Data life cycle management in a large scale project

Open Science and Reproducibility Series

Workshop III - Data management and Open Data , 22.05.2017

Swiss Institute of Bioinformatics

Mark Ibberson and Robin Liechti

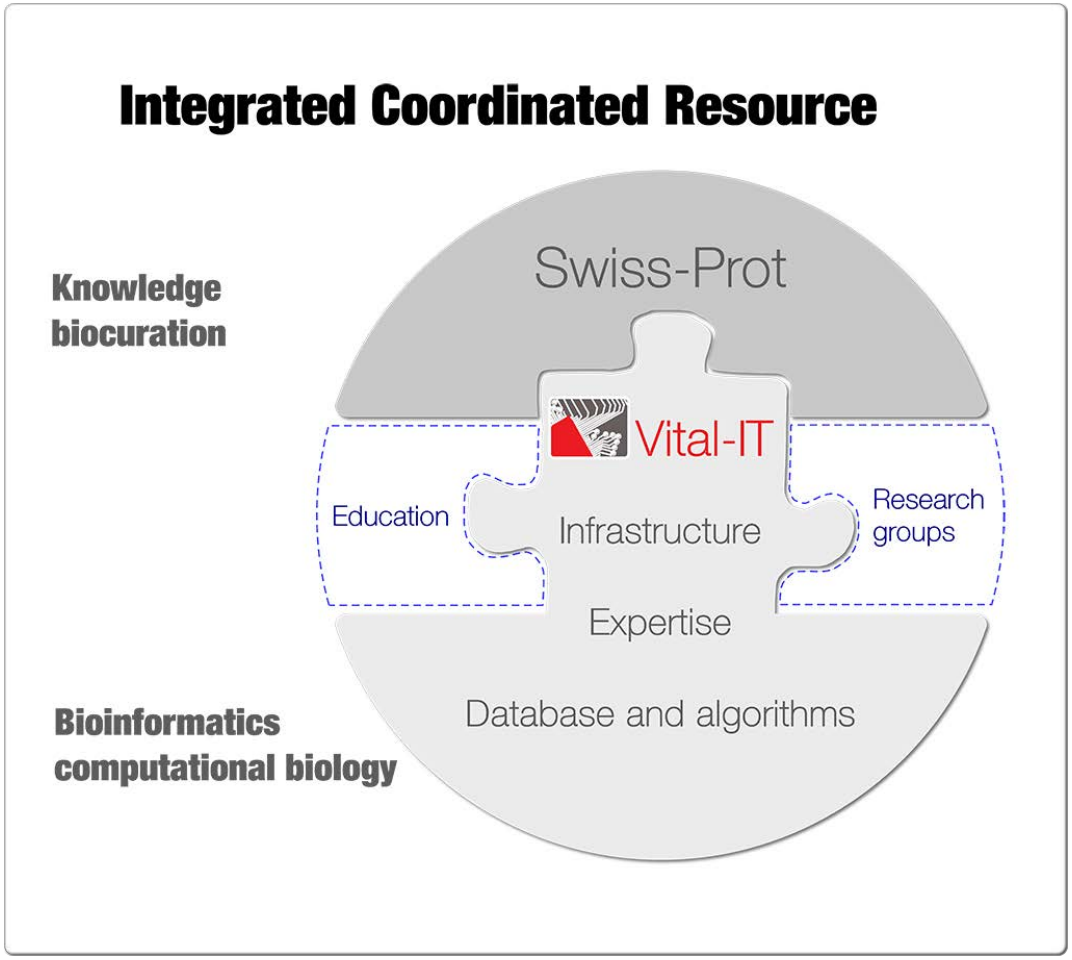
Vital-IT, Department of Systems Biology and Medicine, SIB Swiss Institute of Bioinformatics, Lausanne

Vital-IT & SwissProt

Strategic Goal

To provide key competencies & research support to the national life science community

Vital-IT
High Performance Computing Center



www.vital-it.ch

Contents

- Introduction – why is good data life cycle management important
- An example from a recent project
- Conclusion and take-home messages

Past, Present & Future

The Past

GENOMICS **28,** 131–139 (1995)

Genomic Organization of the Human T-Cell Receptor Variable α (TCRAV) Gene Cluster

MARK R. IBBERSON, JOHN P. COPIER,[1] AND ALEX K. SO[2]

Rheumatology Unit, Hammersmith Hospital, Royal Postgraduate Medical School, Du Cane Road, London W12 ONN, England

Received November 29, 1994; accepted May 11, 1995

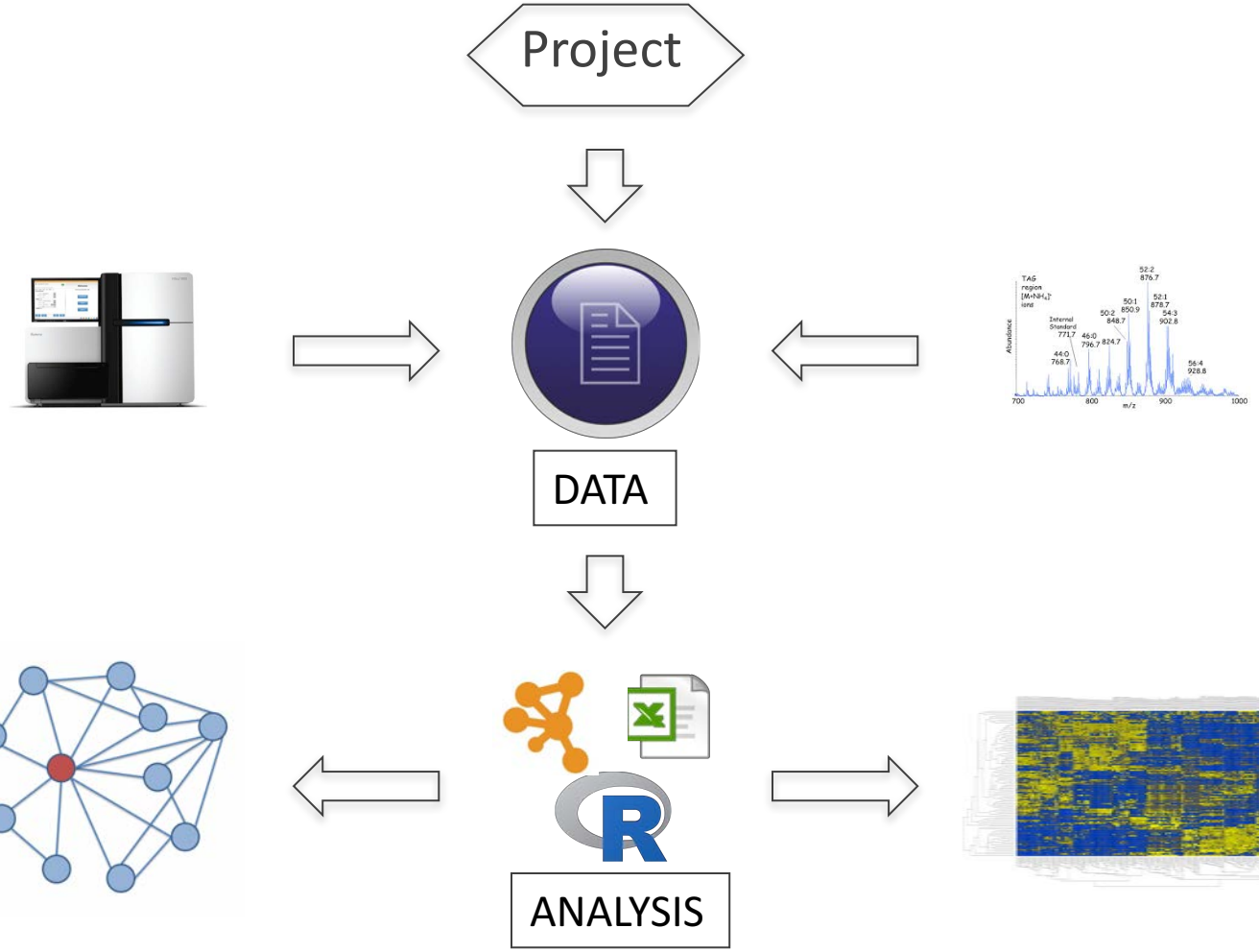
We are moving towards a brighter future

- Less data
- Knowledge in pdfs

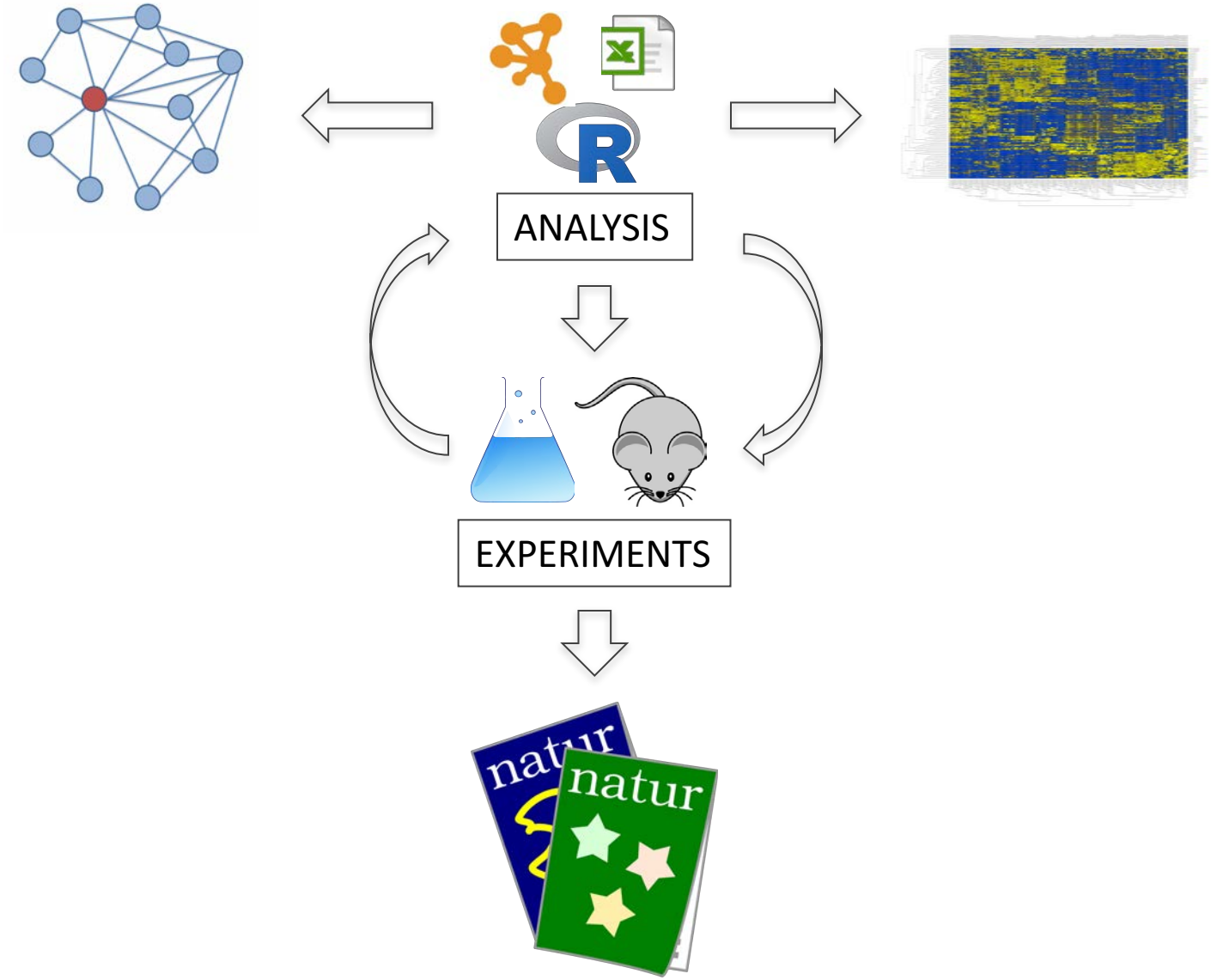
- Lots of diverse data
- Knowledge resources

