DigiMed Bayern

für die Medizin der Zukunft

Data Integration Architecture of DigiMed Bayern

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Vision: Data and Analysis at your Fingertips

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- Integration of different data types:
  - structured clinical data, genetic data, images, narratives,…
- Integration from different domains:
  - research, clinical care
- Integration from different sources:
  - hospital information system (HIS), laboratory information system (LIS), biobank information management system (BIMS), picture archiving and communication system (PACS), …
- Integration of data from different "clinical pictures“
- Integration of cross-sectional and longitudinal data

Goal: Improve Research and Care

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- Improve:
  - Data quality
  - Collaboration
  - **Traceability**
  - Reproducibility
  - **Data security**
  - **Data protection**
  - Transparency
  - **Reusability**

Risk: Highly Sensitive Data

- Special category of personal data
  (Art. 9 GDPR: genetic data, data concerning health)

- Many attributes, big collectives, different data sources, ubiquitous data collections (e.g. „quantified self“)

Conflict: **Research ←→ Privacy**

Design Principles / Corner Stones

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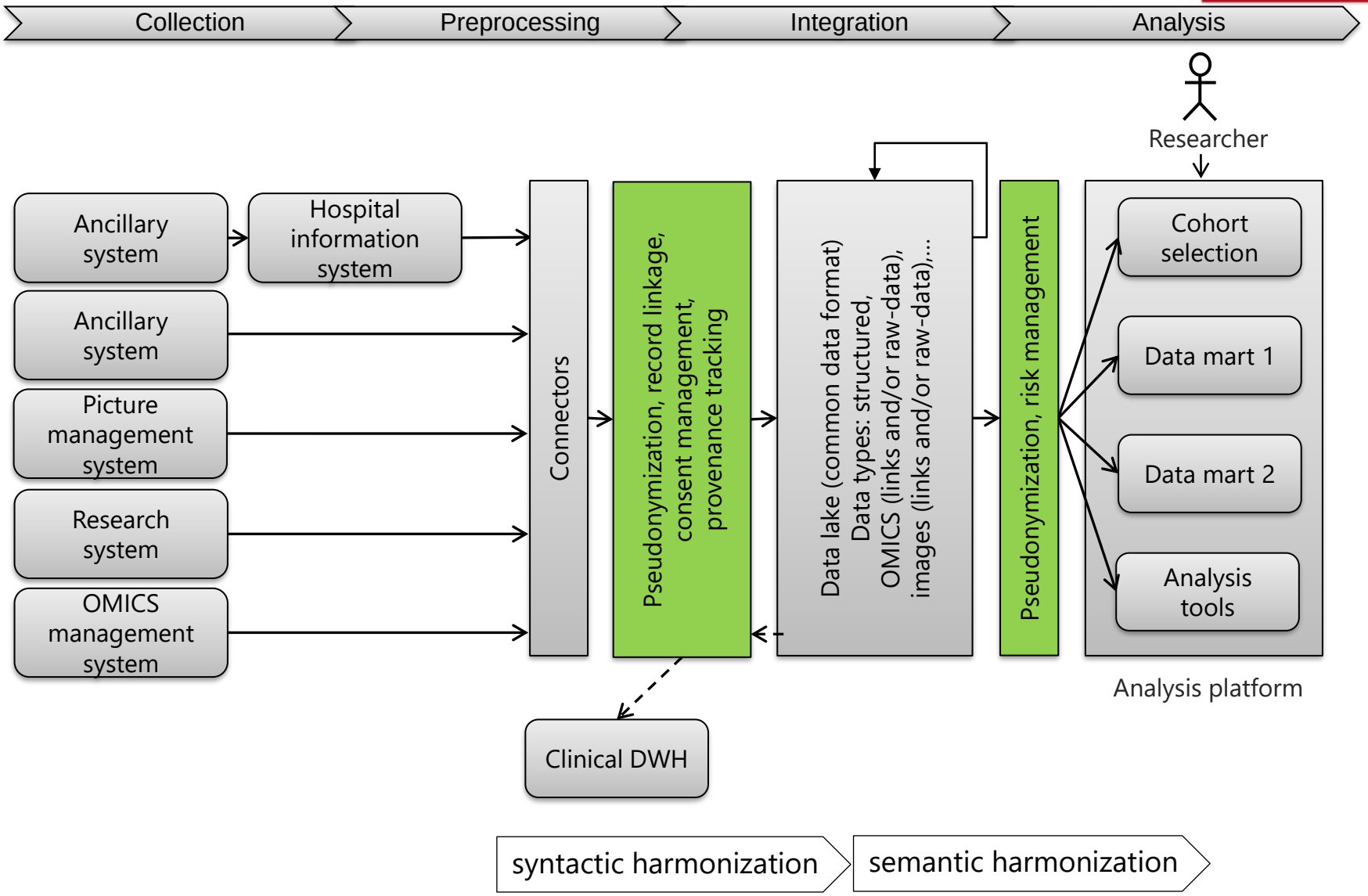
- Cooperate for concepts,
  architecture and tools with DIFUTURE and other projects

