Some data warehouse procedures in banking

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The issues to be presented (1)

- **In university environment, acquire a real-life SWE project with a major bank**
  - The Bank opted for outsourcing instead of hiring new staff
  - Alumni influential in the Bank
  - Addressed their Alma Mater to propose a joint project
  - Negotiated and signed a contract for consultancy and programming help in data cleansing and warehousing

The issues to be presented (2)

- **Employ high quality young professionals**
  - SWE professionals in high demand on the labour market, in spite of (permanent) crisis in Croatia
  - Employ our own “products”
  - Employ them fully on the project for the Bank and provide compensation for the departmental teaching staff

The issues to be presented (3)

- **Establish a well motivated project team in university environment**
  - Transparent management (all the data accessible to the team members)
  - Charging the Bank according to each individual's level of competence (Profiles 0 to 4) and the monthly hourly workload
  - Half of the monthly individual gross income goes to the employees' individual portfolios:
    - Modest fixed salary + generous variable bonus
    - Additional HW (Faculty property, but for individual use), conference fees, travelling costs, etc. on individual choice

The issues to be presented (4)

- **Benefits for education**
  - Existing teaching staff additionally paid for performing educational activities instead of the project staff
  - Presenting to students real-life case studies
- **Benefits for scientific research**
  - Contact with real-life professional challenges triggers the motivation for research
- **General benefit for the Faculty**
  - Additional income
  - New equipment
  - Increased relevance and image,...

The issues to be presented (5)

- **Reasons to establish s start-up company**
  - Senior (i.e. working already for 3 years) project members were receiving income comparable to full professors' salary
  - What if the Bank closes the project?
  - A company would have some market value even if that happens
  - More appropriate environment for commercialisation of knowledge

The issues to be presented (6)

- **Principles of management in the new start-up Koios Consulting**
  - The ownership was split:
    - among project members (according to their accumulated contribution to the project)
    - the project leader + 2 closest collaborators of the project leader (all 3 professors at FER)
  - The project leader waived from his relatively high proposed proportion in ownership in order to increase the employees' share
    - Increase overall motivation

The issues to be presented (7)

- **Analysis after 8 years**
  - In spite of the global crisis created in 2008, Koios has weathered until now
  - In most of the years, the profit was distributed among the owners
  - In a few years, the profit was withhold to diminish the future risk
- **Scientific contribution in the PhD thesis of a Koios employee**
  - To be discussed further on...

The principal author

Vedran Vrbanić, PhD

Thesis:

- Incorporation of ontology model into banking data warehouse system, Mentor: D. Kalpić, FER, Zagreb, 2015

- Graduated at University of Zagreb
  - Faculty of electrical engineering and computing
- Employed on the Faculty's Department of applied computing
  - Professional collaborator since 2007
  - Paid from a **consulting, data-cleansing and data warehousing** project for the Privredna banka Zagreb (Intesa Sanpaolo)
  - Project leader D. Kalpić
  - A team of up to 8 graduated engineers

The Company KOIOS

- **In 2008 a start-up company Koios Consulting was established**
- **Ceding of the contract with PBZ from FER to KOIOS**
- **Owners:**
  - Former students (86%) + professors (Kalpić, Mornar, Fertalj)
  - Slowly but steadily growing and profitable
  - In 2016 transferred to UK (to diminish paperwork, endemic in Croatia), just in the wake of Brexit ☹

Wikipedia:

- **Koios** (also known as **Coeus**) is a son of Ouranos and Gaea. He is the Titan of farsight, intellect, and knowledge, and is also the Titan Lord of the North. His Roman form is **Polus**.
- **Old Greek god of business intelligence** ☺

Thesis contributions

- How to make the programmers understand what they are doing?

➢ **Banking ontology**

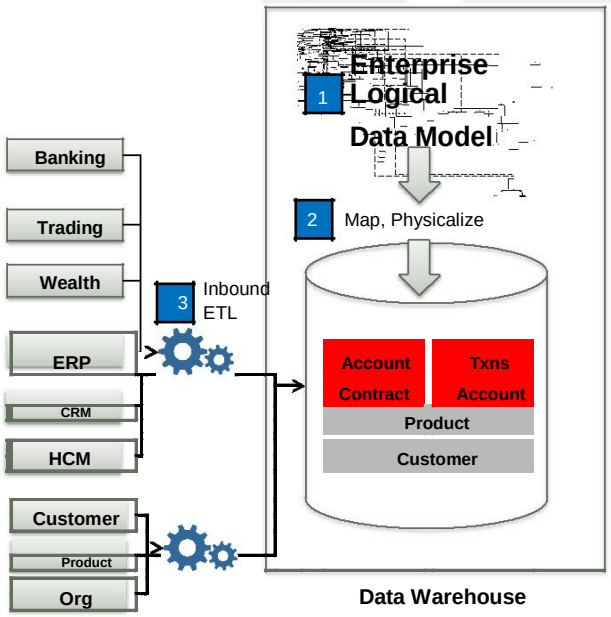
- How to schedule the ETL activities?