- More and more data
- Resource interoperability

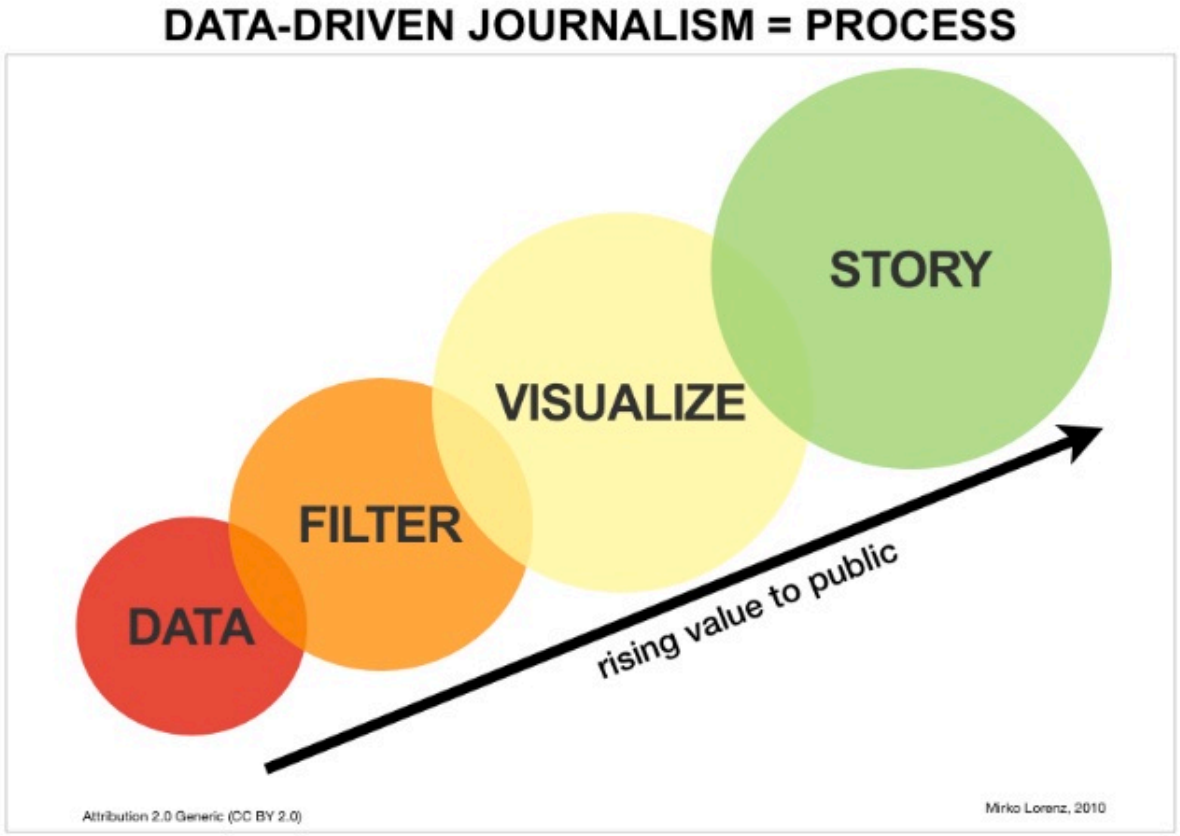
The Present



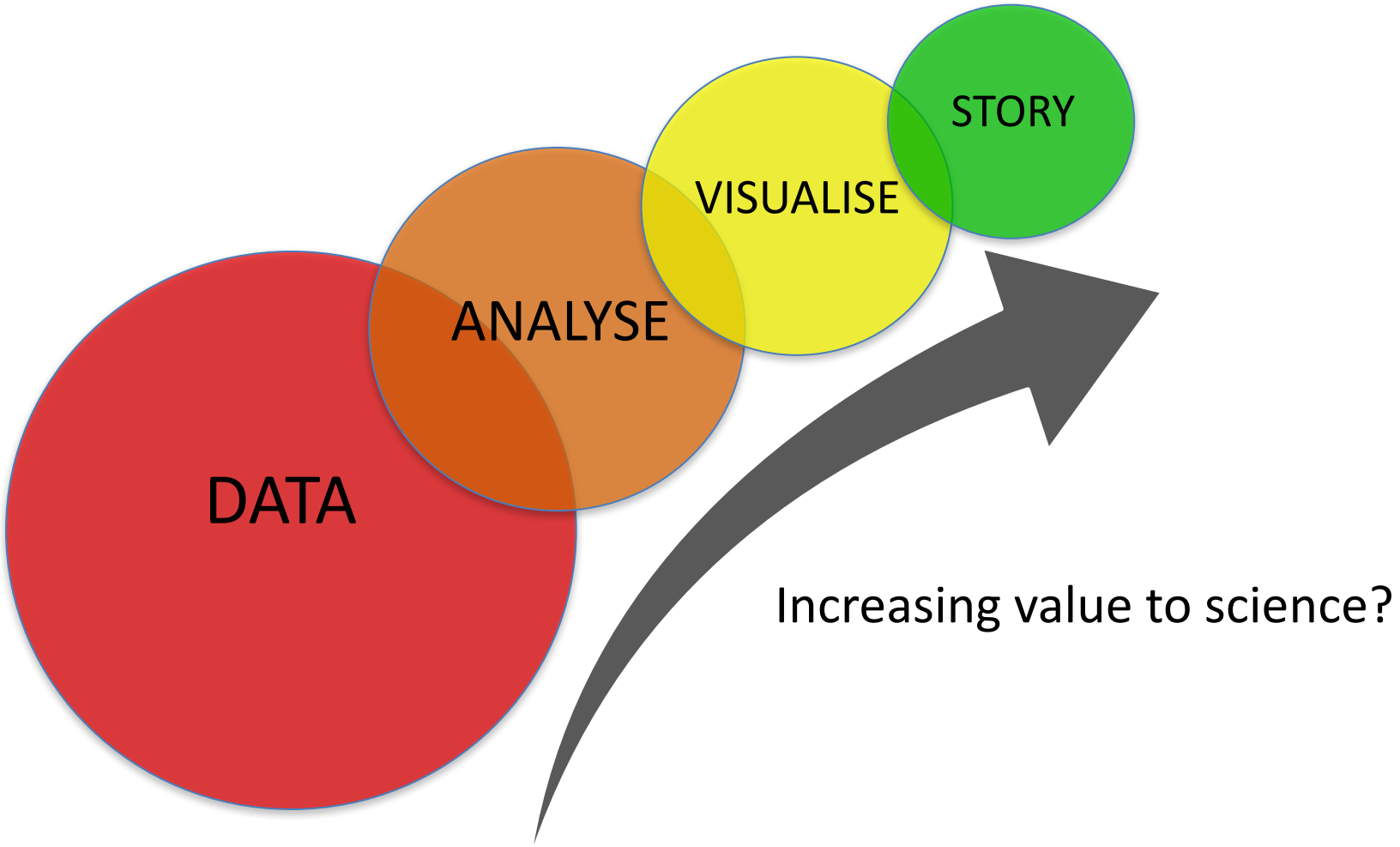
Focus is still on publishing



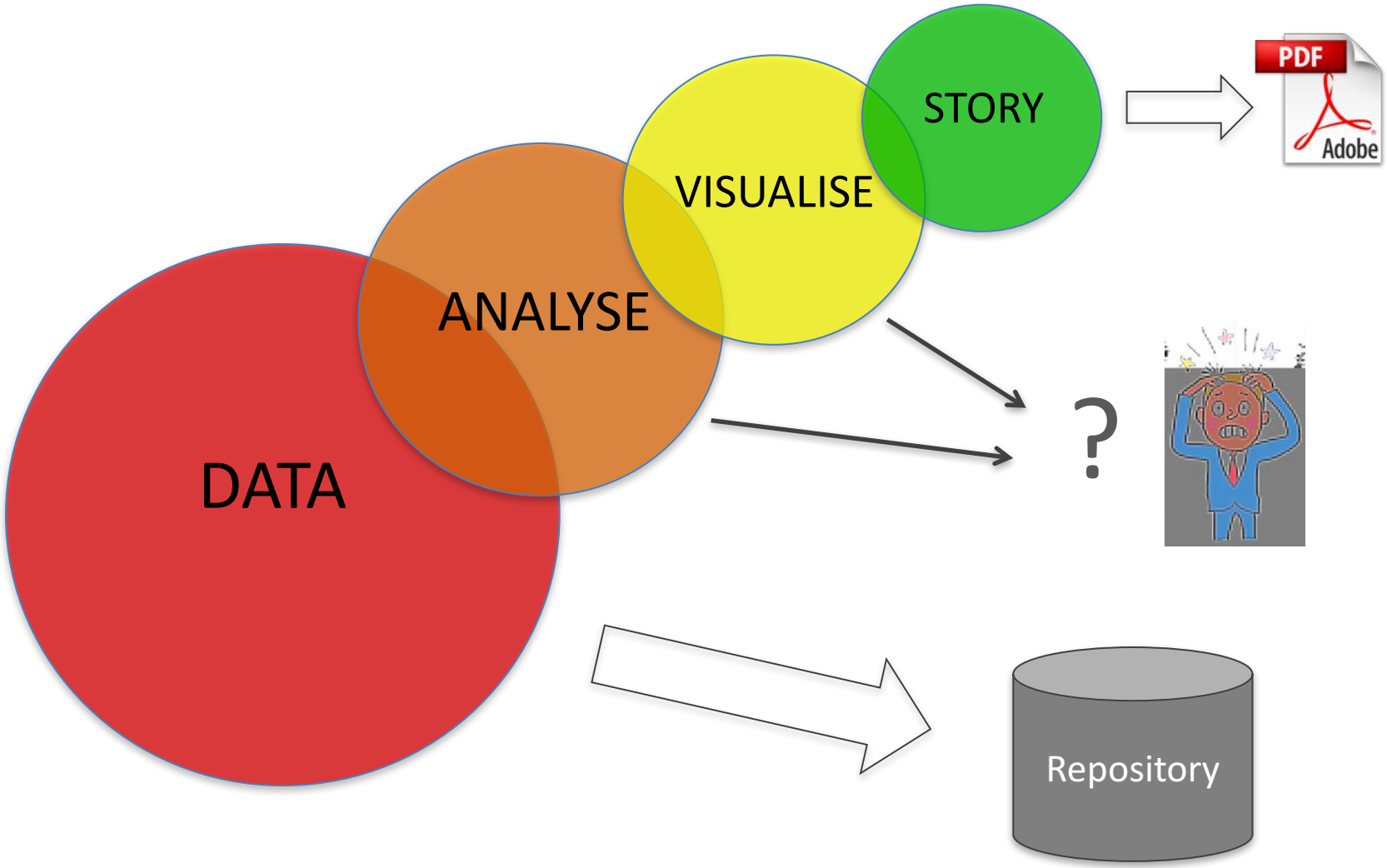
Scientists are also journalists ..



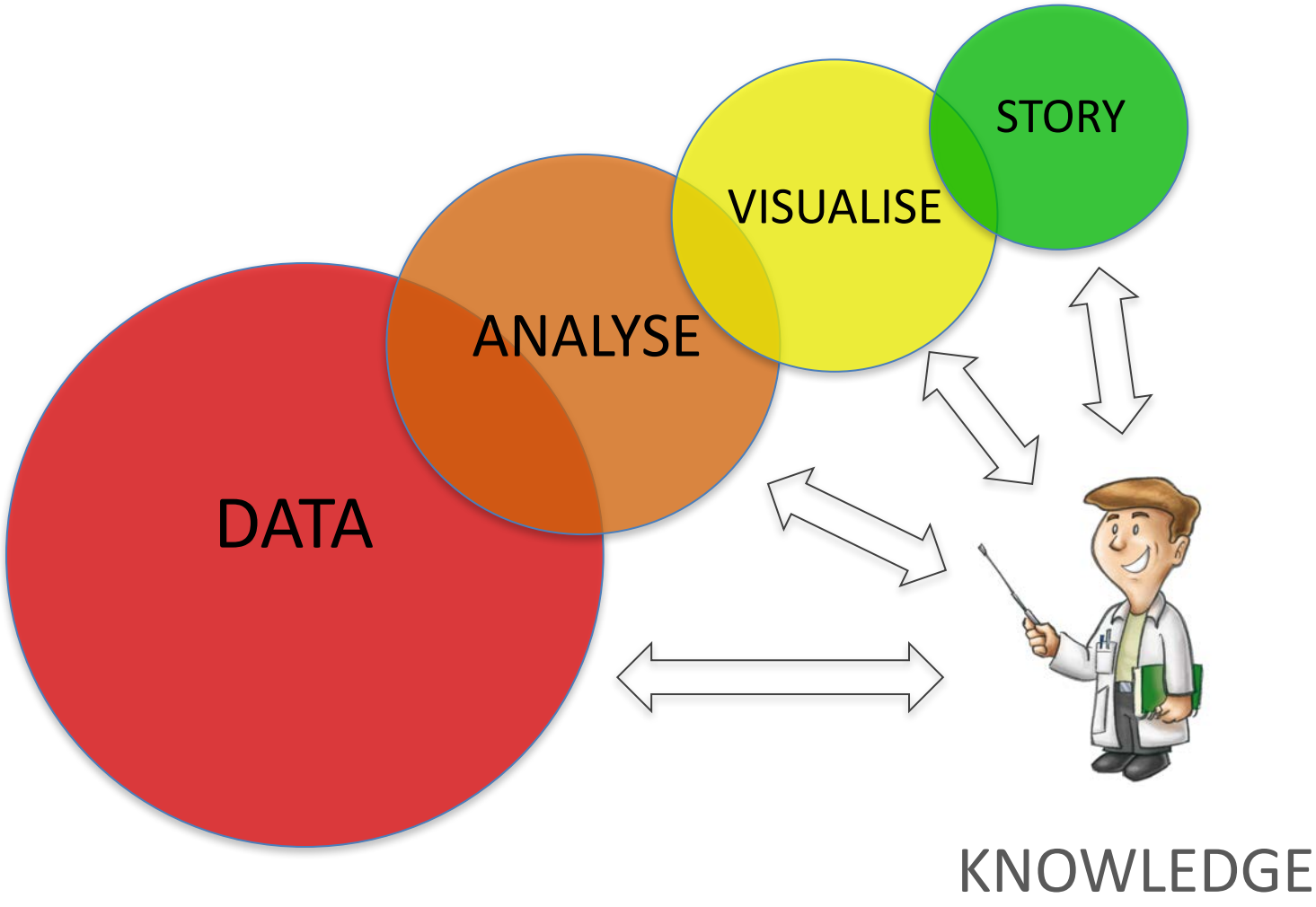
To publish we need a story ..



