Biobanks and Imaging: the Bioinformatic Challenge, from MIABIS to DICOM

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What are biobanks?

- Repositories of resources for medicine and medical research.

- Bio**samples**,
- **accompanying data**: clinical, phenotypes, lifestyle, …
- **data generated** from samples: **imaging**, omics, …
- **expertise**: data interpretation and integration, …
- **services**: sample & data hosting, analysis of samples, …

```
biobanks := samples + data + expertise + services;
```

What are imaging biobanks?

▶ Biobanks which focus primarily on collection of imaging data
- ■ typically radiology imaging data,
- ■ with relevant clinical data,
- ■ possible other modalities,
- ■ rarely with biological samples.

▶ Radiology uses well-developed DICOM model to describe various modalities, with main focus on imaging.

What are current goals of collaboration of ESR and BBMRI-ERIC?

▶ Develop aggregate data/metadata model for describing imaging biobanks.

⟹ setup of MIABIS-Imaging WG

▶ Implement proposed data model in BBMRI-ERIC Directory 2.x/3.x

▶ Populate the Directory with ESR Imaging Biobanks data

 ■ via BBMRI-ERIC National Nodes where available
 ■ directly from ESR otherwise

Directory 2.x Model

▶ Implementation of **MIABIS 2.0** data model with additional extensions

- ■ **biobanks** – institutional "envelopes"
- ■ **collections** – contain information on samples and data
  - ● can be recursively split into sub-collections
  - ● for countable material (samples) requires partitioning
- ■ **biobank networks**
  - ● can aggregate biobanks or even directly selected collections
  - ● ESR can be also considered a network
- ■ **contact information** – auxiliary entity for "normalization of database" purposes

Proposal of MIABIS-Imaging

▶ New subtype of collections – **imaging collection**

- imaging biobanks store image collections just as biobanks store biological samples.
  - The existing types of collections were felt fully relevant for image collections, i.e., *case control collection, cohort collection, cross-sectional collection, longitudinal collection,* etc.
- Donors (of images) can be described in the same way as donors (of samples).

Description of *Image Collections*

▶ *Body part examined*

- based on DICOM data element (0018,0015) characterizing DICOM series,
- DICOM Part 16 provide a list of terms and corresponding SNOMED CT codes,
- 116 terms.

ABDOMEN	HAND	SCAPULA
ABDOMENPELVIS	HEAD	SCLERA
ADRENAL	HEADNECK	SCROTUM
ANKLE	HEART	SHOULDER
AORTA	HIP	SKULL
AXILLA	HUMERUS	SPINE
BACK	ILEUM	SPLEEN
BLADDER	ILIUM	STERNUM
BRAIN	IAC	STOMACH
BREAST	JAW	SUBMANDIBULAR
BRONCHUS	JEJUNUM	TMJ
BUTTOCK	KIDNEY	TESTIS
CALCANEUS	KNEE	THIGH
CALF	LARYNX	TSPINE
CAROTID	LIVER	TLSPINE
CEREBELLUM	LEG	THUMB
CSPINE	LSPINE	THYMUS
CTSPINE	LSSPINE	THYROID
CERVIX	LUNG	TIBIA
CHEEK	MAXILLA	TIBIAFIBULA
CHEST	MEDIASTINUM	TOE
CHESTABDOMEN	MOUTH	TONGUE
CHESTABDPELVIS	NECK	TRACHEA
CIRCLEOFWILLIS	NECKCHEST	ULNA
CLAVICLE	NECKCHESTABDOMEN	ARM
COCCYX	NECKCHESTABDPELV	URETER
COLON	NOSE	URETHRA
CORNEA	ORBIT	UTERUS
CORONARYARTERY	OVARY	VAGINA
DUODENUM	PANCREAS	VULVA
EAR	PAROTID	WRIST
ELBOW	PATELLA	ZYGOMA
WHOLEBODY	PELVIS	
ESOPHAGUS	PENIS	
EXTREMITY	PHARYNX	
EYE	PROSTATE	
EYELID	RADIUS	
FACE	RADIUSULNA	
FEMUR	RECTUM	
FINGER	RIB	
FOOT	SSPINE	
GALLBLADER	SCALP	

Description of *Imaging Modality*

▶ *Imaging modality*

  ■ based on DICOM data element (0008,0060) characterizing DICOM series,

  ■ denotes a category of equipment, e.g., an *acquisition modality*,

  ■ 54 terms.