➢ **Priority based optimisation**

Introduction

- Data warehousing in banking
  - Large quantity of data
  - Focus on technical problems of data extraction and retrieval
  - Business rules “hidden” within the program code
  - Transparency diminished
  - High complexity
  - Problems in integration and unification
  - Obligatory reporting to regulatory authorities
  - Indispensable for decision making
  - ETL scheduling to provide timeliness
- Demystification of the business domain
- Improvement of flexibility and transparency
- Declarative approach

Introduction – How to create a unique source of facts?



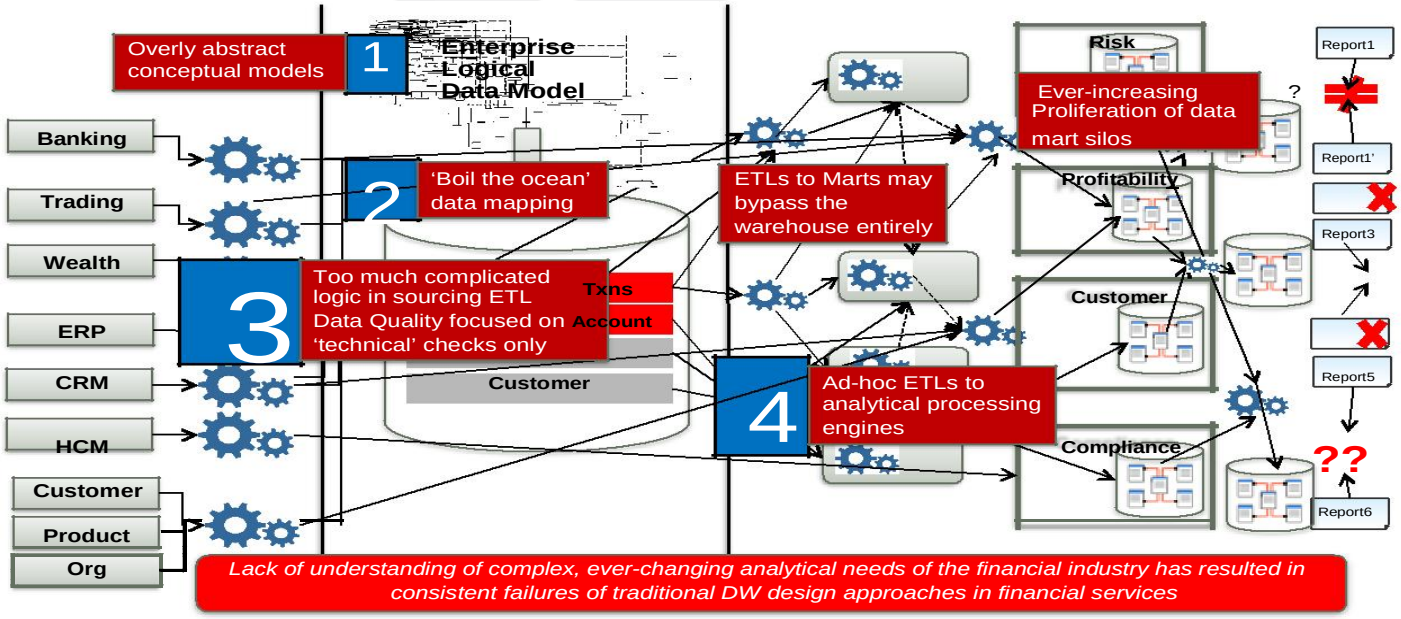
Goal: 'Single Source of Truth'

Common Approaches

- *Start with Enterprise Logical Data Model*
- *Map source data*
- *Physicalize 'selected' portions*
- *Build ETL to populate from sources*
- *Repeat process for each data source*

Source: Evolving the Data Warehouse: The Next Generation for Financial Services Institutions, An Oracle White Paper, May 2011

Introduction – Complexity



Source: Evolving the Data Warehouse: The Next Generation for Financial Services Institutions, An Oracle White Paper, May 2011