- Use case driven
- Agile/iterative and pay-as-you go approach
- Security and privacy by design
- Minimize number of interfaces

- Data lake approach
- Multiple extract-transform-load (ETL) steps,
  separating syntactic and semantic harmonization
- Common data block format
- Only pseudonymized data will be loaded into the data lake
- Separation of components with strict access permissions

Architecture: Overview



Data Lake – Data Model: Data Block Example (pre-pseudo)

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"blockVersion": 1,
"blockContent": "DATA",
"identity": {
    "subjectID": "12345",
    "otherIDs": [
        {
            "type": "CASE_ID",
            "value": "55566778"
        }
    ],
    "directlyIdentifyingInfos": [
        {
            "key": "Lastname",
            "value": "Tester",
            "datatype": "STRING"
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            "value": "Test",
            "datatype": "STRING"
        }
    ],
    "pseudonymized": false,
    "sourceSystem": "HK_DB"
},
"importTimestamp": "2019-05-06T12:50:27.718",
"contentType": {
    "type": "LAB_DATA",
    "version": 1
},
"beginTimestamp": "2019-04-08T11:32:00",
"endTimestamp": "2019-04-09T00:00:00",
"consent": …,
"provenance": …,
"values": [
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        {
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            "value": "Kalium",
            "datatype": "STRING"
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        {
            "key": "Value",
            "value": "5.2",
            "datatype": "DOUBLE"
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        {
            "key": "Unit",
            "value": "mmol/L",
            "datatype": "STRING"
        }
    ],
    [
        {
            "key": "Param",
            "value": "INR",
            "datatype": "STRING"
        },
