the boundaries of the research activity and the interdependence with the society requires a more precise description and delineation of the *boundaries* of the production process whose productivity has to be measured before making the estimate, and to consider the *dynamics* of the inputs, outputs and their connection

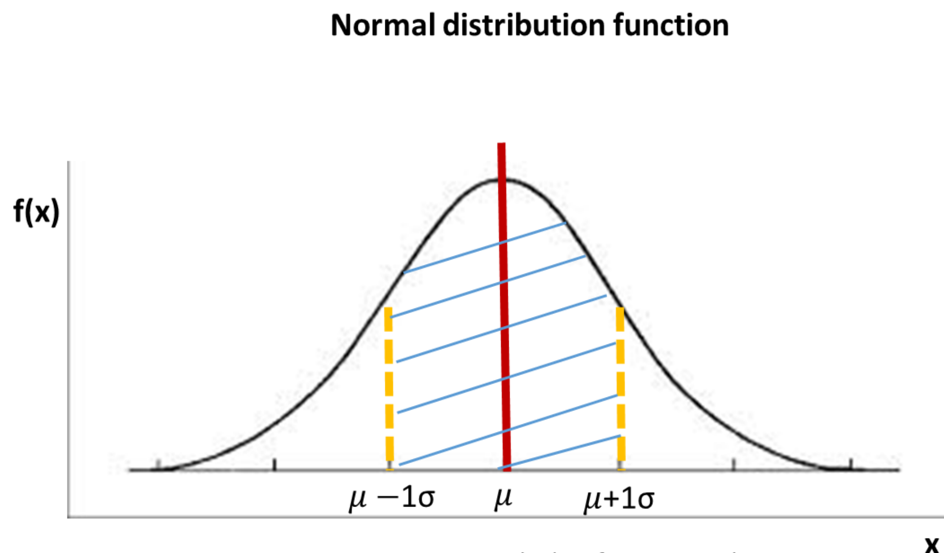
Source: **Daraio C. (2019), Econometric approaches to the measurement of research productivity, in *Springer Handbook of Science and Technology Indicators* edited by Glänzel W., Moed H.F., Schmoch H. and Thelwall M., pp. 633-666.**

Inequality of performance indicators





x is a Performance Indicator



x is an *ideal* Performance Indicator

The *expected value* μ is reached by only a small fraction of the population.
There are a *few outlying performers* and a long tail.
These f(x) *highlight the* ***inequality*** of the population.

The *expected value* μ is reached by half of the population.
In around 68% of the cases, an observation randomly chosen will fall within μ+/-1σ : the majority of the population is around the average performance.
This f(x) *highlights the* ***cohesion*** of the population.

Source: **Daraio, C. (2021). Altmetrics as an Answer to the Need for Democratization of Research and Its Evaluation. *Journal of Altmetrics*, 4(1)**

Altmetrics as an Answer to the Need for Democratization of Research and Its Evaluation

Altmetrics as an Answer to the Need for Democratization of Research and Its Evaluation

Journal of Altmetrics

RESEARCH

CINZIA DARAIO

ABSTRACT

In the evaluation of research, the same unequal structure present in the production of research is reproduced. Despite a few very productive researchers (in terms of papers and citations received), there are also few researchers who are involved in the research evaluation process (in terms of being editorial board members of journals or reviewers). To produce a high number of papers and receive many citations and to be involved in the evaluation of research papers, you need to be in the minority of *giants* who have high productivity and more scientific success. As editorial board members and reviewers, we often find the same minority of giants. In this paper, we apply an economic approach to interpret recent trends in research evaluation and derive a new interpretation of Altmetrics as a response to the need for democratization of research and its evaluation. In this context, the majority of *pygmies* can participate in evaluation with Altmetrics, whose use is more democratic, that is, much wider and open to all.

Daraio, C. (2021). Altmetrics as an Answer to the Need for Democratization of Research and Its Evaluation. *Journal of Altmetrics*, 4(1)

II. Need for a Framework

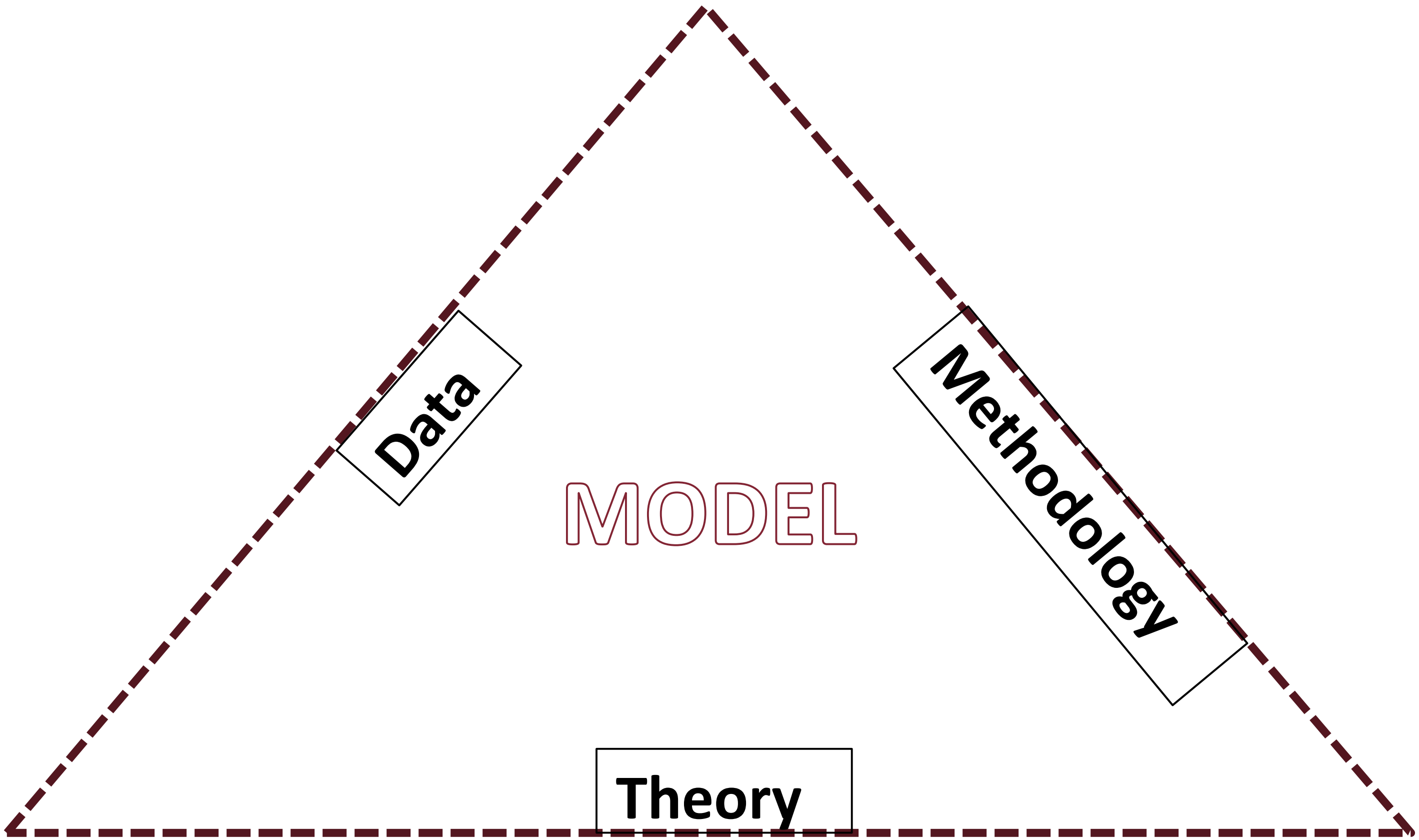
Need for an overall framework for the assessment of Performance

- Crucial importance of the issue of designing relevant models to assess the performance.
- The evaluation of performance is a complex task for many reasons.
- There are no perfect methods/estimators which fit for all purposes.
- In order to understand the appropriateness of the methods/estimators to be used, we need to frame the problem taking into account
  - the *systemic* nature of the phenomena and
  - to develop *models* of performance that are as close as possible to the reality being assessed.