Some of what we do gets captured



To maximize the value of research we need to be able to interact with data at all levels



Current issues

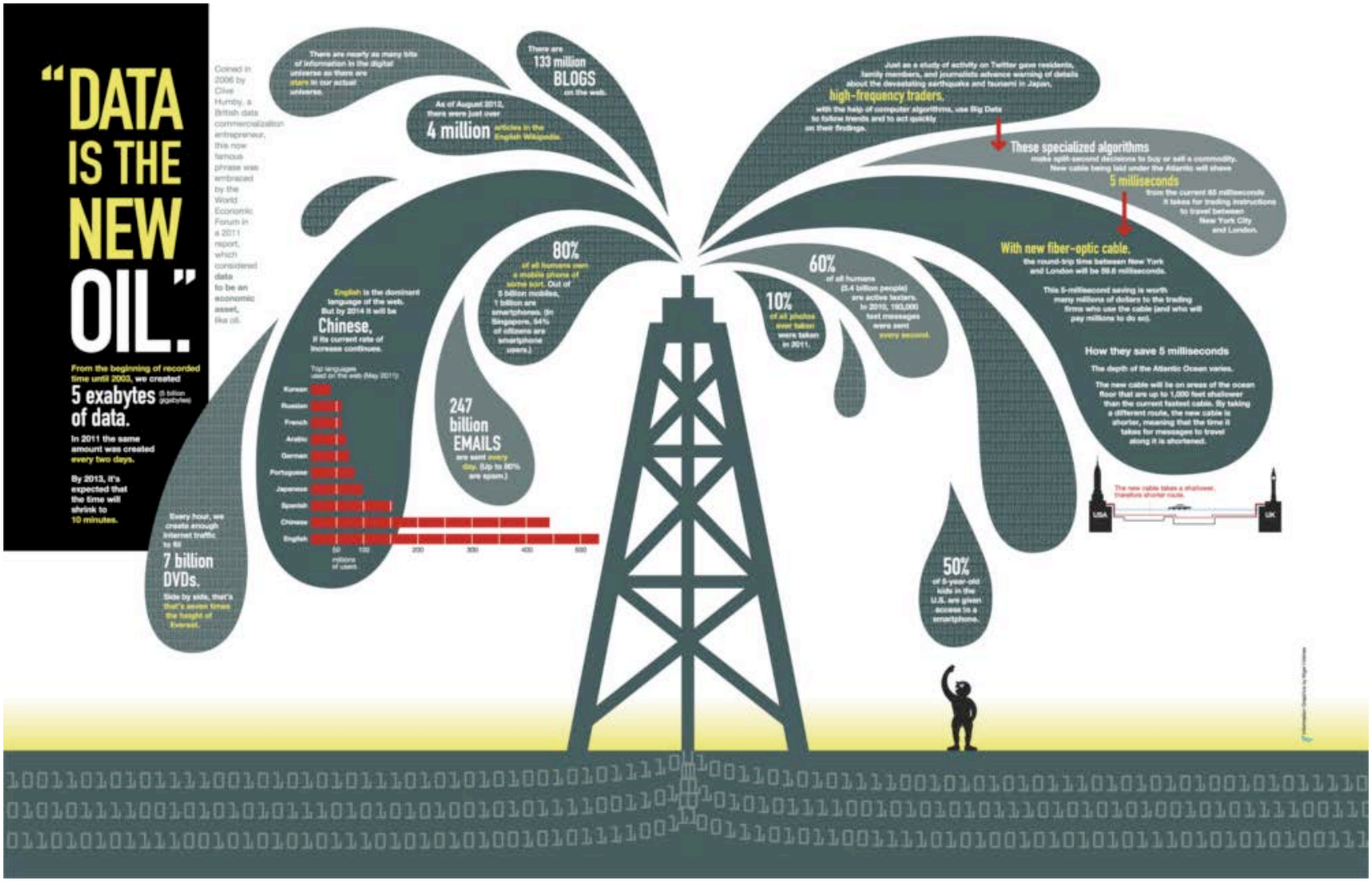
- Often only raw data is available
  - *Loss of time for reanalysis*
  - *Expertise is often not available*
- Methods often unclear or incomplete
  - *Lack of reproducibility*
- Knowledge is “lost”

How can we do this better?

F A I R

Mark D. Wilkinson et al. The FAIR Guiding Principles for scientific data management and stewardship. Sci Data. 2016 Mar 15;3:160018.

Data is the new oil and we are *refining* it



An example

IMIDIA is an Innovative Medicines Initiative (IMI) joint public/private partnership for type 2 diabetes research

- 14 academic
- 8 pharmaceutical
- 1 biotech
- Joint public/private funding
- Budget: 26M over 5 years

IMIDIA is focused on understanding pancreatic beta cell dysfunction in type II diabetes – novel pathways and biomarkers

Prof. Bernard Thorens,
IMIDIA Academic lead,
UNIL, Lausanne

Integration and Interoperability at the heart of IMIDIA

Phenotypes

In vitro models (human beta cells)

In vivo models (mouse models)

Gene expression

Genotyping

Systems Biology (Integration, Network biology)

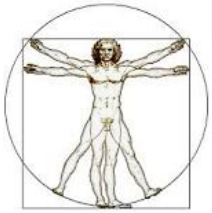
RNASeq

Lipidomics

Human repository (pancreas tissue)

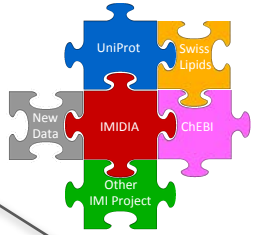
Cell imaging (Antibodies)

Clinical data



Working with FAIR principles

Standardized Format



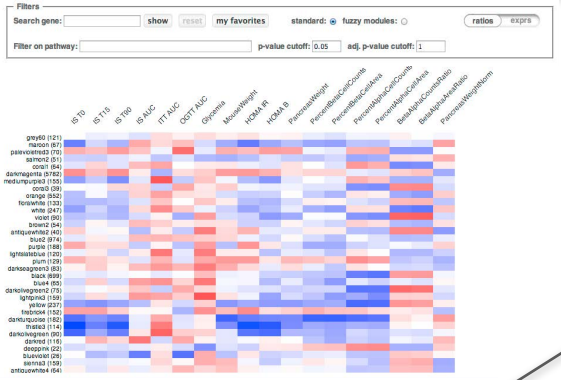
Resource Description Framework (RDF)

(Meta)Data Harmonisation

Data curation

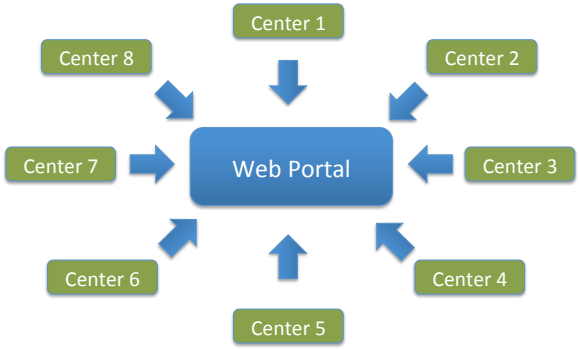
Usability

Interactive visualisation



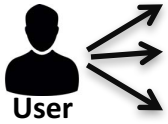
Shared Data

Single access point



- Findability
- Accessibility
- Interoperability
- Reusability

Resource Management



Tools
Database
Storage

Hardware Infrastructure

Working with FAIR principles

Standardized Format

Resource Description Framework (RDF)

(Meta)Data Harmonisation

Data curation

Usability

Interactive visualisation

Shared Data

Single access point

Center 1
Center 2
Center 3
Center 4
Center 5
Center 6
Center 7
Center 8
Web Portal

- Findability
- Accessibility
- Interoperability
- Reusability

User

Tools

Database

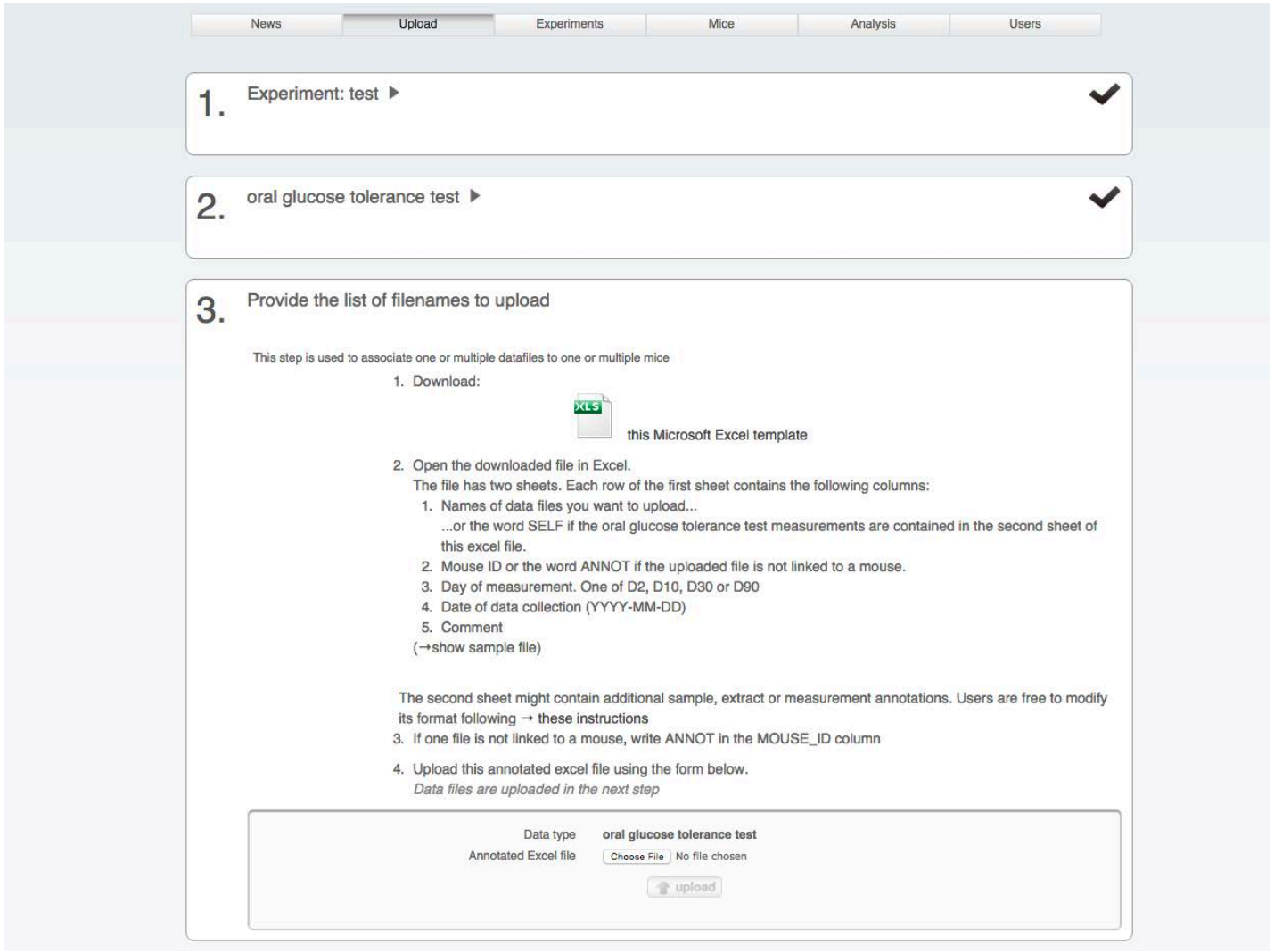
Storage

Resource Management

Hardware Infrastructure

Specific templates used for each data type

Templates downloadable from a central database



We worked with the lab biologists to adapt their own templates and standardize the input data and metadata

Day of measurement (D2, D10, ...) : D10

Glycemia (mg.dL-1)

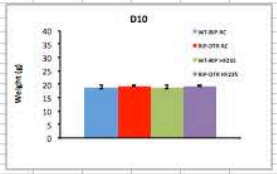
RC

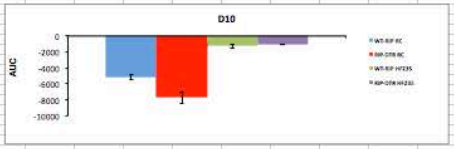
Strain	Diet	ID IMMdia	Mouse	DayO	Date of measurement	Weight (g)	Vol. Ins (µL) at 0.5UI/Kg	0	15	30	45	60	90	120	AUC = Δ(G)	Comment
								Glycemia (mg/dL)								
WT-RIP RC	RC	10RC69	943	25/01/13	31/01/13	19.1	191	142	98	86	79	87	92	122	-5483	
WT-RIP RC	RC	10RC70	946	25/01/13	31/01/13	22.1	221	168	110	125	128	122	114	128	-5370	
WT-RIP RC	RC	10RC71	904	25/01/13	31/01/13	17.6	176	156	118	88	85	111	86	104	-6548	
WT-RIP RC	RC	10RC72	905	25/01/13	31/01/13	17.3	173	178	135	106	112	131	148	144	-5183	
WT-RIP RC	RC	10RC73	906	25/01/13	31/01/13	16.9	169	126	98	82	95	84	104	125	-3165	
WT-RIP RC	RC	10RC74	943	25/01/13	31/01/13	19.1	191	142	98	86	79	87	92	122	-5483	
WT-RIP RC	RC	10RC75	946	25/01/13	31/01/13	22.1	221	168	110	125	128	122	114	128	-5370	
WT-RIP RC	RC	10RC76	904	25/01/13	31/01/13	17.6	176	156	118	88	85	111	86	104	-6548	
WT-RIP RC	RC	10RC77	905	25/01/13	31/01/13	17.3	173	178	135	106	112	131	148	144	-5183	
WT-RIP RC	RC	10RC78	906	25/01/13	31/01/13	16.9	169	126	98	82	95	84	104	125	-3165	
WT-RIP RC	RC	10RC79	943	25/01/13	31/01/13	19.1	191	142	98	86	79	87	92	122	-5483	
WT-RIP RC	RC	10RC80	946	25/01/13	31/01/13	22.1	221	168	110	125	128	122	114	128	-5370	
AVERAGE						18.9		154	111	99	100	107	108	125	-5196	
SEM						0.60		5.33	3.98	5.11	5.41	5.58	6.20	3.54	305	
RIP-DTR RC	RC	9RC69	944	25/01/13	31/01/13	19.9	199	179	111	97	71	92	96	152	-9323	
RIP-DTR RC	RC	9RC70	945	25/01/13	31/01/13	19.4	194	194	119	98	99	90	98	120	-10320	
RIP-DTR RC	RC	9RC71	896	25/01/13	31/01/13	17.9	179	190	120	103	93	123	147	158	-7088	
RIP-DTR RC	RC	9RC72	931	25/01/13	31/01/13	19.8	198	179	158	113	113	138	147	174	-4253	
RIP-DTR RC	RC	9RC73	944	25/01/13	31/01/13	19.9	199	179	111	97	71	92	96	152	-9323	
RIP-DTR RC	RC	9RC74	945	25/01/13	31/01/13	19.4	194	194	119	98	99	90	98	120	-10320	
RIP-DTR RC	RC	9RC75	896	25/01/13	31/01/13	17.9	179	190	120	103	93	123	147	158	-7088	
RIP-DTR RC	RC	9RC76	931	25/01/13	31/01/13	19.8	198	179	158	113	113	138	147	174	-4253	
RIP-DTR RC	RC	9RC77	944	25/01/13	31/01/13	19.9	199	179	111	97	71	92	96	152	-9323	
RIP-DTR RC	RC	9RC78	945	25/01/13	31/01/13	19.4	194	194	119	98	99	90	98	120	-10320	
RIP-DTR RC	RC	9RC79	896	25/01/13	31/01/13	17.9	179	190	120	103	93	123	147	158	-7088	
RIP-DTR RC	RC	9RC80	931	25/01/13	31/01/13	19.8	198	179	158	113	113	138	147	174	-4253	
AVERAGE						19.3		186	127	103	94	111	122	141	-7746	
SEM						0.24		2.01	5.50	1.95	4.56	6.17	7.54	7.78	703	
student						0.000		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	
								***	*						**	