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            "key": "Value",
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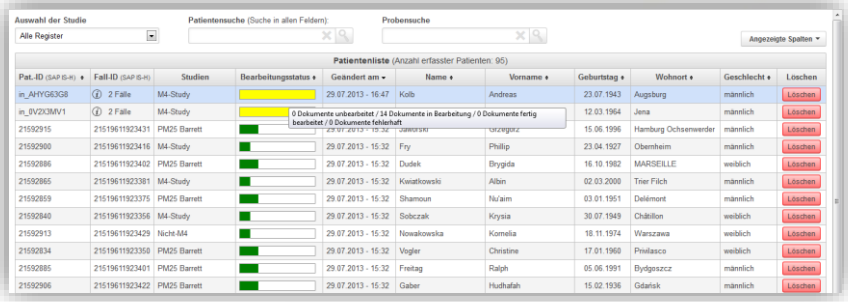
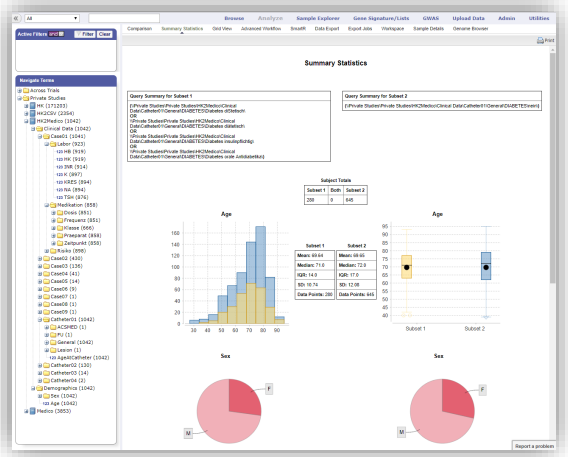
            "datatype": "DOUBLE"
        }
    ]
]
```

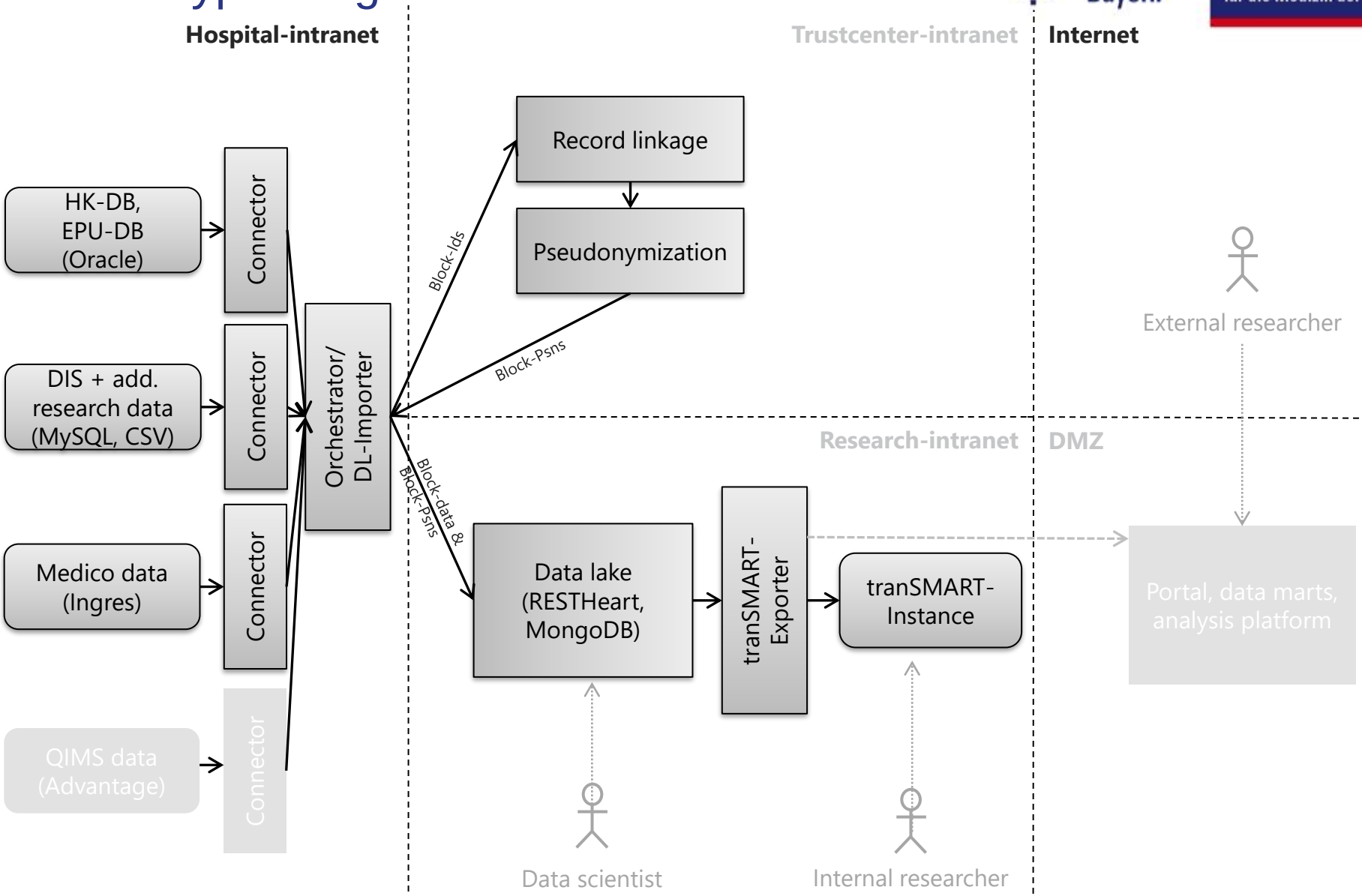
Software Solutions Used (Examples)



- **Collection**
  - DIS
- **Workflow pipelines / OMICS**
  - Galaxy
  - OpenBIS
- **Integration**
  - DIFUTURE und DigiMed Softwarelösungen
- **Analysis**
  - tranSMART
  - I2b2
  - Re-dash
  - Clinical Knowledge Graph



Prototype: Segments



Prototype: Key-Facts

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- Integration of:
  - Lab results, medication, risk factors
  - Catheter, lesions, medication, follow-up
  - Electrophysiological examination
  - Research data, genotypic metadata

- Data lake dimension:
  - Five collections (MEDICO, HK_DB, EPU_DB, DIGIMED_CSV, GWAS_CSV)
  - ~19 mio. datablocks
    - MEDICO: ~ 6.9 Mio