Need for an overall framework for the assessment of Performance

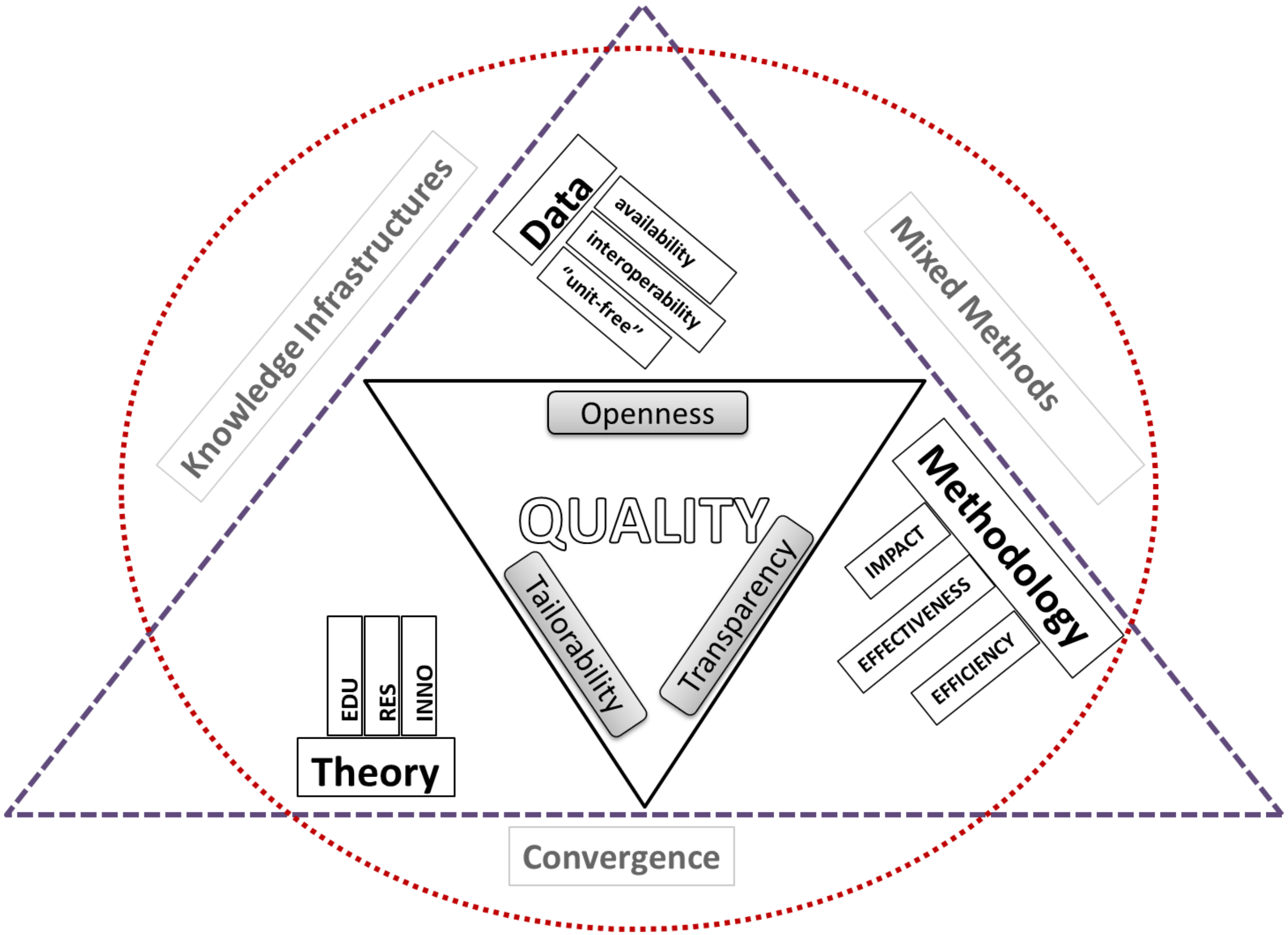
- each metric (quantitative evaluation based on the application of an estimator in our context) is based on a *model* that can be implicitly or explicitly defined and discussed.
- If the model underlying the metric is not described, this does not mean that the indicator is more robust to modelling choice. It simply means that you do not explicitly clarify and account for the underlying theoretical choices, methodological assumptions and data limits.
- Thus, as a consequence, if you do not specify your model of the metric, you may not check its robustness.

Developing a model



Source: Daraio C. (2017), A framework for the assessment of Research and its Impacts, *Journal of Data and Information Science*, Vol. 2 No. 4, 2017 pp 7–42.

A systemic framework for the development of models of metrics



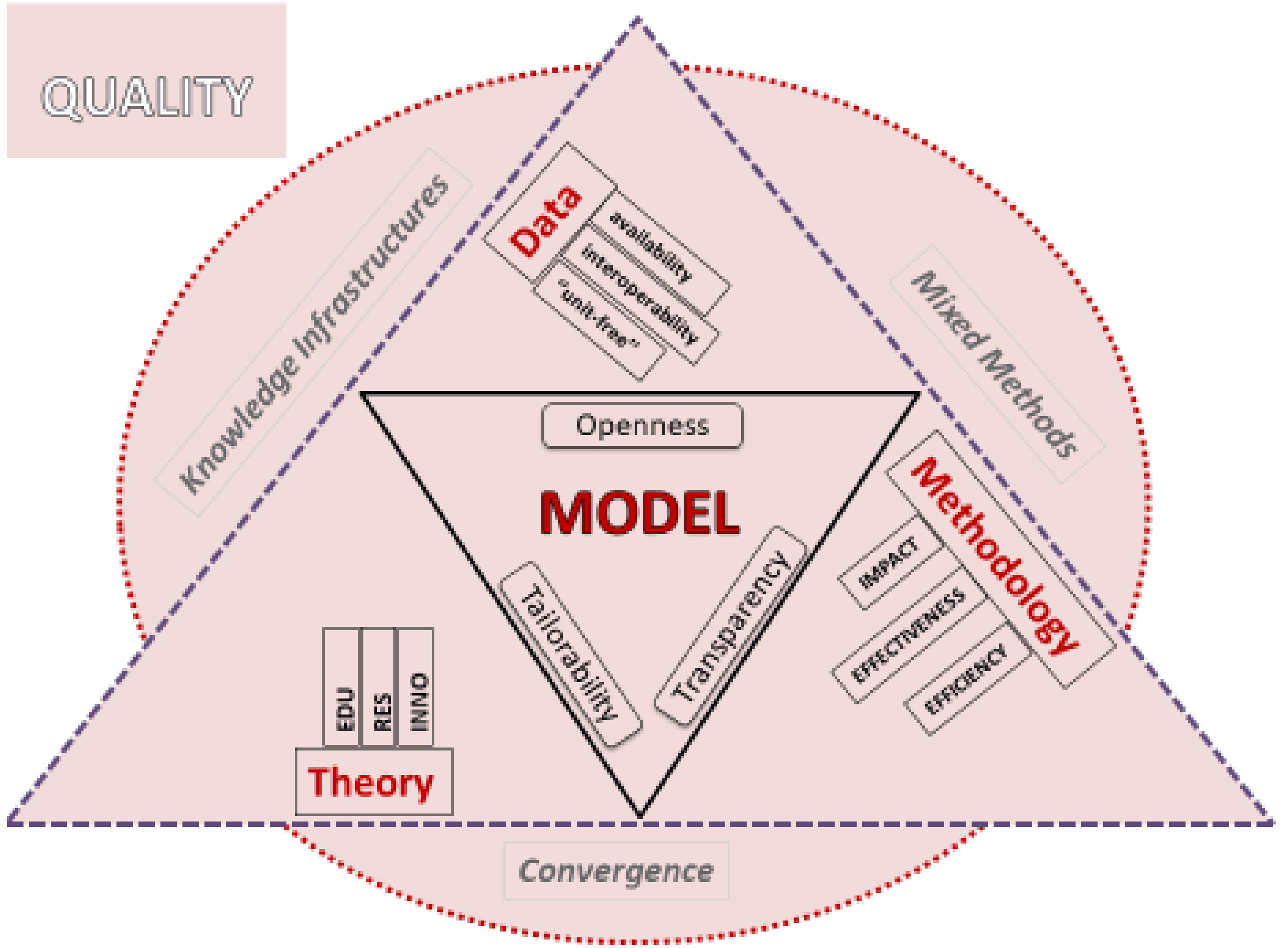
Source: Daraio C. (2017), A framework for the assessment of Research and its Impacts, *Journal of Data and Information Science*, Vol. 2 No. 4, 2017 pp 7–42.

