

1 Introduction

1.1	Prelude	1
1.2	Data Integration, Hypergraphs, and Type Theory	2
1.3	Philosophy and the Semantic Web	4
1.4	Covid, Philosophy, and Science	6
1.5	How Covid-19 May Accelerate Emerging Trends in Research Data-Curation	7
1.6	Navigating the Proliferation of Research Data	8

Part I: Biomedical Data Formats and Data Integration

2 Data Structures Associated with Biomedical Research

2.1	Introduction	1
2.2	Personalized Medicine in the Context of Covid-19	2
2.2.1	Precision Medicine as a Catalyst for Biomedical Data Sharing	3
2.2.2	Software Alignment for Covid Phylogeny Studies	4
2.2.3	Personalized Medicine and Immuno-Profiling	5
2.3	A Review of Certain Commonly-Used Biomedical Data Formats	6
2.3.1	DICOM (Digital Imaging and Communications in Medicine)	6
2.3.2	Next Generation Sequencing and other Genomics Formats	7
2.3.3	The Flow Cytometry Standard (FCS) File Format	9
2.3.4	Image Segmentation, Contours, and Regions of Interest	10
2.3.5	Common Data Models for Clinical Research	11

3 Data Mining and Predictive Analytics for Cancer and Covid-19

3.1	Introduction	1
3.2	Precision Medicine and Bioimaging	1
3.2.1	The Basic Synthesis Between Bioimaging and Precision Medicine	1
3.2.2	Case Study: The Cancer Imaging Phenomics Toolkit	1
3.2.3	Multi-Application Networks in the Context of Scientific Research Data	3
3.3	Precision Medicine in Trial Design	4
3.3.2	Customizing Clinical Trial Management Software	5
3.3.1.1	Toward Fine-Grained Sociodemographic Models	5
3.3.1.2	Measuring Cognitive and Neurological Effects	6
3.3.1.3	Aggregating Trial Data via Graph Models	7
3.3.2	Representing Trial Data via Object Models	7
3.4	Text and Data Mining via CORD-19	8
3.4.1	Overview of CORD-19	8
3.4.2	Data Integration within CORD-19	10
3.4.3	Reviewing the CORD-19 Document Model	12

4 Modular Design, Image Biomarkers, and Radiomics

4.1	Introduction	1
4.2	Image Biomarkers (and Others) for Cardiac and Oncology Diagnostics	1
4.2.1	Image Registration and Radiomics for Cardiac Diagnosis	2
4.2.2	From Image-Annotations to Image Biomarkers	6
4.2.3	Tumor Histopathology and Simulation	9
4.3	Multi-Aspect Modular Design in a Heterogeneous Data Space	12
4.3.1	The Overlap Between Research and Clinical Data	13
4.3.2	The Problem of Software Ecosystem Fragmentation	15
4.4	Data-Integration via Multi-Aspect Modules	17
4.4.1	Research Dissemination and Incremental Replicability	18
4.4.2	Heterogeneous Health Data and Data Curation	20
4.4.3	Modularity and the Clinical/Research Overlap	22

Part II: Type Theory and Conceptual Spaces

5 Types' Internal Structure and "Non-Constructive" ("NC4") Type Theory

5.1	Introduction	1
5.1.1	Cocyclic Types, Precyclic and Endocyclic Tuples	1
5.1.2	Cocyclic Types for Hypernodes	1
5.1.3	Channelized Types and Channel Algebra	2
5.1.4	Constructors and Carrier States	3
5.1.5	Nonconstructive Type Theory	6
5.2	Types as Conceptual Structures	8
5.2.1	Dimensional Analysis and Axiations	9
5.3	Hypergraph Ontologies	11
5.3.1	Type Theoretic Foundations for Hypergraph-Based Data Sharing	14
5.3.2	Hypergraphs as a Meta-Model for Data Sharing	15

6 Using Code Models to Instantiate Data Models

6.1	Introduction	1
6.2	Syntagmatic Graphs and Pointcut Expression Semantics	2
6.2.1	Query-Evaluation Foundations for Syntagmatic Graphs	7
6.2.2	Use-Cases for Source-Code Graphs	8
6.3	Applying Pointcut Expressions for Data Modeling	9
6.3.1	Code Annotation with Units of Measurement	11
6.3.2	Documentation by Implementation	12
6.3.3	Annotation-Based Reflection and Procedural Binary Equivalence	13
6.3.4	Meta-Procedural, Procedural, and Sub-Procedural Syntagmatic Scales	16
6.3.5	Case Study: Annotation and Image Markup	16

6.4	Hypergraph Representations for Data-Persistence Bridge Code	17
6.4.1	Multipart Relations with Roles	20
6.4.2	Syntagmatic Graphs and Conceptual Spaces	22

Part III: Bioimage Annotations and Radiomics

7 Multi-Aspect Modules and Image Annotation

7.1	Introduction	1
7.1.1	Comments on Procedural and Database Aspectss	1
7.1.2	Assessing the Proper Scope of an Image-Annotation Module	2
7.2	Image Annotations: Core Data Models	4
7.2.1	Magnitudes and Coordinates	4
7.2.2	Procedural and Modeling Considerations	6
7.2.3	Annotations with Curved Geometries or Cross-References	7
7.3	Annotations and Image Features	8
7.3.1	Specifying Annotations' Roles and Origins	9

8 Image Annotation as a Multi-Aspect Case-Study

8.1	Introduction	1
8.1.1	Design Questions for Image-Annotation Modules	1
8.1.2	Procedural Data Modeling (and the limitations of Ontologies)	3
8.1.3	Different Aspects of Image-Annotation Data	5
8.2	Annotations and Radiomics	7
8.2.1	GUI Operations Involving Images and Image-Annotations	7
8.2.2	Image Processing in the Context of Broader-Scale Workflows	9
8.2.3	Data Profiles for Annotation and Image Markup	11
8.2.4	Tradeoffs Between Data Models' Narrower and Wider Scope	13

9 Conceptual Spaces and Scientific Data Models

9.1	Introduction	1
9.2	Verb-Centric Grammars and Information-Delta Paths	2
9.2.1	The Emergent Syntax/Semantics Interface	7
9.3	Conceptual and Thematic Roles	7
9.3.1	Disjoint Conceptual Spaces	9
9.3.2	Conceptual Spaces and Scientific Data	14
9.4	Delta Roles and Conceptual Space Markup Language	15
9.4.1	Information Delta and Data Modeling	15
9.4.2	The Artificiality of Data Semantics	17
9.5	Conclusion: Toward a Scientific Data Semantics	18
9.5.1	Research Data and Data Integration	19
9.5.2	Toward a Procedural Conceptual-Space Semantics	20