AR	Autorefraction
BMD	Bone Mineral Densitometry
BDUS	Ultrasound Bone Densitometry
EPS	Cardiac Electrophysiology
CR	Computed Radiography
CT	Computed Tomography
DX	Digital Radiography
ECG	Electrocardiography
ES	Endoscopy
XC	External-camera Photography
GM	General Microscopy
HD	Hemodynamic Waveform
IO	Intra-oral Radiography
IVOCT	Intravascular Optical Coherence Tomography
IVUS	Intravascular Ultrasound
KER	Keratometry
LEN	Lensometry
MR	Magnetic Resonance
MG	Mammography
NM	Nuclear Medicine
OAM	Ophthalmic Axial Measurements
OCT	Optical Coherence Tomography
OPM	Ophthalmic Mapping
OP	Ophthalmic Photography
OPR	Ophthalmic Refraction
OPT	Ophthalmic Tomography
OPV	Ophthalmic Visual Field
OSS	Optical Surface Scanner
PX	Panoramic X-Ray
PT	Positron emission tomography
RF	Radiofluoroscopy
RG	Radiographic imaging
SM	Slide Microscopy
SRF	Subjective Refraction
US	Ultrasound
VA	Visual Acuity
XA	X-Ray Angiography

Description of *Image Dataset Type*

▶ *Image dataset type*

- based on DICOM data element (0008,0016) SOP Class UID, characterizing a DICOM dataset,
- denotes a category of image, or report, or set of measurements,
- 120 terms.

1.2.840.10008.5.1.4.1.1.1	Computed Radiography Image IOD
1.2.840.10008.5.1.4.1.1.1.1	Digital X-Ray Image IOD
1.2.840.10008.5.1.4.1.1.1.1.1	Digital X-Ray Image IOD
1.2.840.10008.5.1.4.1.1.1.2	Digital Mammography X-Ray Image IOD
1.2.840.10008.5.1.4.1.1.1.2.1	Digital Mammography X-Ray Image IOD
1.2.840.10008.5.1.4.1.1.1.3	Digital Intra-Oral X-Ray Image IOD
1.2.840.10008.5.1.4.1.1.1.3.1	Digital Intra-Oral X-Ray Image IOD
1.2.840.10008.5.1.4.1.1.2	Computed Tomography Image IOD
1.2.840.10008.5.1.4.1.1.2.1	Enhanced CT Image IOD
1.2.840.10008.5.1.4.1.1.2.2	Legacy Converted Enhanced CT Image IOD
1.2.840.10008.5.1.4.1.1.3.1	Ultrasound Multi-frame Image IOD
1.2.840.10008.5.1.4.1.1.4	Magnetic Resonance Image IOD
1.2.840.10008.5.1.4.1.1.4.1	Enhanced MR Image IOD
1.2.840.10008.5.1.4.1.1.4.2	MR Spectroscopy IOD
1.2.840.10008.5.1.4.1.1.4.3	Enhanced MR Color Image IOD
1.2.840.10008.5.1.4.1.1.4.4	Legacy Converted Enhanced MR Image IOD
1.2.840.10008.5.1.4.1.1.6.1	Ultrasound Image IOD
1.2.840.10008.5.1.4.1.1.6.2	Enhanced US Volume IOD
1.2.840.10008.5.1.4.1.1.7	Secondary Capture Image IOD

(extract)

Prototype-Based Proposal Validation

- ▶ Implemented in the upcoming BBMRI-ERIC Directory 2.5
  - ■ interim release scheduled for September 2016, before release of BBMRI-ERIC Directory 3.0 in November 2016
- ▶ Deployed on a testing server – `https://molgenis52.gcc.rug.nl/`
- ▶ Filled in Grenoble Institute of Neurosciences (GIN) – Michel Dojat with 4 collections

		name	acronym		biobank
✎ 🗑 🔍		CoCoA	CoCoA		biobank@GIN
✎ 🗑 🔍		Synesthesia	Syn		biobank@GIN
✎ 🗑 🔍		AGIR-PARK	AGIR-PARK		biobank@GIN
✎ 🗑 🔍		OxyTC	OxyTC		biobank@GIN

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Prototype-Based Proposal Validation

Prototype-Based Proposal Validation

Prototype-Based Proposal Validation

▶ Main remarks

- data limited to acquired images (no processed images),
- closed collections versus still open collections (study still in progress),
  - distinguish between minimum and maximum age of actual donors and minimum and maximum age in study protocol.

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Discussion: DICOM Metadata

- ▶ Not relevant for new imaging modalities, or processed images.
- ▶ Need for more precision on imaging sub-modalities,
  - ■ e.g., in MRI: DTI, DCE, fMRI, ASL etc.,
  - ■ concerns most imaging modalities
- ▶ In DICOM, Body part examined is optional; information about body part can also be found in other DICOM data elements (but in free text)

Further plans

- ▶ Short term: need for more systematic testing with image collections from several european countries.
- ▶ Ontologization of imaging proposal
  - ■ … waits on ontologization of MIABIS 2.0 core – OMIABIS → OBIB release
- ▶ Extensions of the model for digital pathology
  - ■ expected activity in 2017.

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Thank you for your attention!
Q?/A!

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