Components of the framework

Dimension and component	*Definition*
1. *Theory*	Identifies the conceptual content of the analysis, answering the question *what is the domain of interest* and delineating the boundary of the investigation.
Education Research Innovation	These are the main conceptual blocks of theory. Their interrelations and their complementarities should be considered in a systematic way when assessing research.
2. *Methodology*	Identifies the range of methods, techniques and approaches that are relevant for the evaluation of research. It answers the question *how* the investigation is handled.
Efficiency Effectiveness Impact	These are the subjects of the assessment. They go from the *output* (baseline) that is the result of the transformation of inputs in outputs, to *efficiency*, which relates output to inputs with respect to an estimated efficient frontier, to *effectiveness*, which considers inputs, output and accounts for the aims of the activity, while *impact* refers to all contributions of research outside academia.
3. *Data*	Data are a relevant dimension often neglected in model building. Data have a problematic definition because this depends on their use not on inherent characteristics of the data [24.79, p. 74]. Data are instances coming from the domain of interest and represent the means by which the analyses are carried out.
Availability Interoperability *Unit-free* property	Refers to the usability of data, alternatives and choices that affect the data. This is the way in which heterogeneous data systems are able to exchange information in a meaningful way. Need of consistent and coherent observations across different levels of analyses.
Quality	*Fitness for purpose*. It is the overarching concept of the framework. It is also an attribute of the different dimensions of the framework.
Implementation factors	
Tailorability	Adaptability to the features of the problem at hand.
Transparency	Description of the choices made and underlying hypothesis masked in the proposed/selected theory/method/data combination
Openness	Accessibility to the main elements of the modeling.
Enabling conditions	
Convergence	Evolution of the transdisciplinary approach, which allows for overcoming the traditional paradigms, increasing the dimensional space of thinking.
Mixed methods	Intelligent combination of qualitative and quantitative approaches.
Knowledge infrastructures	Networks of people that interact with artifacts, tools and data infrastructures.

Source: **Daraio C. (2019), Econometric approaches to the measurement of research productivity, in *Springer Handbook of Science and Technology Indicators* edited by Glänzel W., Moed H.F., Schmoch H. and Thelwall M., pp. 633-666.**

A systemic framework for the development of models of metrics



The ability to develop (and afterwards understand and use effectively) models for the assessment of research is linked and depends, among other factors, on the degree or depth of the conceptualization and formalization, in an unambiguous way, of the underlying idea of quality.

Source: Daraio C. (2017), A framework for the assessment of Research and its Impacts, *Journal of Data and Information Science*, Vol. 2 No. 4, 2017 pp 7–42.

Nature of models

- A **model** is an abstract representation, that from some point of view and for some end, represents an object or real phenomenon.
- The representation of reality is achieved through the **analogy** established between aspects of reality and aspects of the model.
- We have focused our attention on **quantitative models:** models in which the analogy with the real world takes place in two steps:
  - 1. *quantification* of objects, facts and phenomena in an appropriate way;
  - 2. identification of the *relationships* existing between the previously identified objects, closest to the reality (that is the object of the model).

III. Crucial role of Data and Challenges in Data Integration

Grand Challenges in Data Integration for Research and Innovation (R&I) Policy

The Grand Challenges identified (Daraio and Glanzel, 2016) were:

- Handling **Big Data**,
- Coping with **Quality** Issues,
- Anticipating **New Policy Needs**.

Framed in four areas of intervention:

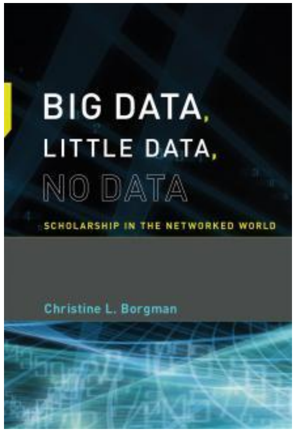
1. Data collection/project initiatives,
2. Open data, linked data and platforms for Science, Technology and Innovation (STI),
3. Monitoring performance evaluation
4. Stakeholders, actions, options, costs and sustainability.

Source: Daraio, C., Glänzel, W. (2016). Grand challenges in data integration - state of the art and future perspectives: an introduction. *Scientometrics*, 108 (1), 391-400.

What are data?

- ***Data are not pure or natural objects with an essence of their own*. They exist in a context, taking on meaning from that context and from the perspective of the beholder. The degree to which those contexts and meanings can be represented influences the transferability of data.**

Borgman (2015, p. 18)



What are data?

- **Data** are representations of observations, objects, or other entities used as evidence of phenomena for the purposes of research or scholarship.
- An entity is «something that has a real existence», as distinguished from a mere function, attribute relation, etc.
- Those entities may have a material existence (text, paper) or they may be digital, such as signals from sensorsor or completed forms from an on line survey.
- Entities become data only when someone uses them as evidence of a phenomenon, and the same entities can be evidence of multiple phenomena. Borgman (2015, p. 28)
- **Concrete bounded definitions in operational contexts**

Data as Infrastructure (Frischmann, 2012)

*Most data (not all) can in principle be considered as **infrastructural resources**, as they are "shared means to many ends"* that satisfy all three criteria of infrastructure resources

1. ***Data are non-rivalrous goods*** that can be consumed in principal an unlimited number of times.
2. ***Data are capital goods*** according to the OECD, are "goods, other than material inputs and fuel, used for the production of other goods and/or services".
3. ***Data are general-purpose inputs*** "infrastructure resources enable many systems (markets and non markets) to function and satisfy demand derived from many different types of users".

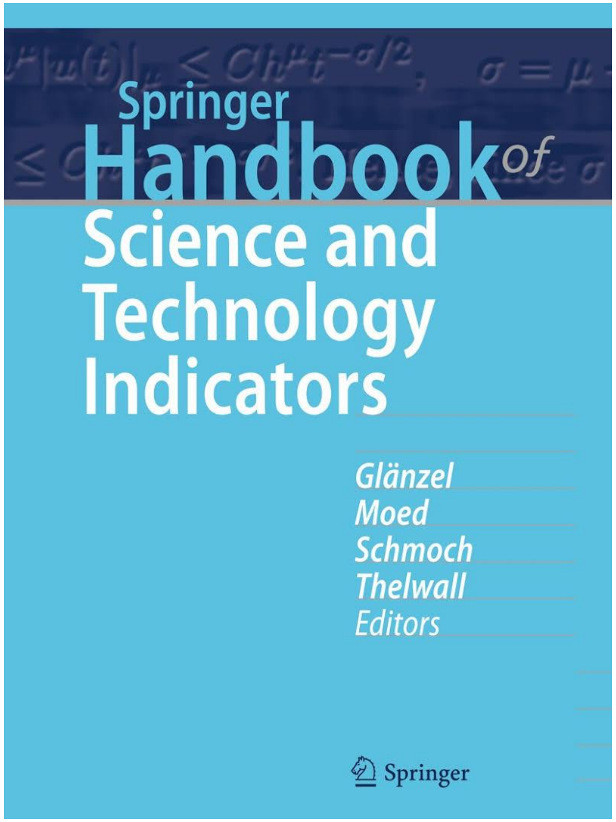
Source: Frischmann (2012), *Infrastructure: The Social Value of Shared Resources*, Oxford University Press.

IV. *Sapientia*: the Ontology of Multi-Dimensional Research Assessment

Background

Two chapters:

- Daraio C. (2019),
- ***Econometric approaches to the measurement of research productivity***
- Lenzerini M. and Daraio C. (2019), ***Challenges, Approaches and Solutions in Data Integration for Research and Innovation***



Data Integration: Interoperability

- The quality of data is *context-dependent* and an appropriate quality of a single dataset, for a specific purpose, is not enough.

- The linkages between different datasets are relevant as well.

- The compatibility, interchangeability and the connectability of a given dataset with other related data are fundamental aspects which need to be taken into account (Daraio and Glanzel, 2016).

Data Integration: Interoperability

Data integration is the problem of combining data residing at different sources, and providing the user with unified view of these data (Lenzerini, 2002). According to Parent and Spaccapietra (2000), ***interoperability*** is the way in which heterogeneous systems talk to each other and exchange information in a meaningful way.