Motivation for introduction of ontology

- Regardless to
  - The level of system arrangement
  - Development methodologies
  - Technologies
  - Security policies
- Complexity of relationships among data in warehouse is unquestionable
- Idea
  - Identify the critical parts of the system, from the perspective of connectivity among different business entities
  - Model them more efficiently

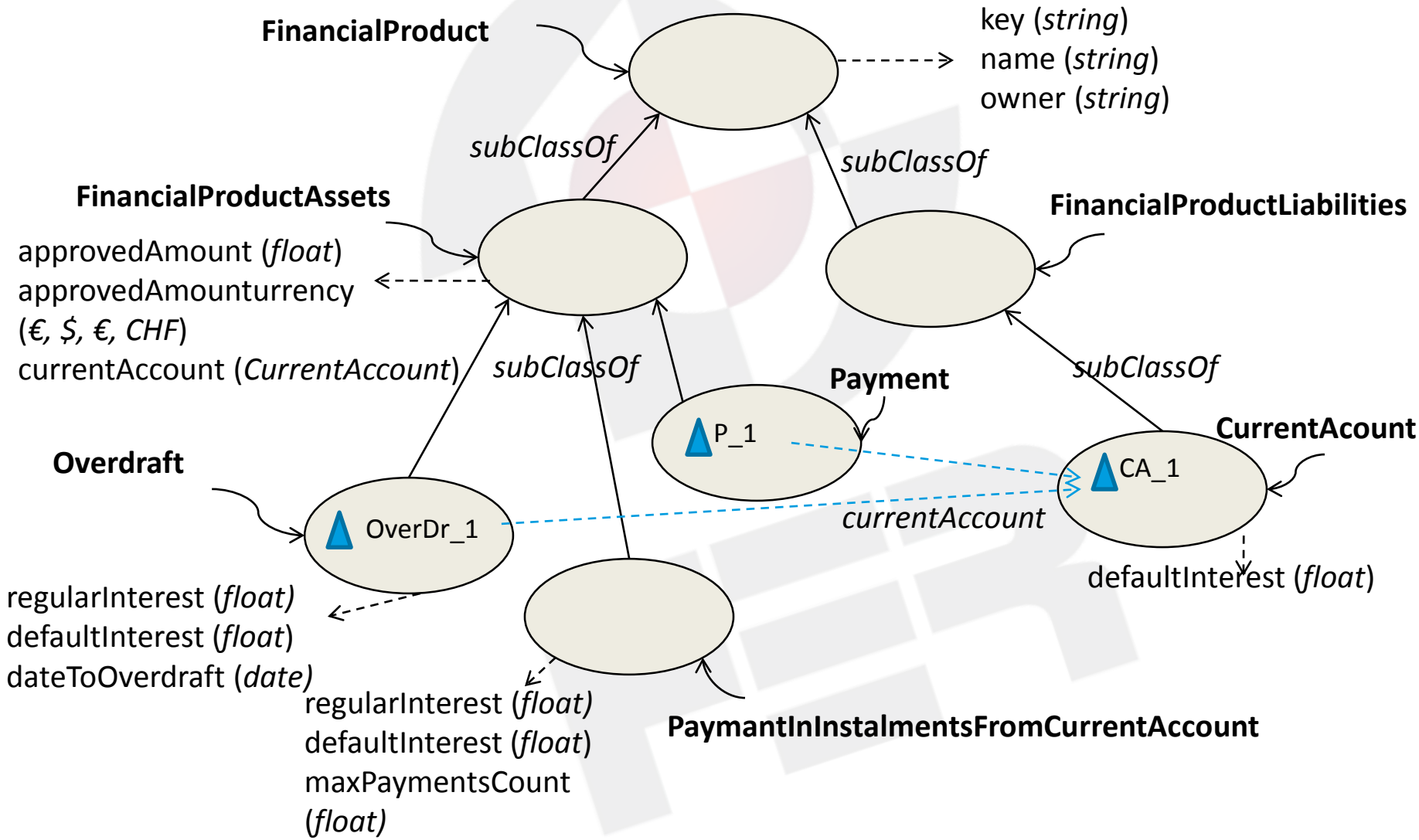
Semantic technologies

- Resource description framework (RDF)
  - Subject, predicate, object
- Resource description framework scheme (RDFS)
  - Classes, inheritance, domains, and predicate co-domains
- OWL
  - Web ontology language
- Ontology
  - Formal, explicit specification of conceptualisation
  - Set of precisely defined concepts for a framework for information exchange
  - Intrinsic problem with ontology:
    - Ambiguity, depending on the point of view