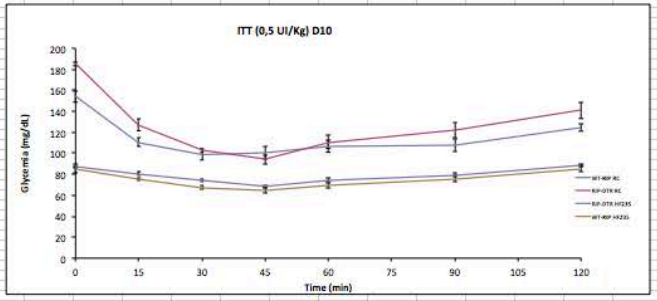
HF235

Strain	Diet	ID IMMdia	Mouse	DayO	Date of measurement	Weight (g)	Vol. Ins (µL) at 0.5UI/Kg	0	15	30	45	60	90	120	AUC = Δ(G)	Comment
								Glycemia (mg/dL)								
WT-RIP HF235	HF 235	10HF69	943	25/01/13	31/01/13	19.1	191	75	75	58	53	55	60	70	-1110	
WT-RIP HF235	HF 235	10HF70	946	25/01/13	31/01/13	22.1	221	80	75	70	65	71	78	87	-808	
WT-RIP HF235	HF 235	10HF71	904	25/01/13	31/01/13	17.6	176	85	82	78	74	82	88	95	-143	
WT-RIP HF235	HF 235	10HF72	905	25/01/13	31/01/13	17.3	173	100	75	70	68	71	77	86	-2858	
WT-RIP HF235	HF 235	10HF73	906	25/01/13	31/01/13	16.9	169	96	70	65	67	75	83	97	-2138	
WT-RIP HF235	HF 235	10HF74	943	25/01/13	31/01/13	19.1	191	75	75	58	53	55	60	70	-1110	
WT-RIP HF235	HF 235	10HF75	946	25/01/13	31/01/13	22.1	221	80	75	70	65	71	78	87	-808	
WT-RIP HF235	HF 235	10HF76	904	25/01/13	31/01/13	17.6	176	85	82	78	74	82	88	95	-143	
WT-RIP HF235	HF 235	10HF77	905	25/01/13	31/01/13	17.3	173	100	75	70	68	71	77	86	-2858	
WT-RIP HF235	HF 235	10HF78	906	25/01/13	31/01/13	16.9	169	96	70	65	67	75	83	97	-2138	
WT-RIP HF235	HF 235	10HF79	943	25/01/13	31/01/13	19.1	191	75	75	58	53	55	60	70	-1110	
WT-RIP HF235	HF 235	10HF80	946	25/01/13	31/01/13	22.1	221	80	75	70	65	71	78	87	-808	
AVERAGE						19.9		85	75	68	64	70	76	86	-1286	
SEM						0.60		3.20	1.05	2.05	2.16	2.77	2.97	2.98	282	
RIP-DTR HF235	HF 235	9HF69	944	25/01/13	31/01/13	19.9	199	80	73	68	63	67	73	83	-998	
RIP-DTR HF235	HF 235	9HF70	945	25/01/13	31/01/13	19.4	194	85	80	73	68	72	75	90	-1028	
RIP-DTR HF235	HF 235	9HF71	896	25/01/13	31/01/13	17.9	179	90	82	77	72	80	83	86	-1080	
RIP-DTR HF235	HF 235	9HF72	931	25/01/13	31/01/13	19.8	198	93	88	80	71	80	87	95	-1268	
RIP-DTR HF235	HF 235	9HF73	944	25/01/13	31/01/13	19.9	199	80	73	68	63	67	73	83	-998	
RIP-DTR HF235	HF 235	9HF74	945	25/01/13	31/01/13	19.4	194	85	80	73	68	72	75	90	-1028	
RIP-DTR HF235	HF 235	9HF75	896	25/01/13	31/01/13	17.9	179	90	82	77	72	80	83	86	-1080	
RIP-DTR HF235	HF 235	9HF76	931	25/01/13	31/01/13	19.8	198	93	88	80	71	80	87	95	-1268	
RIP-DTR HF235	HF 235	9HF77	944	25/01/13	31/01/13	19.9	199	80	73	68	63	67	73	83	-998	
RIP-DTR HF235	HF 235	9HF78	945	25/01/13	31/01/13	19.4	194	85	80	73	68	72	75	90	-1028	
RIP-DTR HF235	HF 235	9HF79	896	25/01/13	31/01/13	17.9	179	90	82	77	72	80	83	86	-1080	
RIP-DTR HF235	HF 235	9HF80	931	25/01/13	31/01/13	19.8	198	93	88	80	71	80	87	95	-1268	
AVERAGE						19.3		88	83	75	69	75	80	89	-1093	
SEM						0.24		1.69	1.61	1.36	1.06	1.67	1.73	1.36	32	
student						0.000		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	
									*	**						

student (WT vs DTR) sous RC	0.00002	0.02370	0.47150	0.39461	0.62152	0.16087	0.06904
student (WT vs DTR) sous HF	0.42879	0.01023	0.00863	0.09681	0.11909	0.29782	0.38281
student WT (RC vs HF)	0.00000	0.00000	0.00001	0.00001	0.00001	0.00012	0.00000
student DTR (RC vs HF)	0.00000	0.00000	0.00000	0.00002	0.00001	0.00002	0.00000

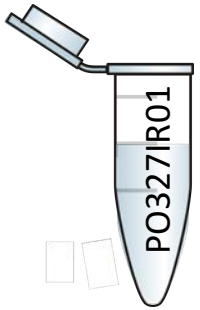






Unique cross-site sample identifiers

- Enabled tracking of samples between different centers
- Not restricted to any particular project
- Short enough to fit on the side of a sample tube!



Curation work is essential but is often underestimated

Egyptian scribe with Papyrus

Biocurator with notebook

Working with FAIR principles

Standardized Format

Resource Description Framework (RDF)

(Meta)Data Harmonisation

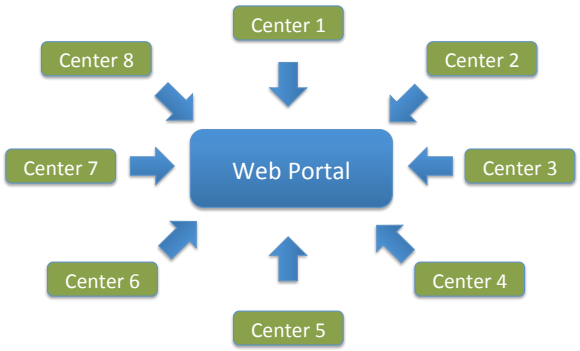
Data curation

Usability

Interactive visualisation

Shared Data

Single access point



- Findability
- Accessibility
- Interoperability
- Reusability

Tools

Database

Storage

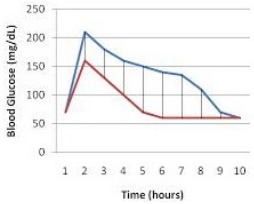
User

Resource Management

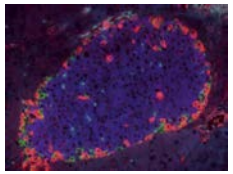
Hardware Infrastructure

Physiological and molecular data were collected

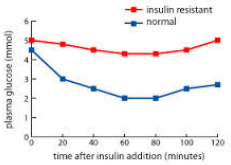
Weight



Glucose Tolerance

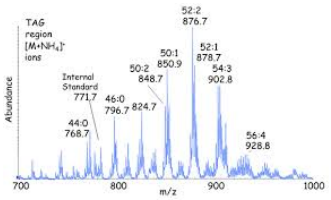


Islet morphology



Insulin Tolerance

RNA-Seq

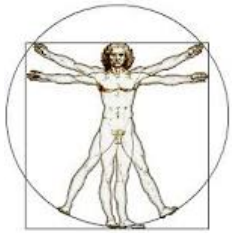


Lipidomics

Physiological Phenotype

Molecular Phenotype

Similar data were generated in human and mouse



Strains

HF-diet model

Physiology

Lipidomics

Gene Expression

Functional Data

Networks

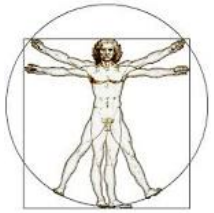
Tissue bank

T2D vs ND

Clinical

Mouse ⟷ Human

A web portal captured the data



392 *human samples*

Genetics

Phenotype

Clinical

968 *mice*

480 *human patients*

Web Portal
IMIDIA DB

Imaging

Functional

440 *mouse samples*
(for beta cell mass)

Lipidomics

Microarray

RNA-Seq

334 *mouse plasma samples*
253 *mouse islet samples*

233 *human samples*

340 *mouse samples*

Working with FAIR principles

Standardized Format

Resource Description Framework (RDF)

(Meta)Data Harmonisation

Data curation

Usability

Interactive visualisation

Shared Data

Single access point

Center 1
Center 2
Center 3
Center 4
Center 5
Center 6
Center 7
Center 8
Web Portal