    - HK_DB: ~12 Mio
    - EPU_DB: ~ 285.000
    - DIGIMED_CSV: ~2.000
    - GWAS_CSV: ~9.000

- Export into tranSMART
  - Four “studies”, integrating data e.g. from HK_DB and Medico
  - Total of ~9 Mio. facts (patients: ~170.000)

Proof-of-Concept: Screenshot “Datalake Browser”

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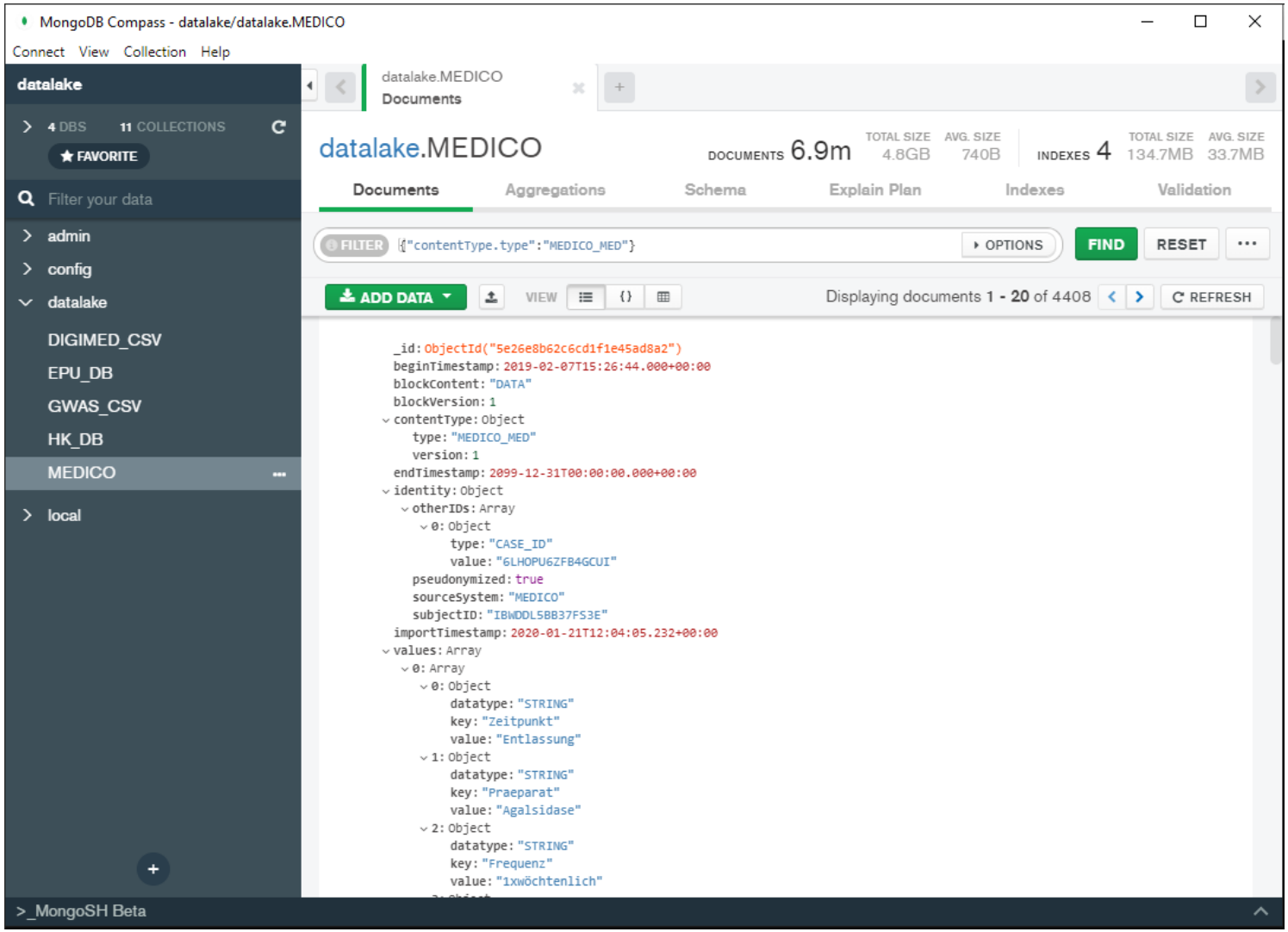

Raw medication data block (truncated)

Proof-of-Concept: Screenshot tranSMART

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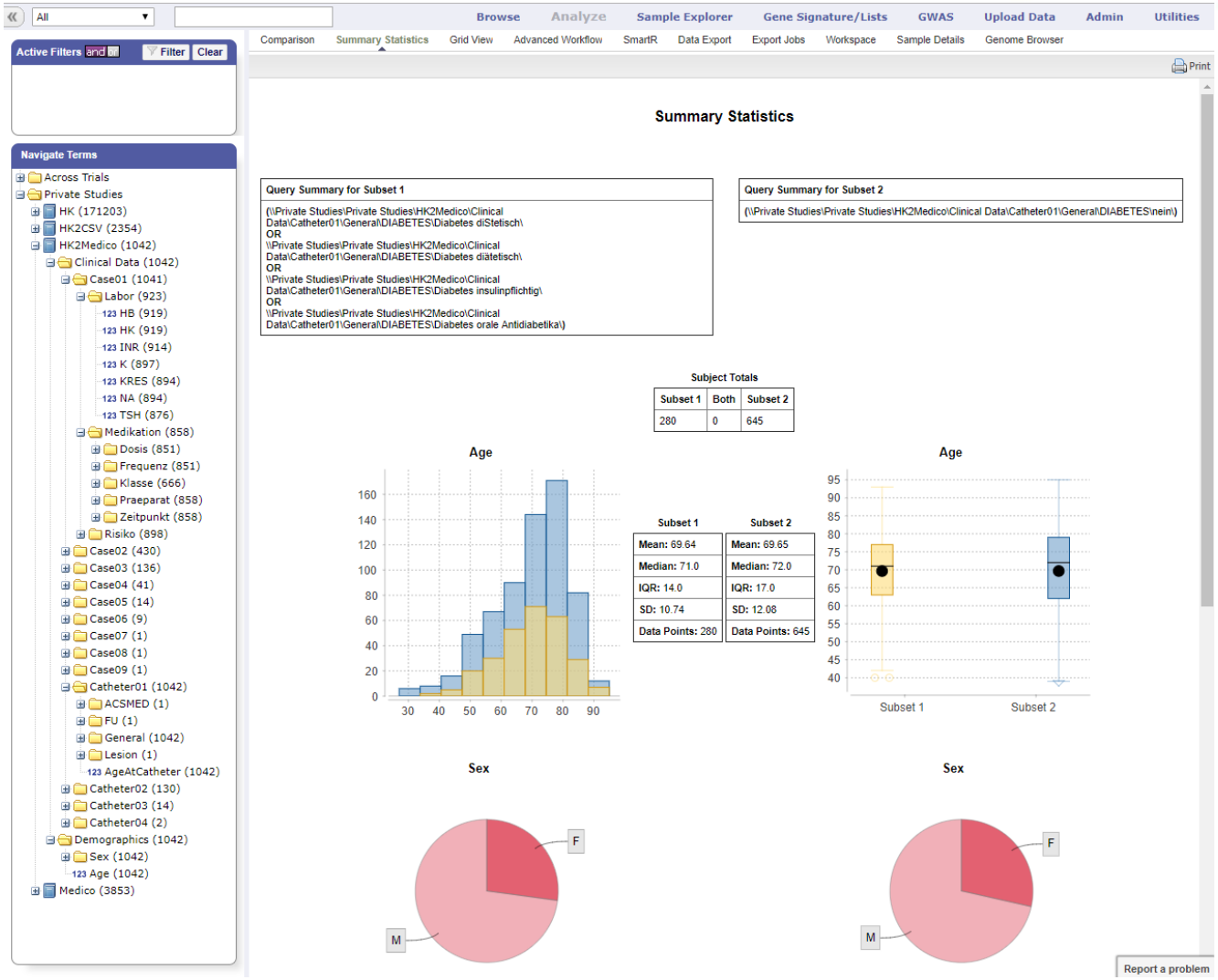

Summary statistics: diabetes vs. non-diabetes

One size fits all?

- Different process steps
  - Collection
  - Preprocessing
  - Integration
  - Analysis

- Every process step has different requirements
  - Data security and privacy
  - Storage of data and processing (OLAP vs OLTP)
  - Functionalities
  - Workflows

→ **Heterogeneous software solutions, but generic/common architecture and security and privacy concept**