They identified three levels of interoperability:

- **lowest level** (no integration),
- **intermediary level** (the system does not guarantee consistency across database boundaries)
- **higher level** that has the goal of developing a global system on top of existing system, to provide the desired level of integration of the data sources.

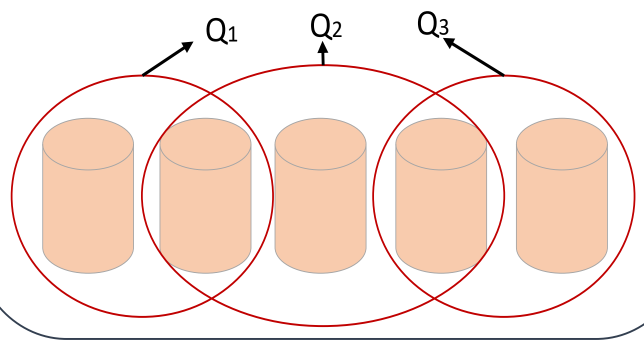
Data Integration: Interoperability

Several levels of conceptual interoperability have been identified in the specialized literature. For instance, Tolk and Muguira (2003) propose the following 5 levels of conceptual interoperability:

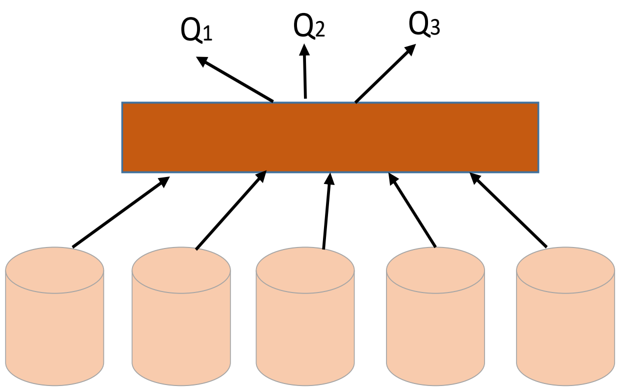
Level 0: System specific data (isolated systems);
Level 1: Documented data (documentation of data and interfaces);
Level 2: Aligned static data through Meta Data Management (use of common reference models/common ontology);
Level 3: Aligned dynamical data and "Implemented processes" (common system approach/open source code);
Level 4: Harmonized data and processes, conceptual model, intend of use (common conceptual model/semantic consistency).
The formal and precise means to achieve level 4 of interoperability (harmonized data and processes) is a *logic-oriented ontology language*. **This is exactly what the OBDM approach allows for: see next slides**

Approaches to Data Integration for R&I

Procedural or bottom-up
(called in gergo silos approach):
For every «indicator need», figure out which data you need and how they can be accessed, and design/realize a corresponding service



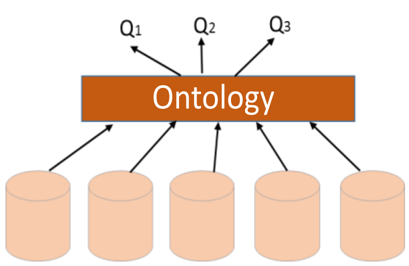
Declarative or top-down:
Define a global structure which is valid for all source data, link this structure to the data, use this structure to specify the «indicator needs» and automatically extract the right data from the sources



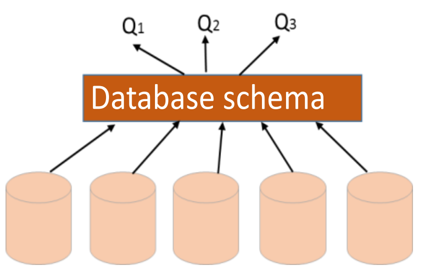
OBDM (Ontology-Based Data Management):
A new declarative paradigm for STI data integration and governance

- Use knowledge Representation and Reasoning principles and techniques for managing data.
- Leave the data where they are.
- Build a conceptual specification of the domain.
- Map such knowledge structure to concrete data sources
- Express all the indicators over the abstract representation
- Automatically translate conceptual indicators to data

OBDM

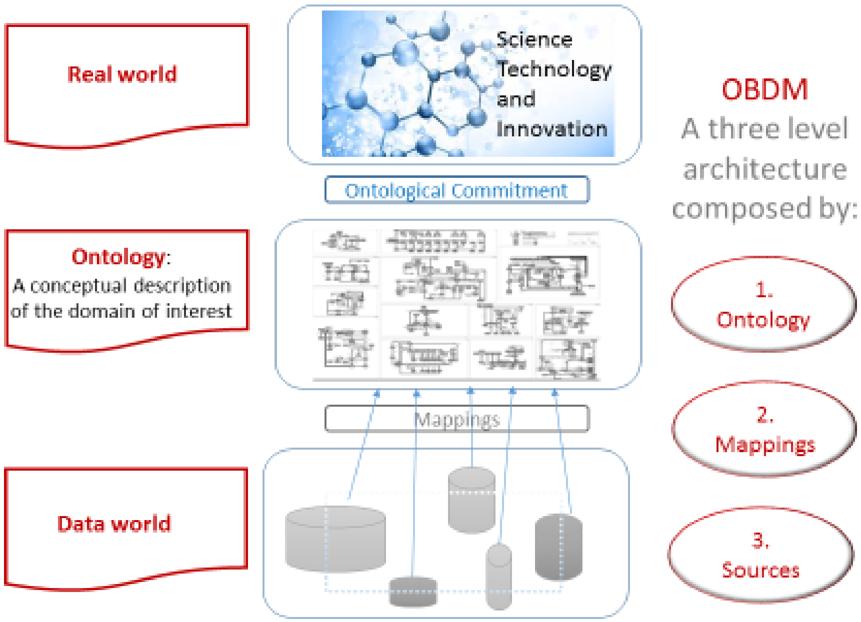


Declarative database integration



The main purpose of an OBDM System

- **is to allow information consumers to query the data using the elements in the ontology as predicates.**
- **it can be seen as a form of information integration, where the usual global schema is replaced by the conceptual model of the application domain, formulated as an ontology expressed in a logic-based language.**



The OBDM Approach (Calvanese et al. 2010; Lenzerini, 2011; Poggi et al. 2008)

- Key idea: a **three-level architecture**, constituted by:
- **The ontology**: is a conceptual, formal description of the domain of interest (expressed in terms of relevant concepts, attributes of concepts, relationships between concepts, and logical assertions characterizing the domain knowledge).
- **The sources**: are the repositories accessible by the organization where data concerning the domain are stored. In the general case, such repositories are numerous, heterogeneous, each one managed and maintained independently from the others.
- **The mapping**: is a precise specification of the correspondence between the data contained in the data sources and the elements of the ontology.

Our experience with *Sapientia*

- This project aimed at providing a general framework for the assessment of research and its impacts.
- The investigations tried to shed light on the efficiency, effectiveness and impact of education, research and innovation, by looking at *direct* and *indirect* measures of performance.
- This goal required overcoming a number of methodological and theoretical challenges, among which: the development of a *general framework* embracing both efficiency and effectiveness, the integration and consolidation of large and heterogeneous sets of micro-level data with meso and macrodata, the identification and development of suitable indicators especially concerning 'quality', and the developments of *new methodologies* to carry out efficiency, effectiveness and impact analyses.
- Despite the great relevance of this theme, there are few analyses that have provided sound empirical evidence.

The main advantages of an OBDM Approach

1. Users can **access** the data by using the elements of the ontology.
2. By making the representation of the domain explicit, we gain **re-usability** of the acquired knowledge.
3. The mapping layer explicitly specify the relationships between the domain concepts and the data sources. It is useful also for **documentation and standardization** purposes.
4. **Flexibility** of the system: you do not have to merge and integrate all the data sources at once which could be extremely costly!