- Findability
- Accessibility
- Interoperability
- Reusability

User

Tools

Database

Storage

Resource Management

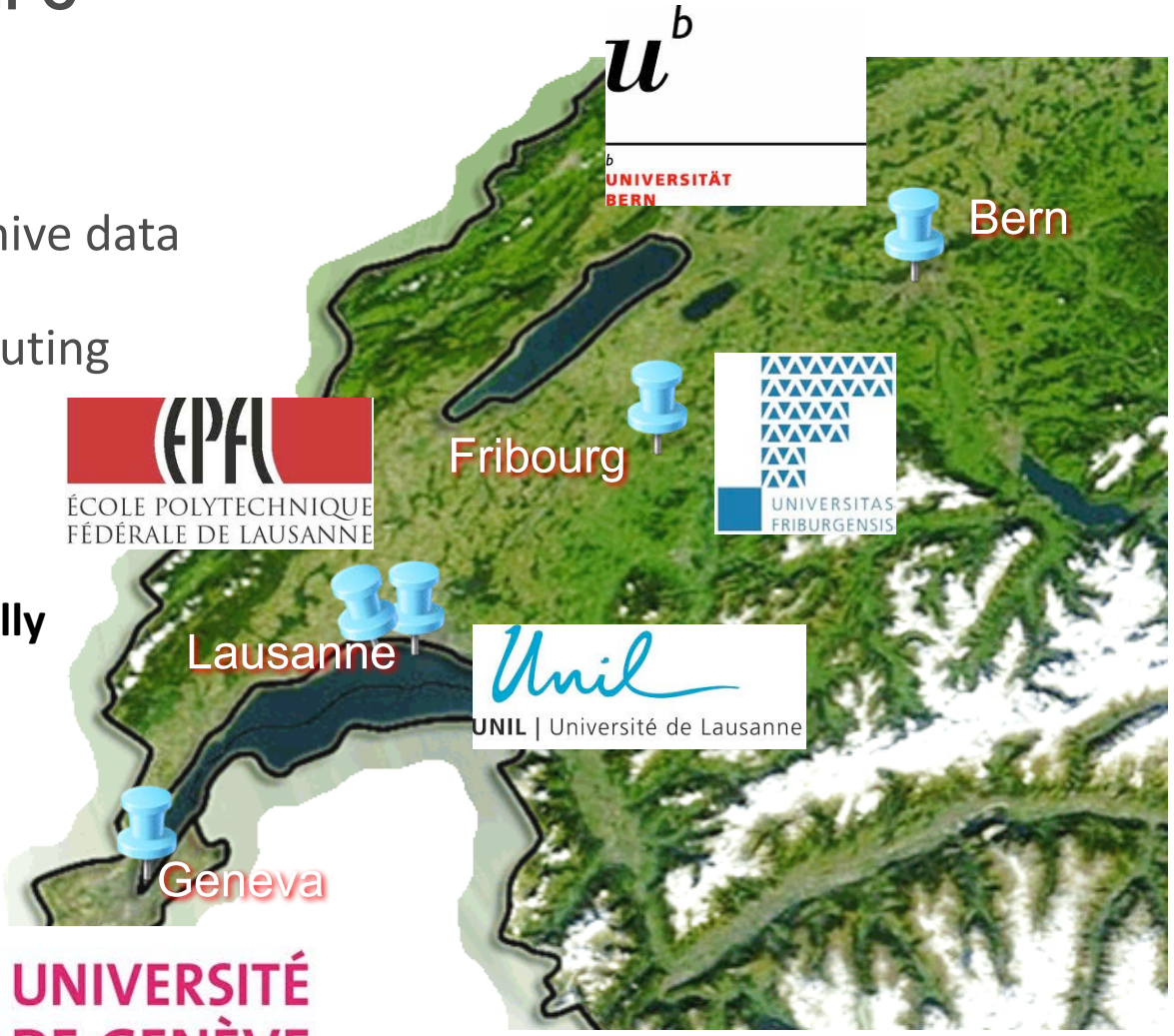
Hardware Infrastructure

Using the Vital-IT distributed platform

Vital-IT : A “cloud” HPC

- > 8000 cores
- > 15 PB near-line/archive data
- GPU/CPU based computing

The infrastructure is centrally managed from Lausanne with a distributed support



UNIVERSITÉ DE GENÈVE

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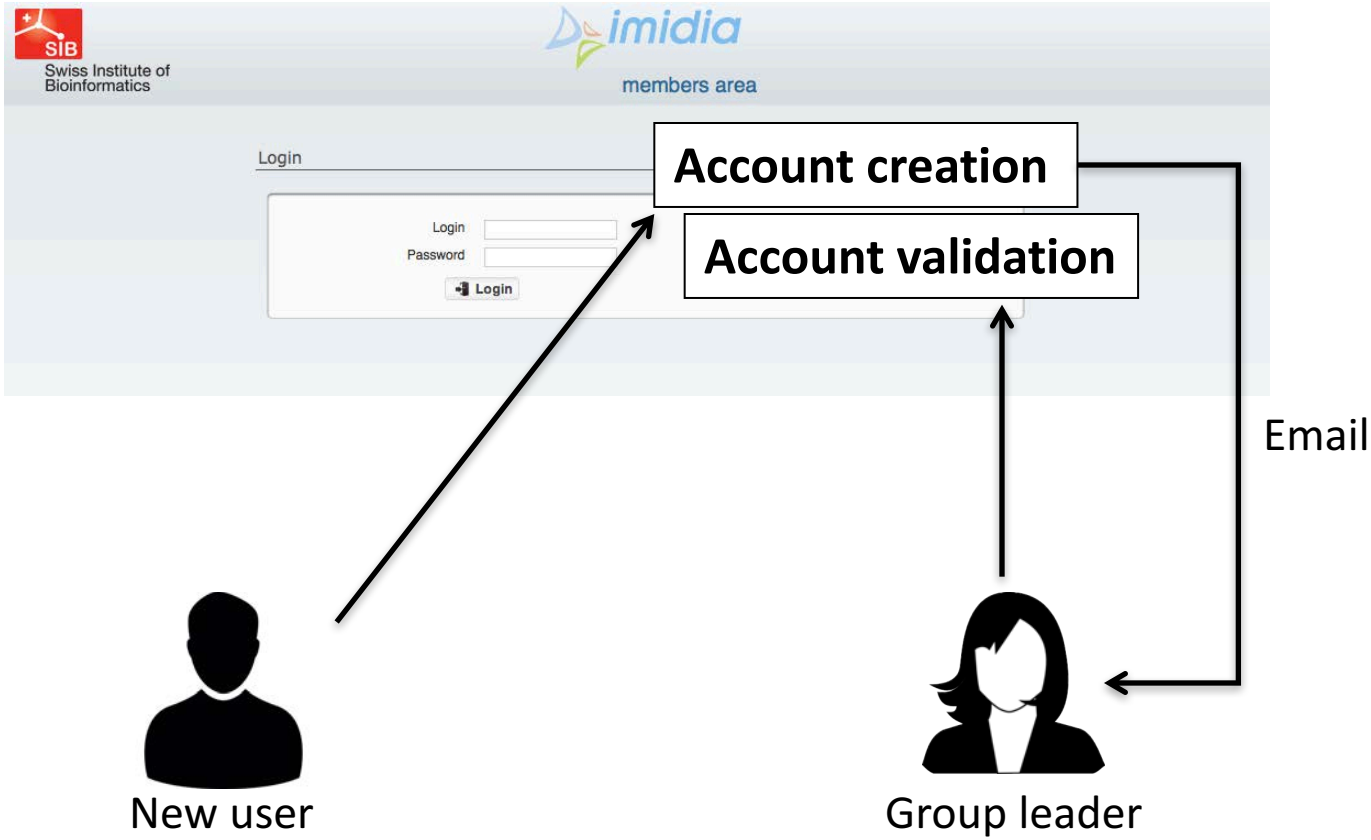
Hardware Infrastructure

Account validation



Data ownership rights managed automatically

Email

Requests access

Grants access

Data “owner”

Project member

Working with FAIR principles

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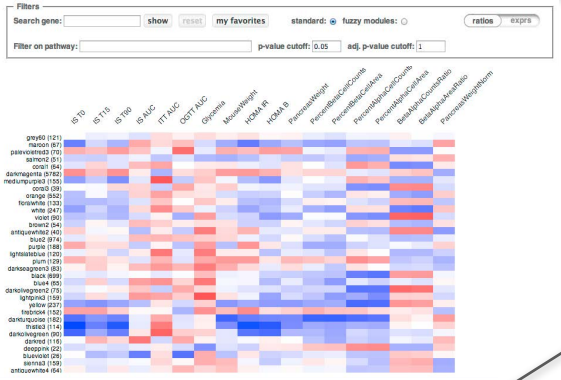


- Findability
- Accessibility
- Interoperability
- Reusability

Single access point

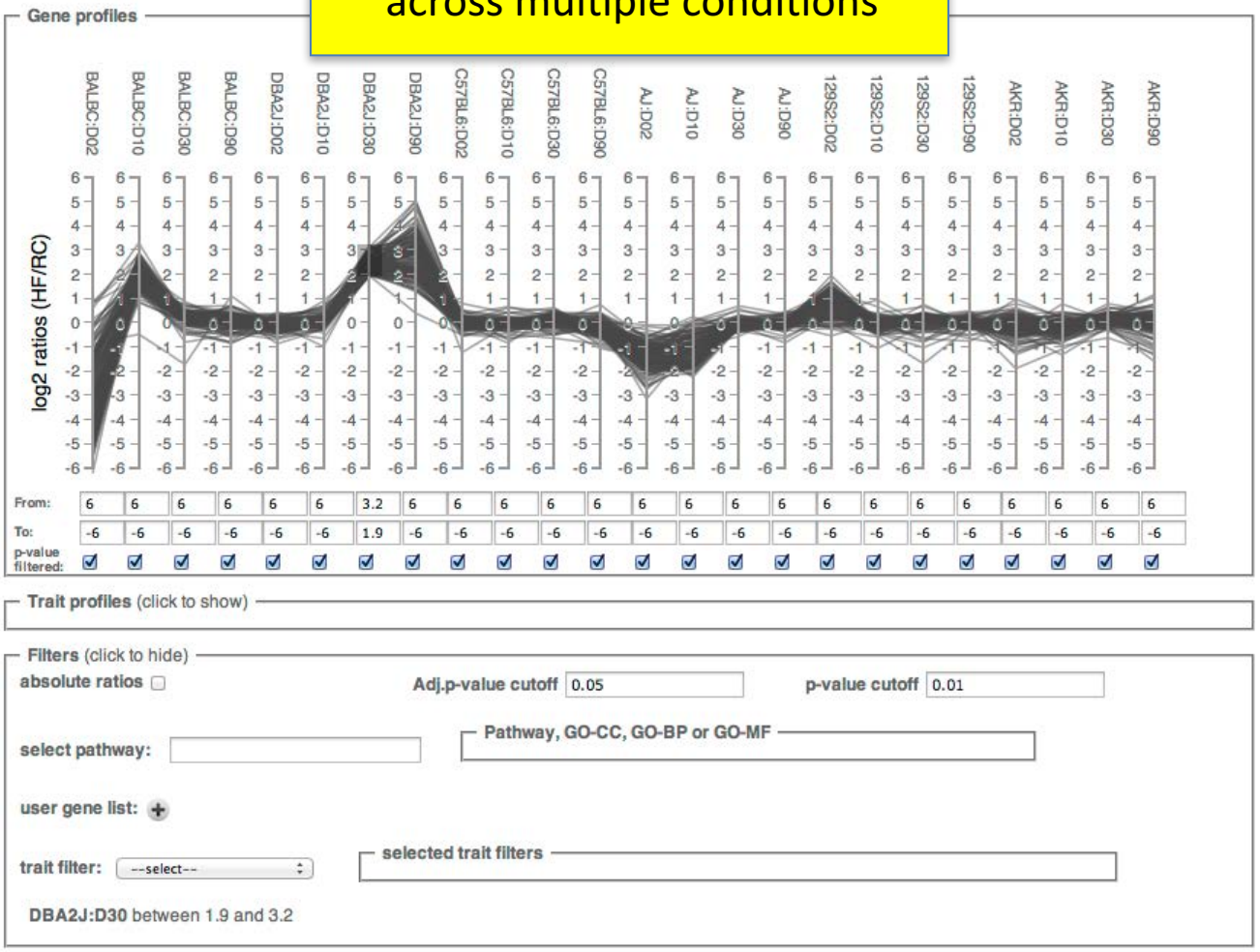
Resource Management

Hardware Infrastructure

Access to detailed, harmonised sample information

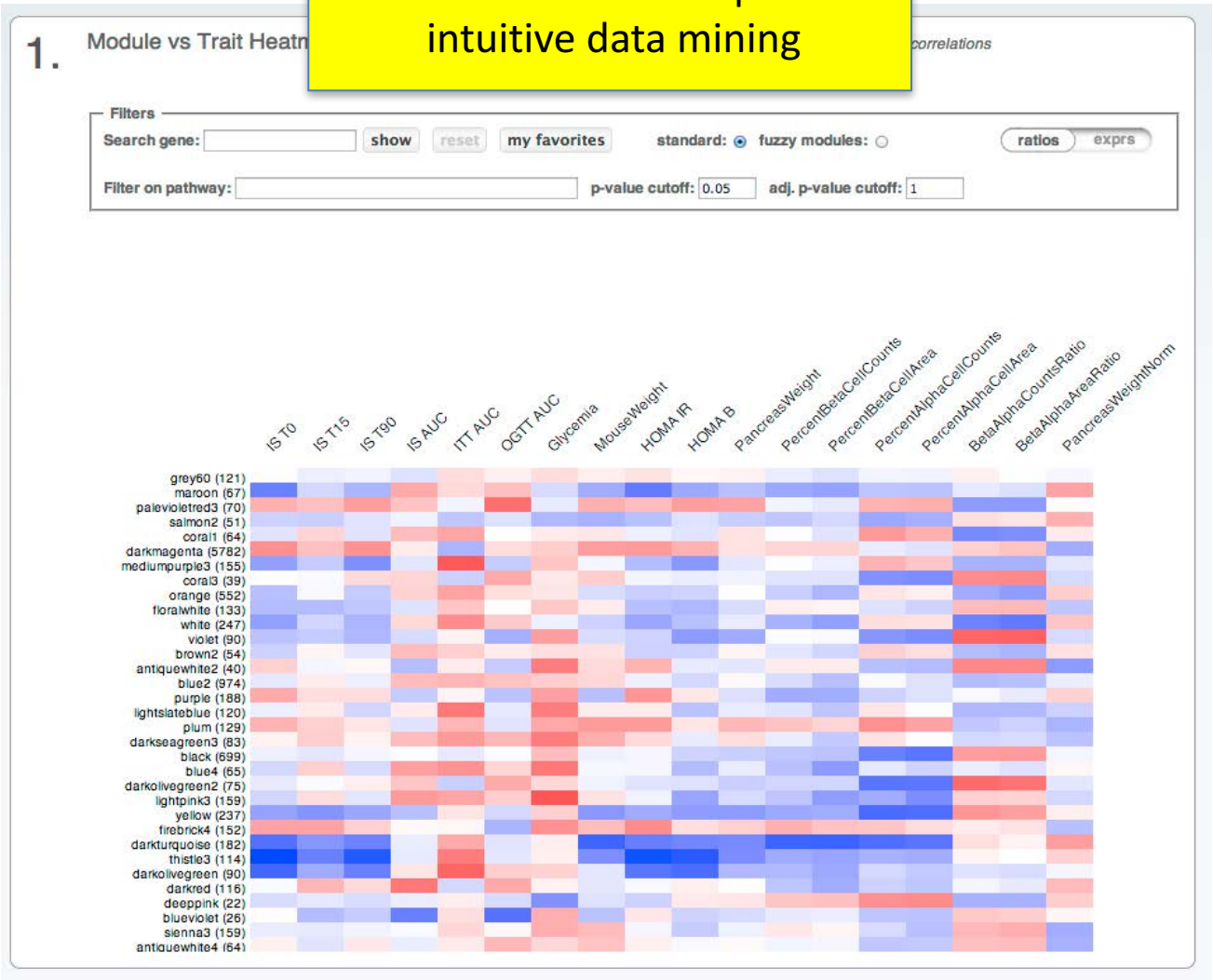
Intuitive web-based tools to explore the data

Parallel plots to visualise data across multiple conditions



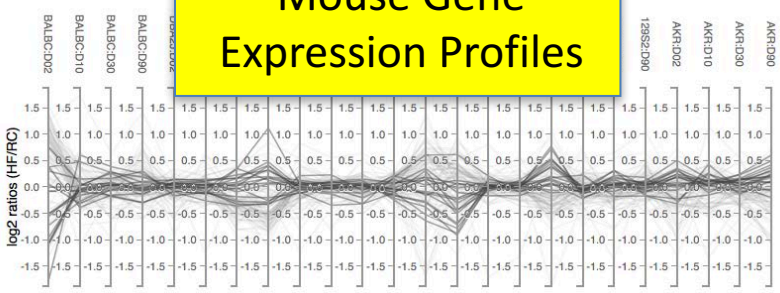
Intuitive web-based tools to explore the data