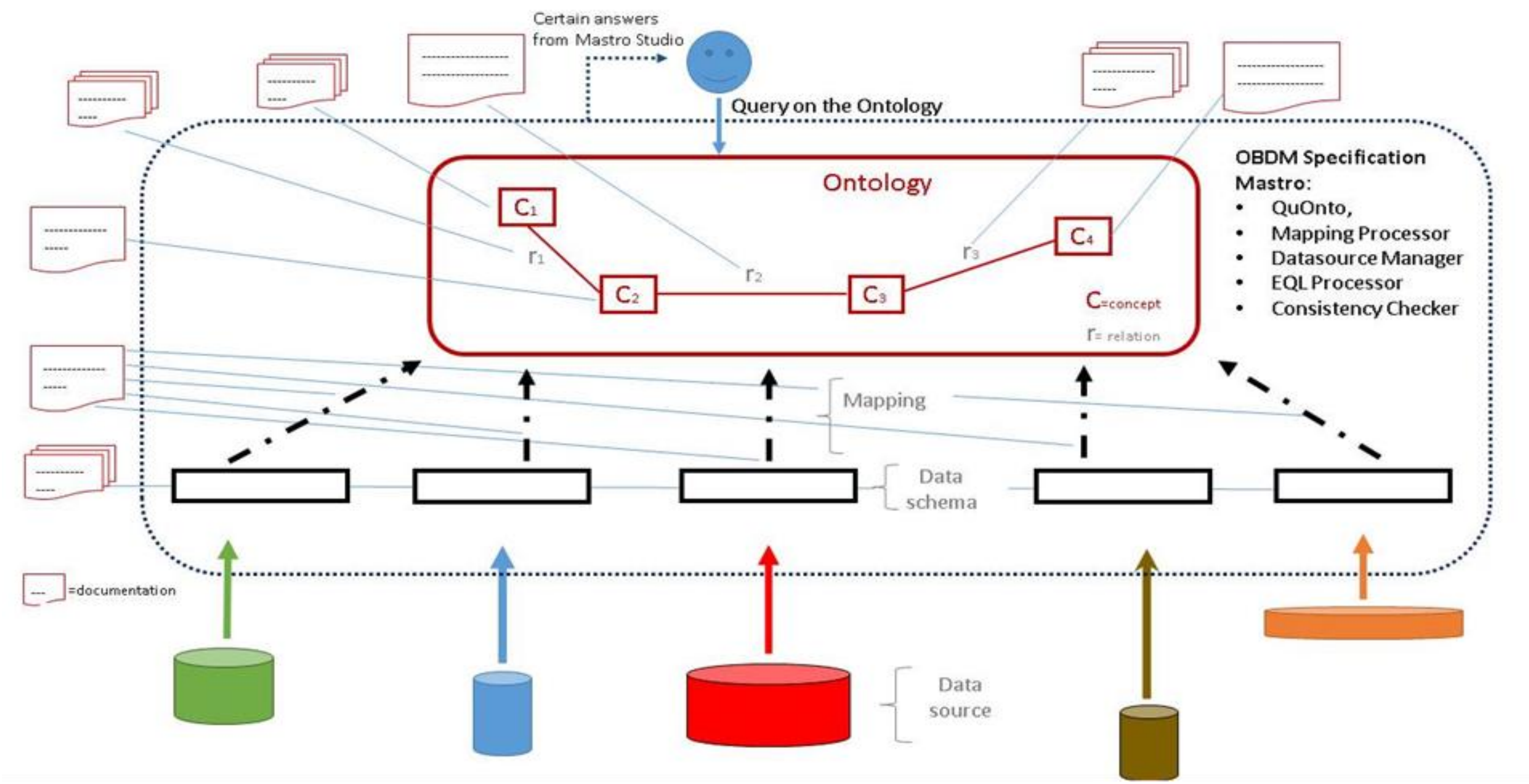
The main advantages of an OBDM Approach (cont.)

5. Extensibility of the system: you can incrementally add new data sources or new elements (ability to follow the incremental understanding of the domain) when they become available!

6. Opening of the system: provide a conceptual framework which can be used as a common language by the community.

7. A step towards an open science system!

The main advantages of an OBDM Approach: interoperability, openness, data quality



Scope of *Sapientia*

- The main objective of *Sapientia* is to model all the activities relevant for the evaluation of research and for assessing its impacts.
- For impact, in a broad sense, we mean any effect, change or benefit, to the economy, society, culture, public policy or services, health, the environment or quality of life, beyond academia.
- This is a difficult task that needs to be addressed with a systemic view accounting for all the interactions of research with education and innovation

Sapientia's principles

1. We started with a *top-down* modelling approach, with subsequent bottom-up refinements and cyclical improvements. We describe and model the domain from a conceptual point of view, *without* considering the existing data and its specificity.
2. We left outside the scope of the ontological commitment all the *methodological* consideration about choice of the methods for the assessment of research. This is because we want that our ontology being the common ground for experimenting and testing different methods and approaches.
3. We left outside the scope of the ontological commitment the *implementation* problem and the consequences of evaluation. Again, this is for keeping our ontology as a common ground, a *shared language* or vocabulary, to build a cooperative and open discussion about evaluation approaches considering the interaction of different stakeholders with different points of view and interests.

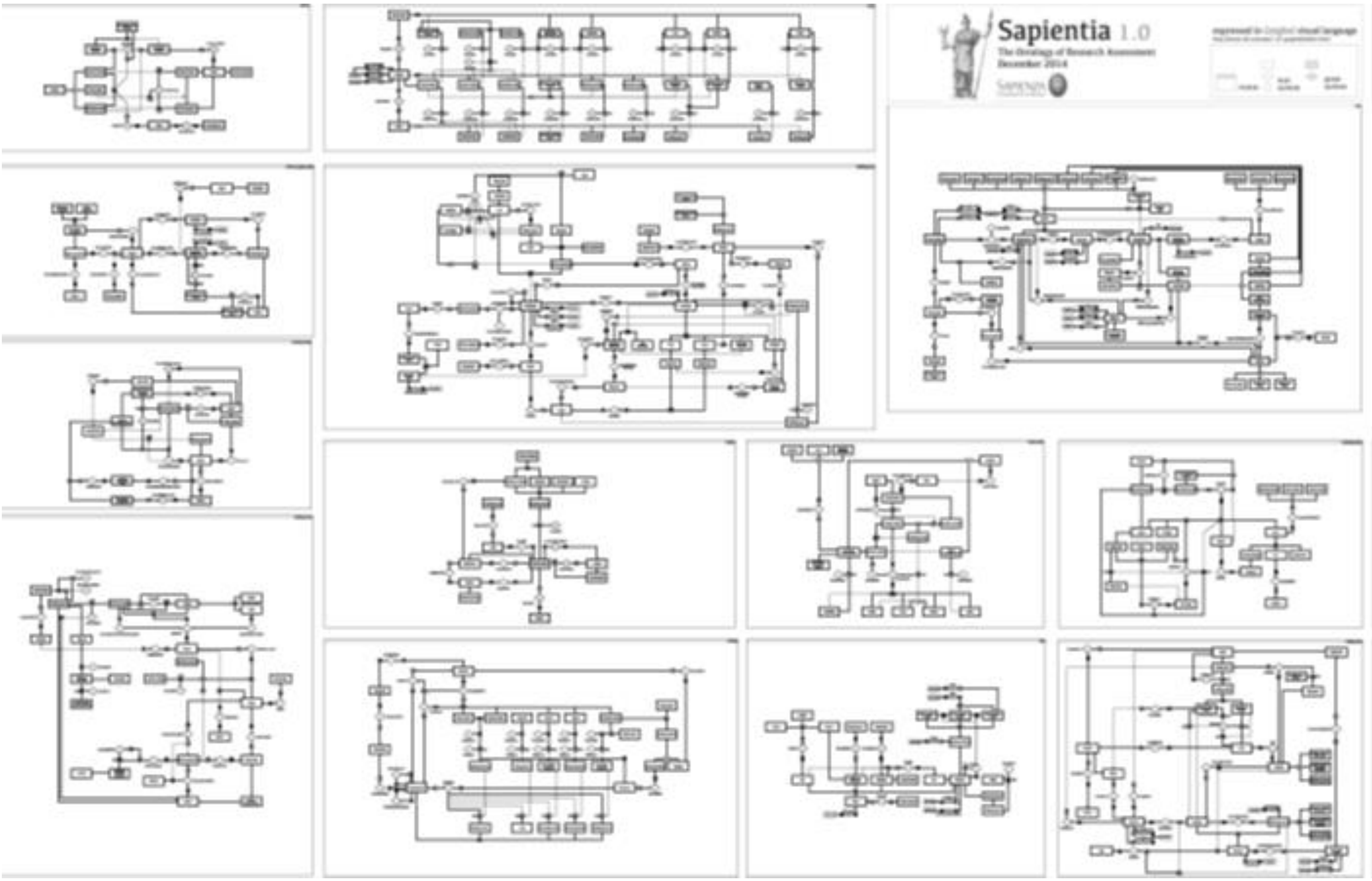
Sapientia's principles

4. We pursued a modelling approach based on *processes*, which are conceived as collections of activities. A process is composed by inputs and outputs.