Interactive heatmaps for intuitive data mining

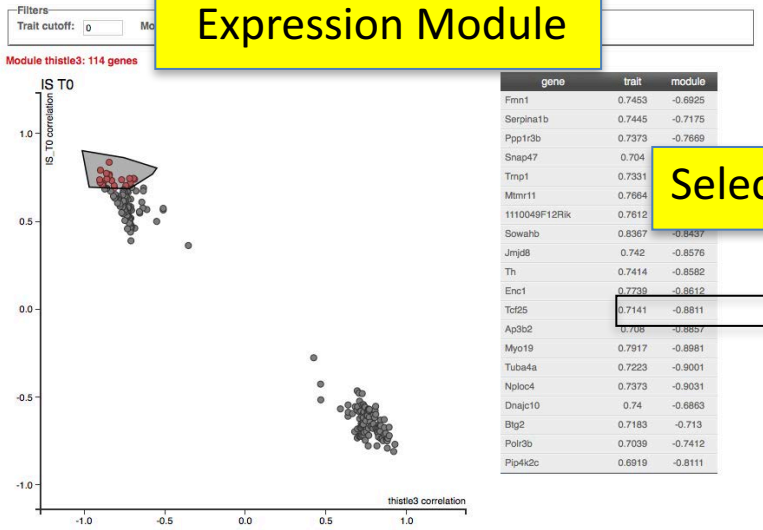


Mouse and Human data integration was possible

Mouse Gene Expression Profiles



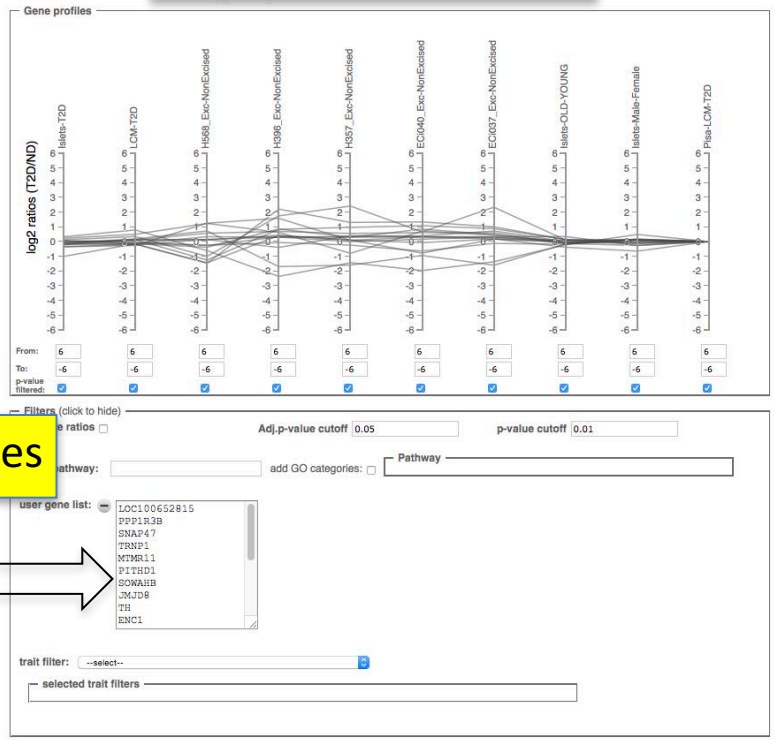
Mouse Gene Expression Module



gene	trait	module
Fmn1	0.7453	-0.6925
Serpina1b	0.7445	-0.7175
Ppp1r3b	0.7373	-0.7669
Snap47	0.704	
Trnp1	0.7331	
Mtmr11	0.7664	
1110049F12Rik	0.7612	
Sowahb	0.8367	-0.8437
Jmjd8	0.742	-0.8576
Th	0.7414	-0.8582
Enc1	0.7739	-0.8612
Tcf25	0.7141	-0.8811
Ap3b2	0.708	-0.8857
Myo19	0.7917	-0.8981
Tuba4a	0.7223	-0.9001
Nploc4	0.7373	-0.9031
Dnajc10	0.74	-0.6863
Btg2	0.7183	-0.713
Polr3b	0.7039	-0.7412
Pip4k2c	0.6919	-0.8111

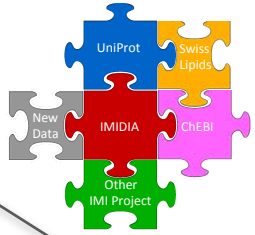
Selected Genes

Human Gene Expression Profiles



Working with FAIR principles

Standardized Format



Resource Description Framework (RDF)

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IMIDIA sustainability and interoperability

Goal : Transform IMIDIA data and results into a standardized format

IMIDIA Integrated Data Set

Transformation

Standardized Framework (RDF)

Dmitry Kuznetsov (*Vital-IT*)
Database architect, RDF

Terms mapping using global standards for medical research (CDISC)

Jerven Bolleman
(Swiss-Prot) RDF
More than 10 years RDF experience

RDF= Resource Description Framework
CDISC= Clinical Data Interchange Standards Consortium

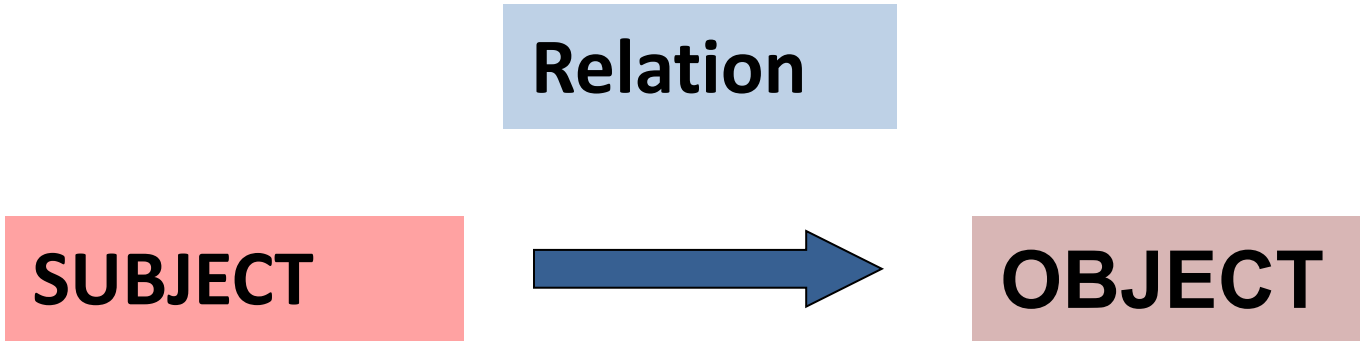
What is RDF ?

Susie is_child_of John Smith

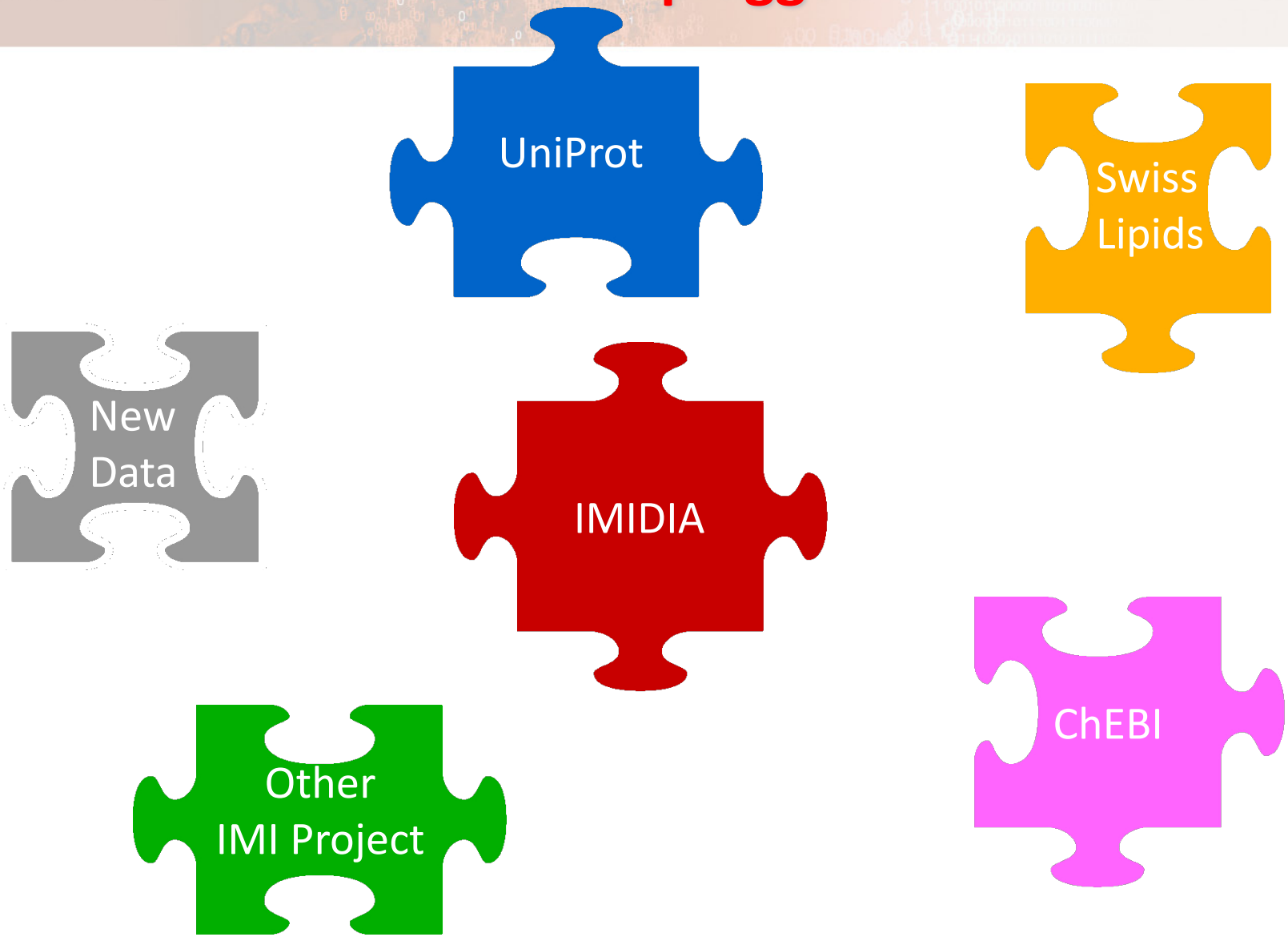
Web page has_author Robin

Ethanol is_oxidized_to acetaldehyde

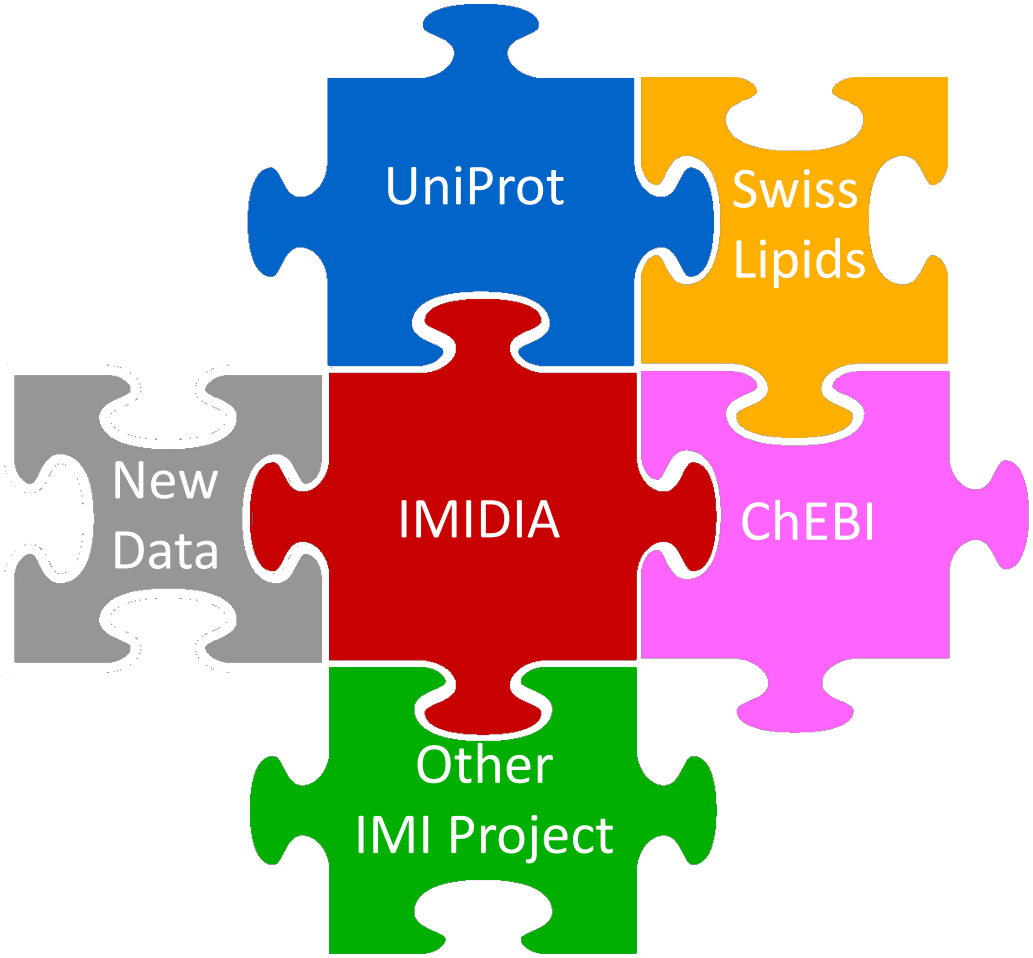
Protein kinase regulates enzyme activity



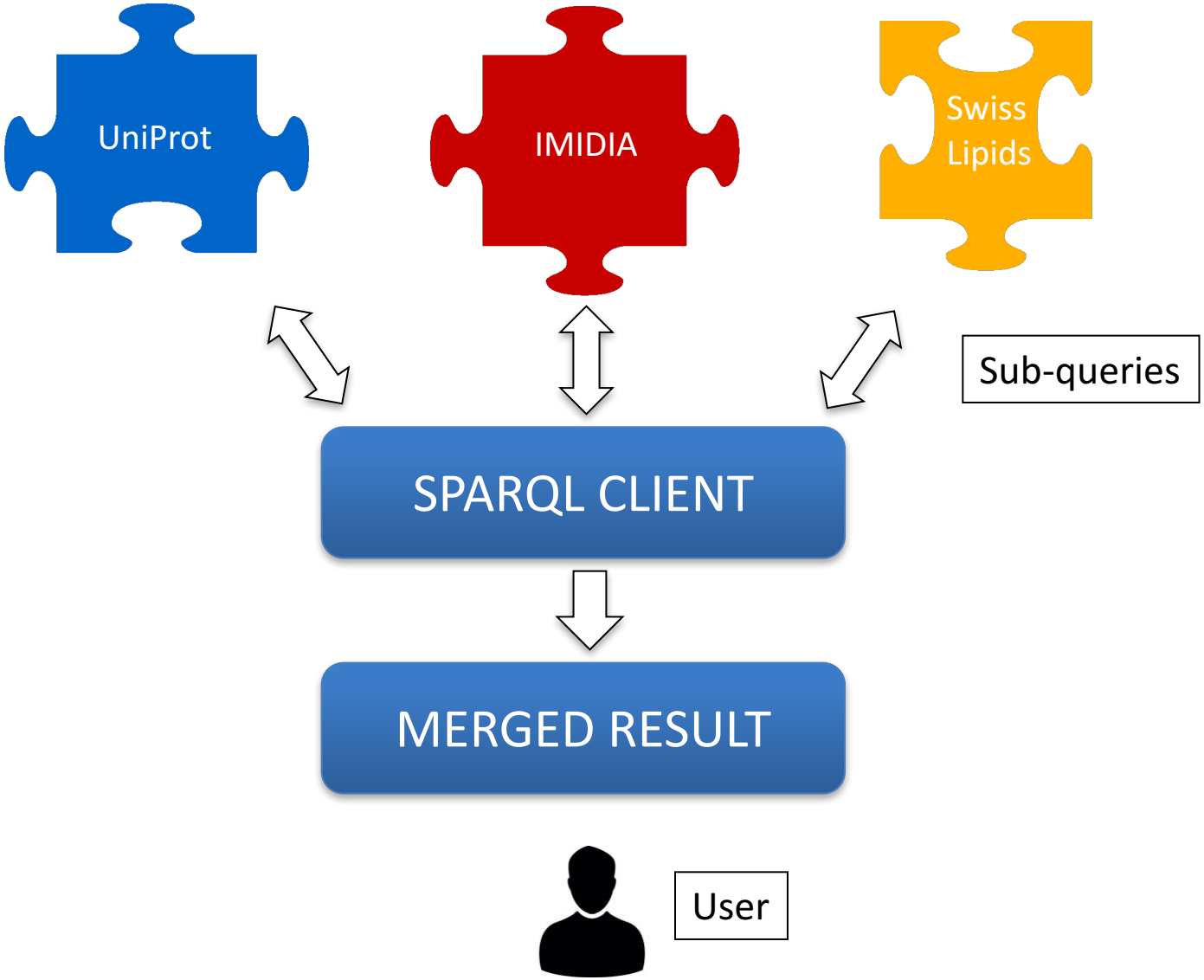
Other RDF sources can be “plugged in” to IMIDIA data



Other RDF sources are “plugged in” to IMIDIA data

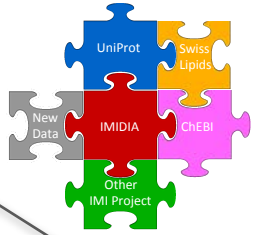


Federated queries can be used to run queries across several SPARQL end-points



Working with FAIR principles

Standardized Format



Resource Description Framework (RDF)

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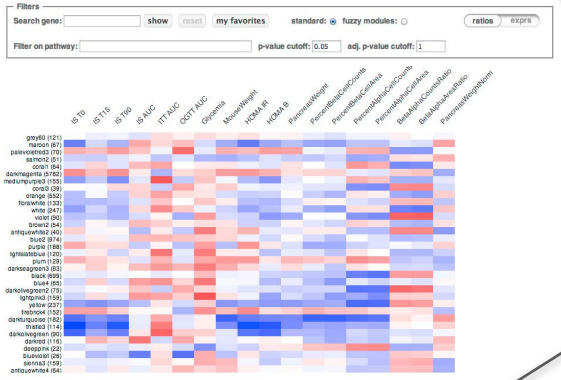
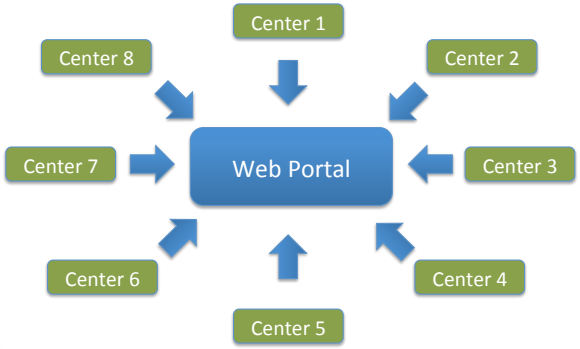


Shared Data

Single access point



- Findability
- Accessibility
- Interoperability
- Reusability

Resource Management

Hardware Infrastructure

SIB people involved in IMIDIA

Mark Ibberson
Data analysis and coordination

Robin Liechti
Database, web interface and analysis tools

Leonore Wigger
Statistical models

Frédéric Burdet
Data management Bioinformatics, RNASeq analysis

Lou Gotz
Web interface development

Dmitry Kuznetsov
Database architect, RDF

Nicolas Guex
Algorithm development and data analysis

Jerven Bolleman
(SwissProt) RDF

Diana Marek
CDISC term mapping

Anne Niknejad
Lipid, gene and pathway annotations

Alan Bridge (SwissProt)
Lipid annotations

Lucilla Aimo (SwissProt)
Lipid annotations

Ioannis Xenarios
Work package leader, director of Vital-IT and SwissProt

Roberto Fabbretti
Vital-IT infrastructure management

Brian Stevenson
Analysis and annotation

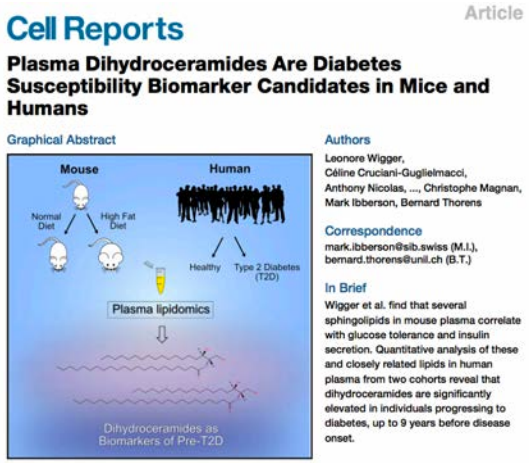
SIB Swiss Institute of Bioinformatics

Vital-IT

Some notes

- FAIRification was only possible because of **protocol harmonisation**, data **centralisation** and **curation** right from the **start** of the project
- Additional funding was set aside to enable the work
- A lot of people with diverse skills were needed
- The process took time and we shouldn't underestimate costs
  - *~4PM/year for data curation and model design/encoding*
  - *This is sustained for 7 years and not by a single PhD/Postdoc*

Some outputs from the project


Article

Cell Reports

Plasma Dihydroceramides Are Diabetes Susceptibility Biomarker Candidates in Mice and Humans

Graphical Abstract

Authors
Leonore Wigger, Céline Cruciani-Guglielmacci, Anthony Nicolas, ..., Christophe Magnan, Mark Ibberson, Bernard Thorens

Correspondence
mark.ibberson@sib.swiss (M.I.), bernard.thorens@unil.ch (B.T.)

In Brief
Wigger et al. find that several sphingolipids in mouse plasma correlate with glucose tolerance and insulin secretion. Quantitative analysis of these and closely related lipids in human plasma from two cohorts reveal that dihydroceramides are significantly elevated in individuals progressing to diabetes, up to 9 years before disease onset.

- Candidate lipid biomarker for T2D
  - *Capture, storage, sharing + **discovery***
- FAIRified data for mouse and human
  - *Interoperable with Uniprot, SwissLipids etc.*
  - *CDISC (clinical standards) compatible*
- SIB (Vital-IT) is now Data Coordination Center for 2 new IMI projects RHAPSODY and BEAt-DKD
  - *Aligning multiple clinical cohorts to CDISC*
  - *Federated database infrastructure and analysis*

Take-home messages

- **We are having to deal with more and more diverse data**

- **Main challenge is making sure knowledge is not lost**
  - *How to make research data sustainable and reusable*
  - *Resources need to be put aside for this*
  - *This can impact future funding allocation (e.g. H2020)*

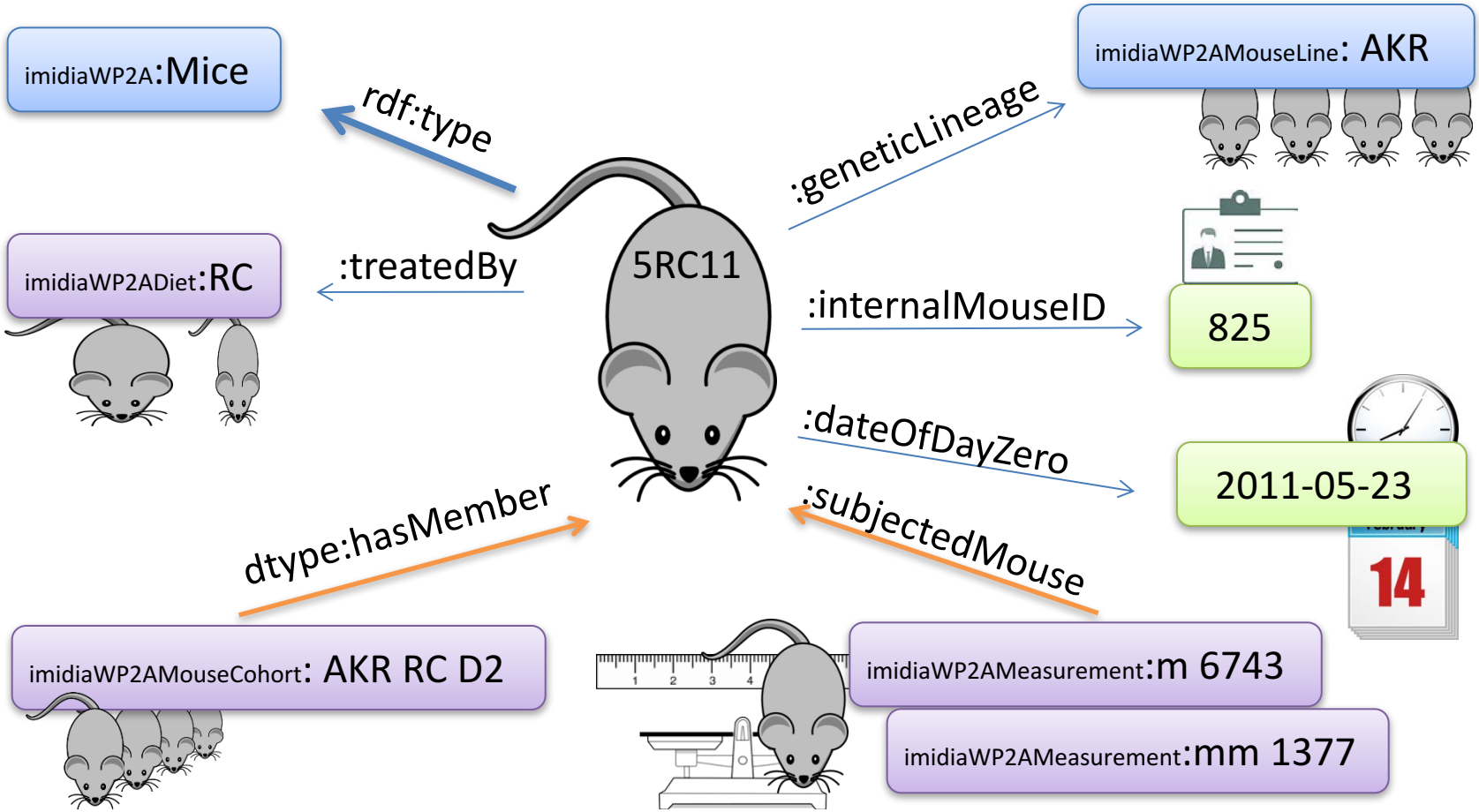
- **FAIR is a good concept to work towards**
  - *Need to think and plan the necessary steps early on (ideally before the project starts)*

- **FAIR does not necessarily mean Open Access**
  - *Many datasets (e.g. Clinical) need to remain restricted access*
  - *These datasets still need to be interoperable with other private and public resources*