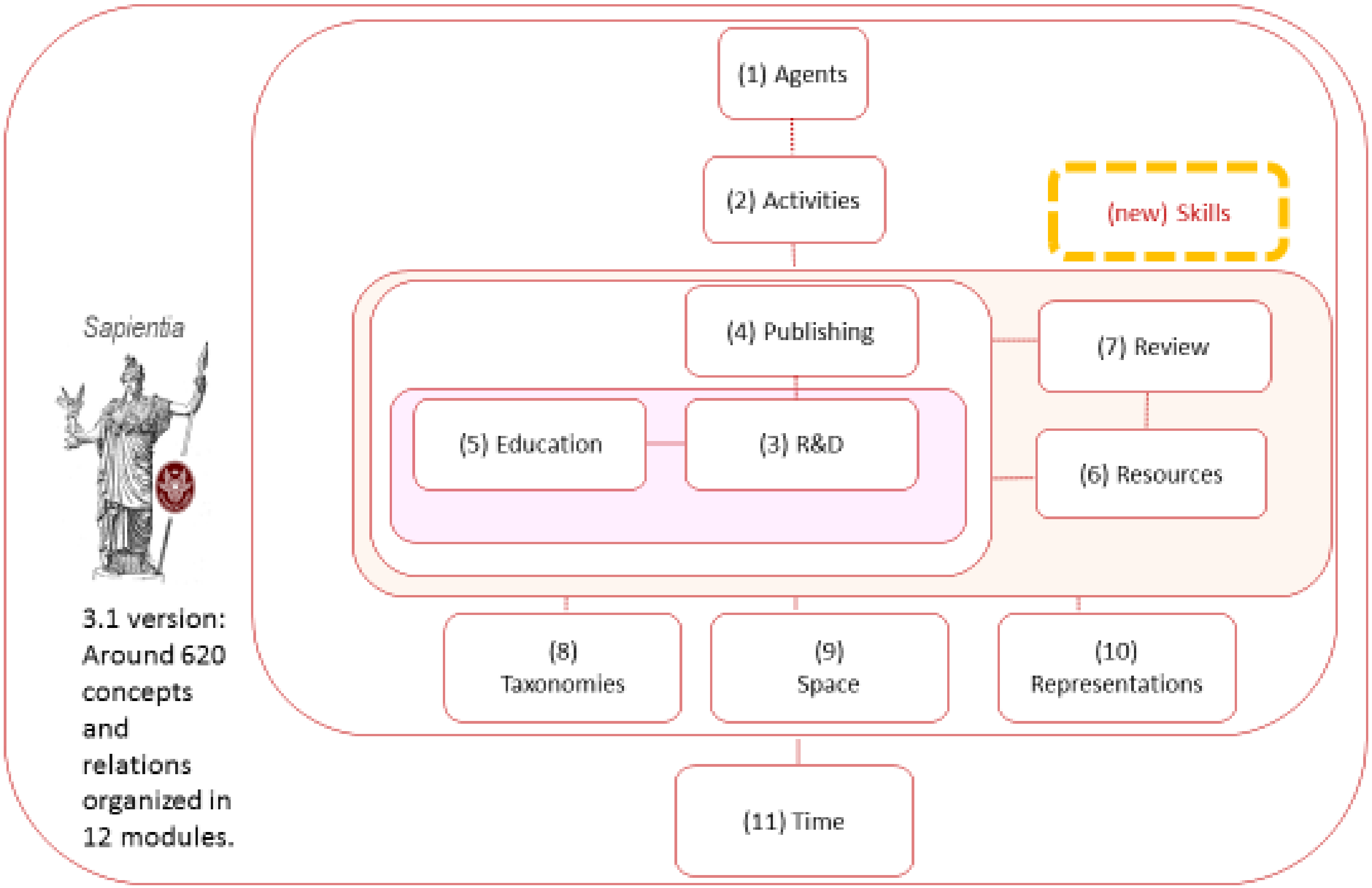
6. Individuals and *activities* are the main pillars of the ontology.

7. We followed a modelling approach based on a *modularization* of the system. Our ontology is organized in modules. As we shall see later, we have two kind of modules: *functional* modules and *structural* modules. By functional modules we mean modules which model the main agents and activities of our domain (namely Agents, Activities, R&D, Publishing, Education, Resources and Review). *By structural modules we mean those modules which represent the constituent elements of the ontology to ensure its long lasting and general-purpose functionality (namely, Taxonomies, Space, Representations and Time).*

First version of *Sapientia: 1.0*



Current version of *Sapientia: 3.1*



Modules of *Sapientia*

*1. **Agents***, that describes all human actors and institutions involved in the education, research and innovation process.

*2. **Activities***, that describes the activities and projects the agents of the previous module are involved in.

*3. **R&D***, that describes the different products (e.g., publications, patents) that are produced in the knowledge production process.

*4. **Publishing*** that describes how knowledge products are published and made available to the public.

*5. **Education*** that formalizes the concepts related to universities and courses.

*6. **Resources*** that describes all the ways an institution can be funded.

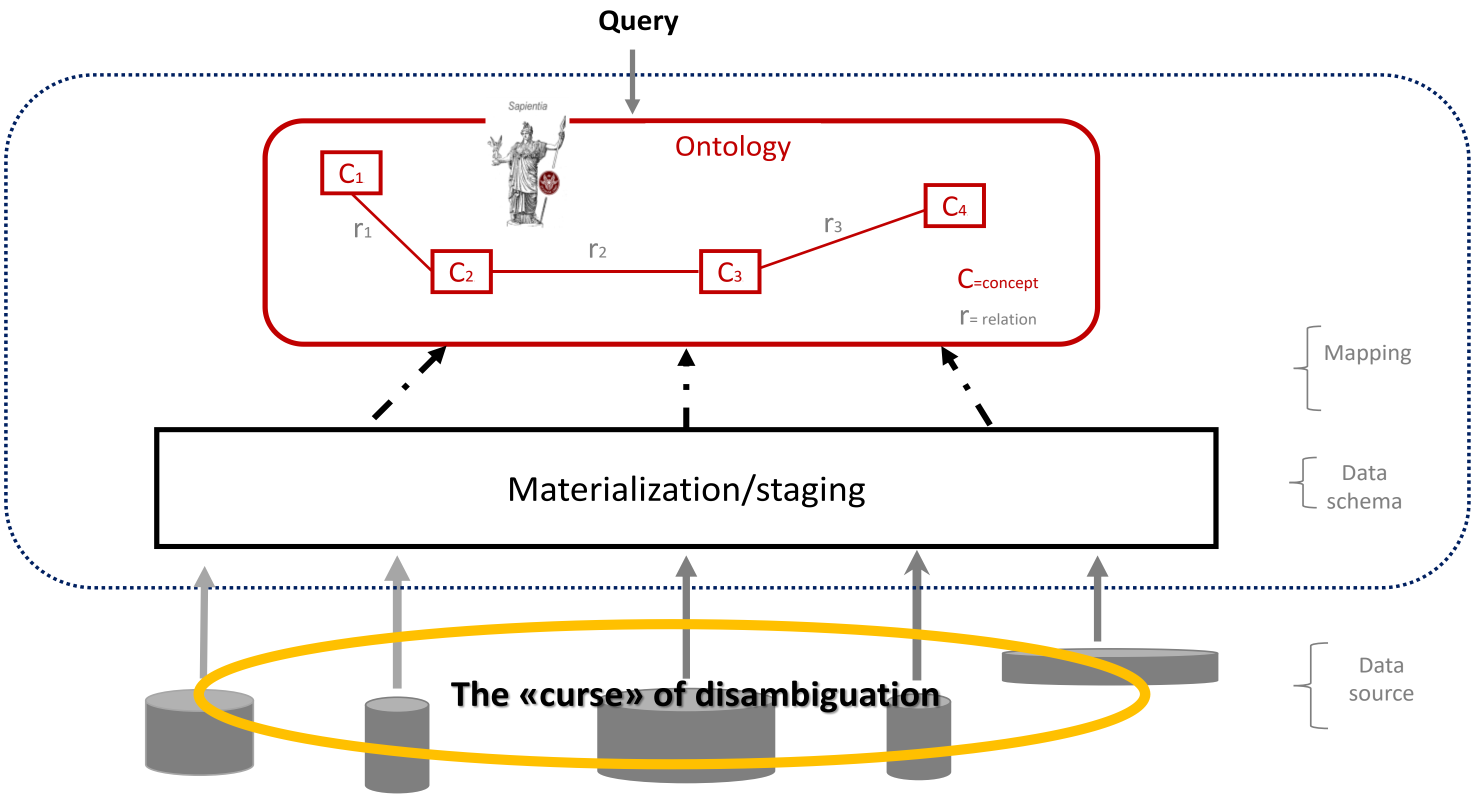
*7. **Review***, that describes the process entities related to the publishing activity.

*8. **Taxonomy***, that describes the elements that allows defining taxonomies applied to the different modules.

9. and 11. ***Space*** and ***Time***, that formalizes respectively geographical entities and time instants and ranges.

10. ***Representation***, that describes that the modeling mechanism by which single instances of other modules can be represented in different ways by the different sources used in *Sapientia*.

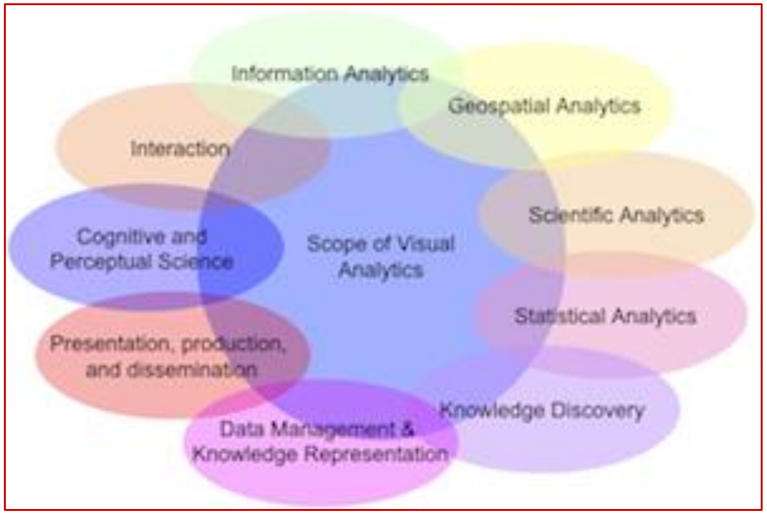
Crucial role of Mappings: Illustration of the materialization phase in an OBDM system



V. Combining Ontology-based Data Management and Visual Analytics

State of the Art: combining OBDM with Visual Analytics for Performance Models' Assessment

Visual Analytics is the science of analytical reasoning supported by interactive visual interfaces.
The complex nature of many problems makes it indispensable to include human intelligence at an early stage in the data analysis process.

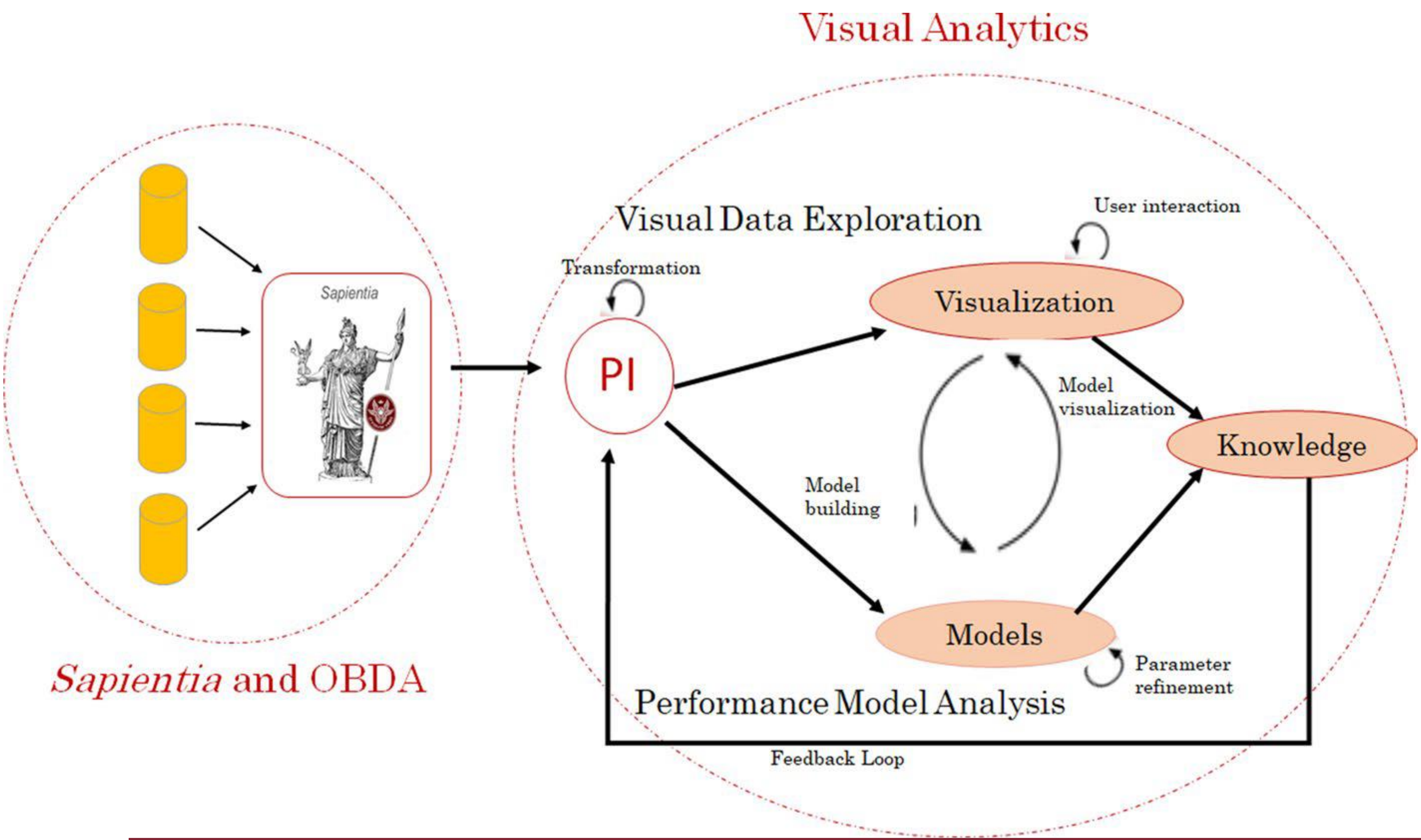


Visual Analytics methods allow decision makers to combine their human flexibility, creativity, and background knowledge with the enormous storage and processing capacities of today's computers to gain insight into complex problems.

Using ***advanced visual interfaces***, humans may directly interact with the data analysis capabilities of today's computer, allowing them to make well-informed decisions in complex situations.

Thomas J., Cook K. (2005) : Illuminating the Path: Research and Development Agenda for Visual Analytics. IEEE-Press

State of the Art: combining OBDA with Visual Analytics for Performance Models' Assessment



Angelini M., Daraio C., Lenzerini M., Leotta F., Santucci G. (2020) Performance Model's development: A novel Approach encompassing Ontology-based Data Access and Visual Analytics, *Scientometrics*, 125, 865–892.

A Visual Analytics Approach for the Assessment of Information Quality of Performance Models

- In this paper we extend the flexibility of a visual analytic approach featured to performance model's development to include data quality procedures and tests.
- The resulting environment is helpful to guide the user to an Information Quality-aware development of Performance models.
- This interactive visual analytics environment offers to the user the possibility to produce and compare information quality-aware indicators.

Angelini M. Daraio C. Urban L. (2022), A Visual Analytics Approach for the Assessment of Information Quality of Performance Models – A Software Review, *Scientometrics*, https://doi.org/10.1007/s11192-022-04399-2.

VI. An Ontology-Based Semantic Design for Good Evaluations of Research Practices

towards the reform of evaluation systems?