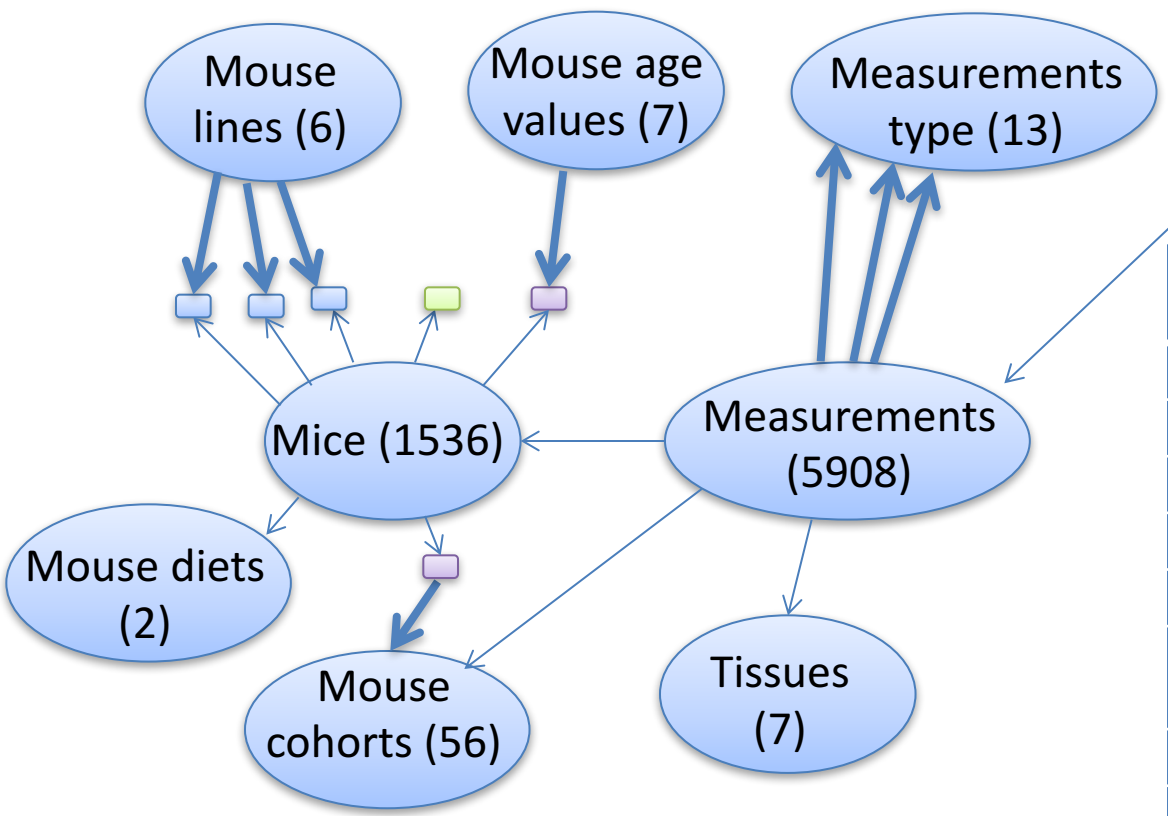
Thank you!

Backup slides

WP2A – mouse data



WP2A – essential classes



Measurement types	# results
pancreas morphology	328
mass measurement	1266
insulin secretion in vitro	1535
insulin secretion in vivo	3370
insulin tolerance test	3783
oral glucose tolerance test	4051
islets lipidomics	13286
plasma lipidomics	51128
RNA SEQ gene expression	7290921

WP2A – classes and properties

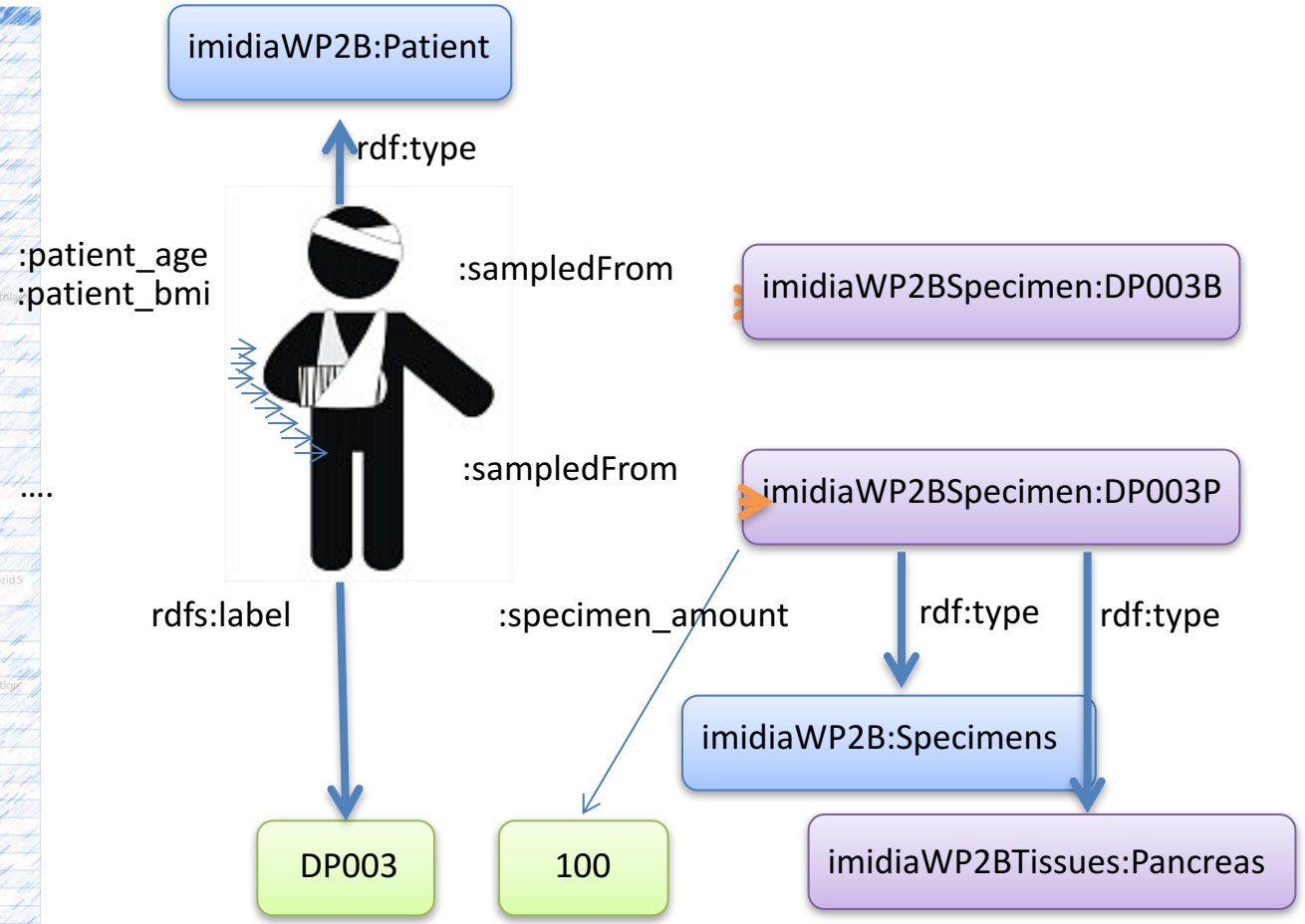
25 classes, 26 properties, 30’488’338 triples

- imidiaWP2A:DataStructures (80985)
  - imidiaWP2A:geneExpressionCount (341)
  - imidiaWP2A:massMeasurement (2398)
  - imidiaWP2A:substanceAmount (78246)
- imidiaWP2A:Diets (2)
- imidiaWP2A:Measurements (7088)
- imidiaWP2A:MeasurementType (13)
- imidiaWP2A:Mice (1536)
- imidiaWP2A:mouseAgeValues (7)
- imidiaWP2A:MouseCohorts (56)
- imidiaWP2A:MouseLines
- imidiaWP2A:Stimuli (744)
- imidiaWP2A:Substances (165)
- imidiaWP2A:Tissues (7)
- imidiaWP2A:Traits (20)

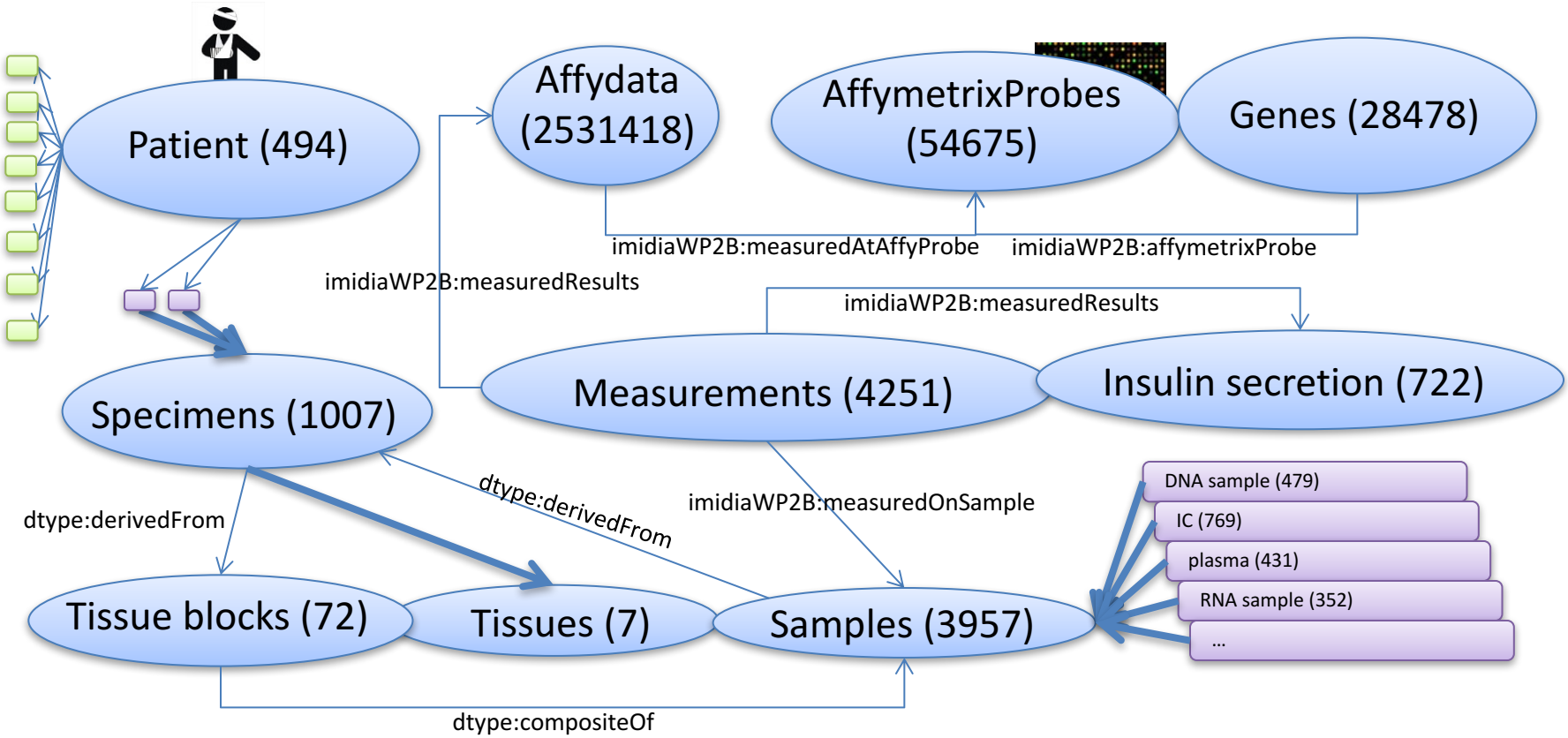
- imidiaWP2A:ageOfTheSubjectedMouse
- imidiaWP2A:calculatedAreaUnderCurve
- imidiaWP2A:calculatedMeanValue
- imidiaWP2A:dateOfDayZero
- imidiaWP2A:delayUnit
- imidiaWP2A:geneticLineage
- imidiaWP2A:internalMouseID
- imidiaWP2A:measuredAfterDelay
- imidiaWP2A:measuredOnDate
- imidiaWP2A:measuredOnTissue
- imidiaWP2A:measuredResults
- imidiaWP2A:measuredSubstance
- imidiaWP2A:measurementTrait

- imidiaWP2A:measurementType
- imidiaWP2A:normalizedCountForGene
- imidiaWP2A:sampleConcentration
- imidiaWP2A:sampleConcentrationUnit
- imidiaWP2A:sampleMass
- imidiaWP2A:sampleMassUnit
- imidiaWP2A:sampleVolume
- imidiaWP2A:sampleVolumeUnit
- imidiaWP2A:subjectedMouseCohort
  - imidiaWP2A:subjectedMouse
- imidiaWP2A:subjectTreatedBeforeExperimentBy
- imidiaWP2A:treatedBy
- imidiaWP2A:usedSubstance

WP2B – patient data



WP2B – essential classes



WP2B – classes and properties

29 classes, 148 properties, 13’150’154 triples

- imidiaWP2B:AffymetrixProbes (54675)
- imidiaWP2B:DataStructures (25540)
  - imidiaWP2B:AFFYdata (24818)
  - imidiaWP2B:geneExpressionCount
  - imidiaWP2B:massMeasurement
  - imidiaWP2B:substanceAmount (722)
- imidiaWP2B:Measurements (4251)
- imidiaWP2B:MeasurementType (22)
- imidiaWP2B:Patient (494)
- imidiaWP2B:Samples (3957)
- imidiaWP2B:SampleTypes (3960)
- imidiaWP2B:Specimens (1007)
- imidiaWP2B:Stimuli (1441)
- imidiaWP2B:Substances
- imidiaWP2B:TissueBlocks (72)
- imidiaWP2B:Tissues (7)

- imidiaWP2B:affymetrixProbe
- imidiaWP2B:Bioanalyzer_data
- imidiaWP2B:calculatedAreaUnderCurve
- imidiaWP2B:calculatedMeanValue
- imidiaWP2B:CDISCequivalent
- imidiaWP2B:cDNA_yield
- imidiaWP2B:Chip_name
- imidiaWP2B:delayUnit
- imidiaWP2B:FlowCell_number
- imidiaWP2B:Library_concentration
- imidiaWP2B:Library_date
- imidiaWP2B:Library_fragment_size
- imidiaWP2B:Library_local_ID
- imidiaWP2B:Library_type
- imidiaWP2B:Library_volume