Using Ontologies for designing Good Evaluations of Research Practices

- The use of ontologies and taxonomic knowledge, and the reasoning algorithms that can make inferences on the basis of such knowledge represents a way for testing the consistency of the information reported in a questionnaire and to analyze in a correct and coherent way the data gathered through it.
- Formally, an ontology in Description Logics is a knowledge base. It is a couple (pair) O=<TBox,ABox>, where
  - TBox is the Terminological Box that represents the *intensional* level of the knowledge or the conceptual model of the portion of the reality of interest expressed in a formal way;
  - ABox is the Assertion Box that represents the *extensional* level of the knowledge or the concrete model of the portion of the reality expressed by means of assertions (instances).

Using Ontologies for designing Good Evaluations of Research Practices

- Snow (2014) has recently launched a promising line of research based on the elements of psychology that characterize the virtues. In its perspective *virtue* is composed of the following three elements:
  - *intelligence*, which highlights the fact that virtue proceeds from a set of cognitive and emotional mental states that enable us to be sensitive to some morally relevant features of the situations in which, really or imaginatively, we find ourselves (Snow, 2014, pp. 4-5). See also Snow (2010 and 2012);
  - *dispositionality*, refers to the fact that this state is a trait of the personality of the agent and is not an occasional element of his psychology;
  - *behaviour*, i.e. virtue typically manifests itself in the actions and other behavioural responses of the virtuous person (Snow, 2010, pp. 4-5).
- The starting point for the semantic modelling of the domain in exam are the virtues of researchers.

Using Ontologies for designing Good Evaluations of Research Practices

An ontology-based semantic modelling approach offers several advantages, including:

- a conceptual specification of the domain of interest, in terms of knowledge structures;
- the mapping of such knowledge structures to concrete data (the answers of the questionnaire);
- the reasoning over the abstract representation of the domain prior to the data collection;
- a flexible conceptual system that can be easily updated;
- an open conceptual system that can be used as a common language for the research community.

How should evaluation be?

- In Daraio and Vaccari (2020) we contributed to the new line of research on philosophical ethics in research evaluation to integrate models that are based exclusively on quantitative criteria.
- This new line enables research to be assessed in the light of broad human interests and to take into account not only the outputs of research but also the psychology and motivation of researchers.
- Our contribution: using MacIntyre we develop a framework that enables us to employ the notion of "good" in the evaluation of research practices.
- Specifically, we use the notion of "good evaluation of research practices", characterizing it as that evaluation that takes into account the constitutive elements of a "good research practice".

The good evaluation of research practices: an overview

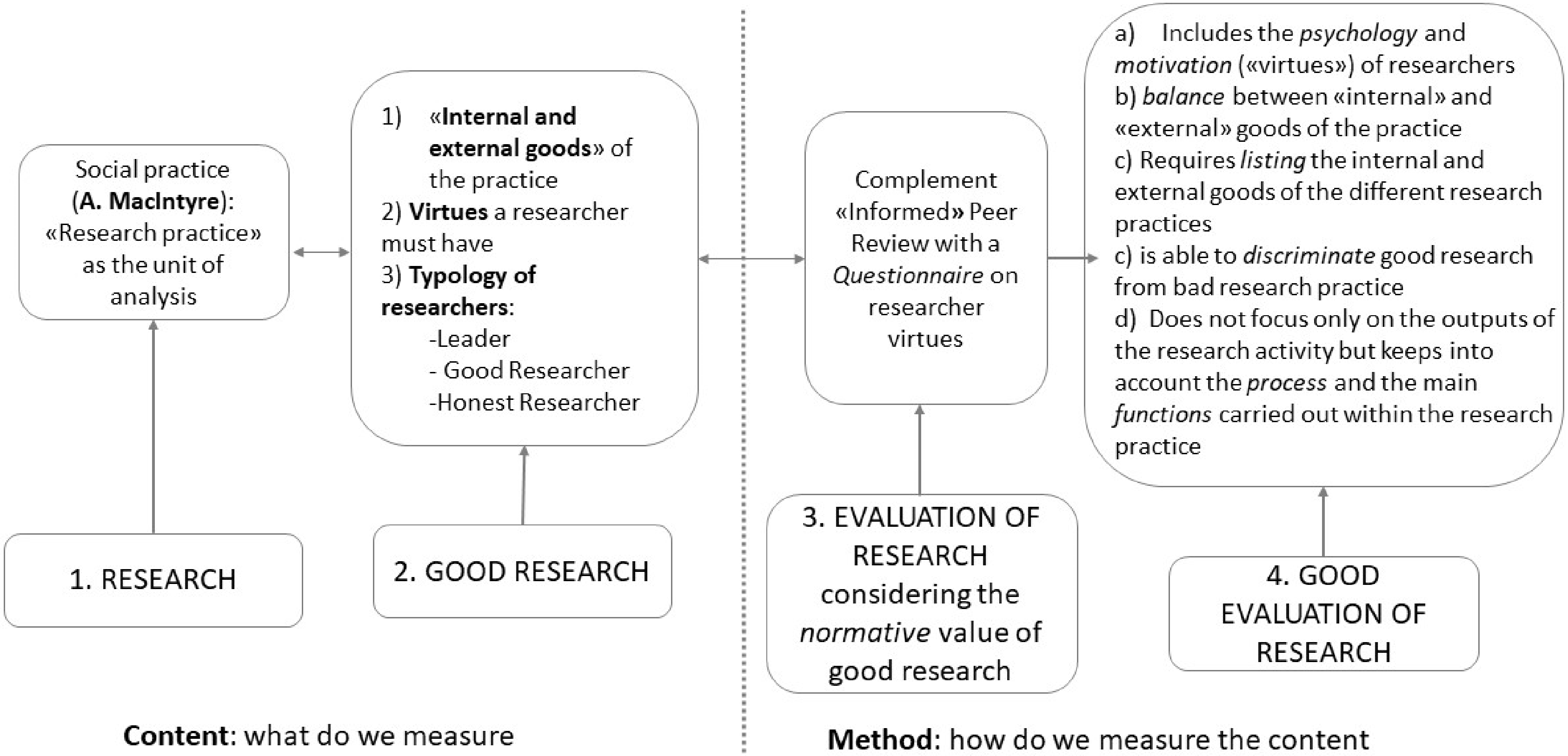


Figure 2. Logical steps of our theoretical contribution. To understand 4 we should come back to 1, focusing on research practice as level of analysis, then go to 2 identify the features of good research, these features yield normative requirements for an appropriate evaluation (evaluation fitness for purposes of the good research), 3 complement informed peer review with a Questionnaire on researcher virtues.

Usefulness of our framework for the «good» evaluation of research practices

Our framework offers

- **a *self-assessment tool* for researchers, to understand the functions of their research activities, their motivations and where they are in their research practice.**
- **helps institutions to collect and *describe* the main functions of the research practices (highlighting their special features) developed by its researchers, and their motivations, to include them in their *strategic plan*.**
- **may be the starting point for a *paradigm shift* in the evaluation of research practices. From an evaluation focused on *products* towards an evaluation focused on the *functions* of research practices.**

How should evaluation be?
Towards the implementation of good evaluation

- **We answer the question of how evaluation should be by proposing a good evaluation of research practices.**
- **A good evaluation of research practices, intended as social practices à la MacIntyre, should take into account the stable motivations and the traits of the characters (i.e. the *virtues*) of researchers.**
- **We also show that a good evaluation is also *just*, beyond the sense of *fairness*, as working on good research practices implies keep into account a *broader sense of justice*.**

Daraio C. Vaccari A. (2022), How should evaluation be? Is a good evaluation of research also just? Towards the implementation of good evaluation, *Scientometrics*, DOI 10.1007/s11192-022-04329-2.

How should evaluation be?
Towards the implementation of good evaluation

- After that, we propose the development of a knowledge base for the assessment of "good" evaluations of research practices to implement a questionnaire for the assessment of researchers' virtues.
- Although the latter is a challenging task, the use of ontologies and taxonomic knowledge, and the reasoning algorithms that can draw inferences on the basis of such knowledge represents a way for testing the consistency of the information reported in the questionnaire and to analyse correctly and coherently how the data is gathered through it.
- Finally, we describe the potential application usefulness of our proposal for the reform of current research assessment systems.

Daraio C. Vaccari A. (2022), How should evaluation be? Is a good evaluation of research also just? Towards the implementation of good evaluation, *Scientometrics*, DOI 10.1007/s11192-022-04329-2.

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