Example for ambiguity: *Food Ontology*

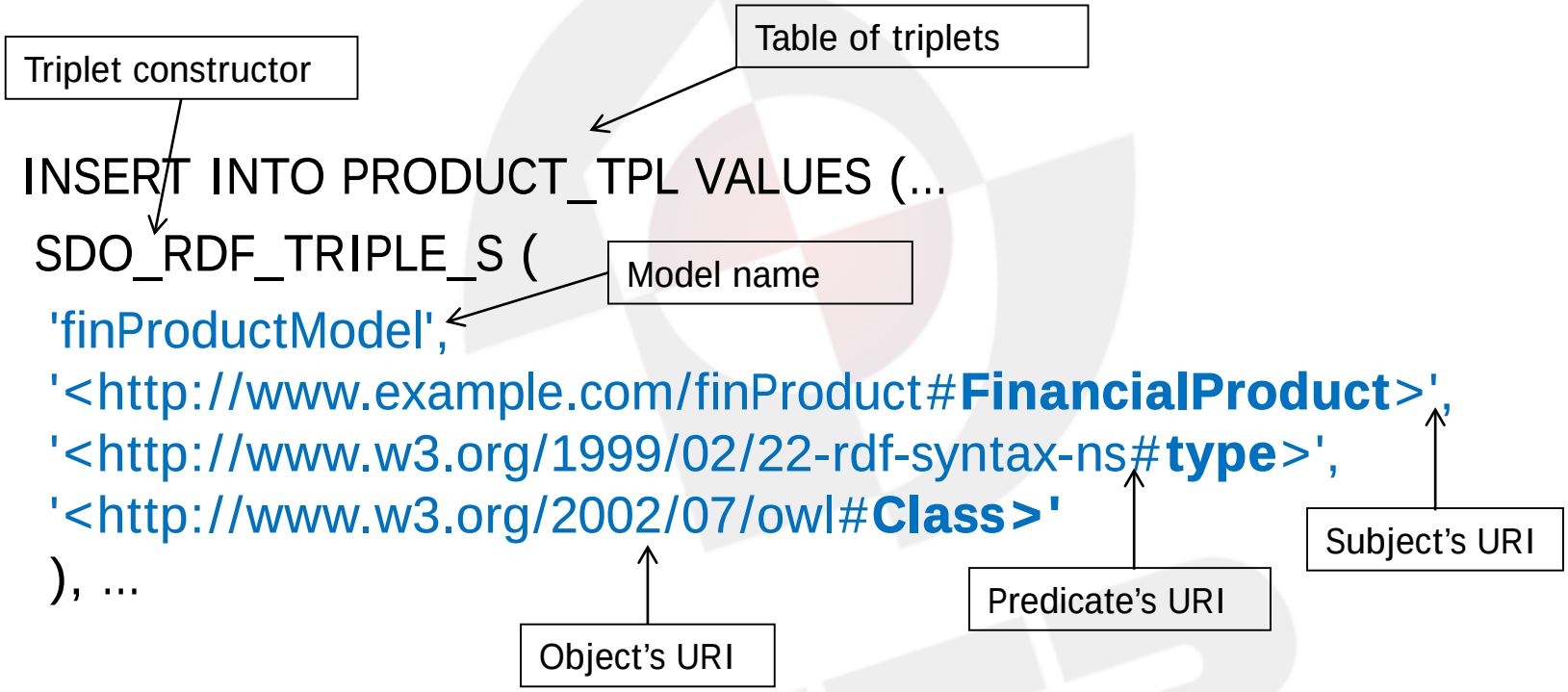
- **Gourmet's view on *recommended food*:**
- Oysters
  - Ask a Jew
- Smoked ham
  - Ask a Muslim
- Beefsteak
  - Ask a Hindu
- Hennessy Cognac and Cohiba cigar
  - Ask a sportsman
- Sacher cake
  - Ask a diabetic

Illustrative example in banking



Model coding

- Class definition



Model coding

- Inheritance

```
INSERT INTO PRODUCT_TPL VALUES (...
 SDO_RDF_TRIPLE_S (
  'finProductModel',
  '<http://www.example.com/finProduct#CurrentAccount>',
  '<http://www.w3.org/2000/01/rdf-schema#subClassOf>',
  '<http://www.example.com/finProduct#FinancialProductLiability>'
  ), ...
```

Model coding

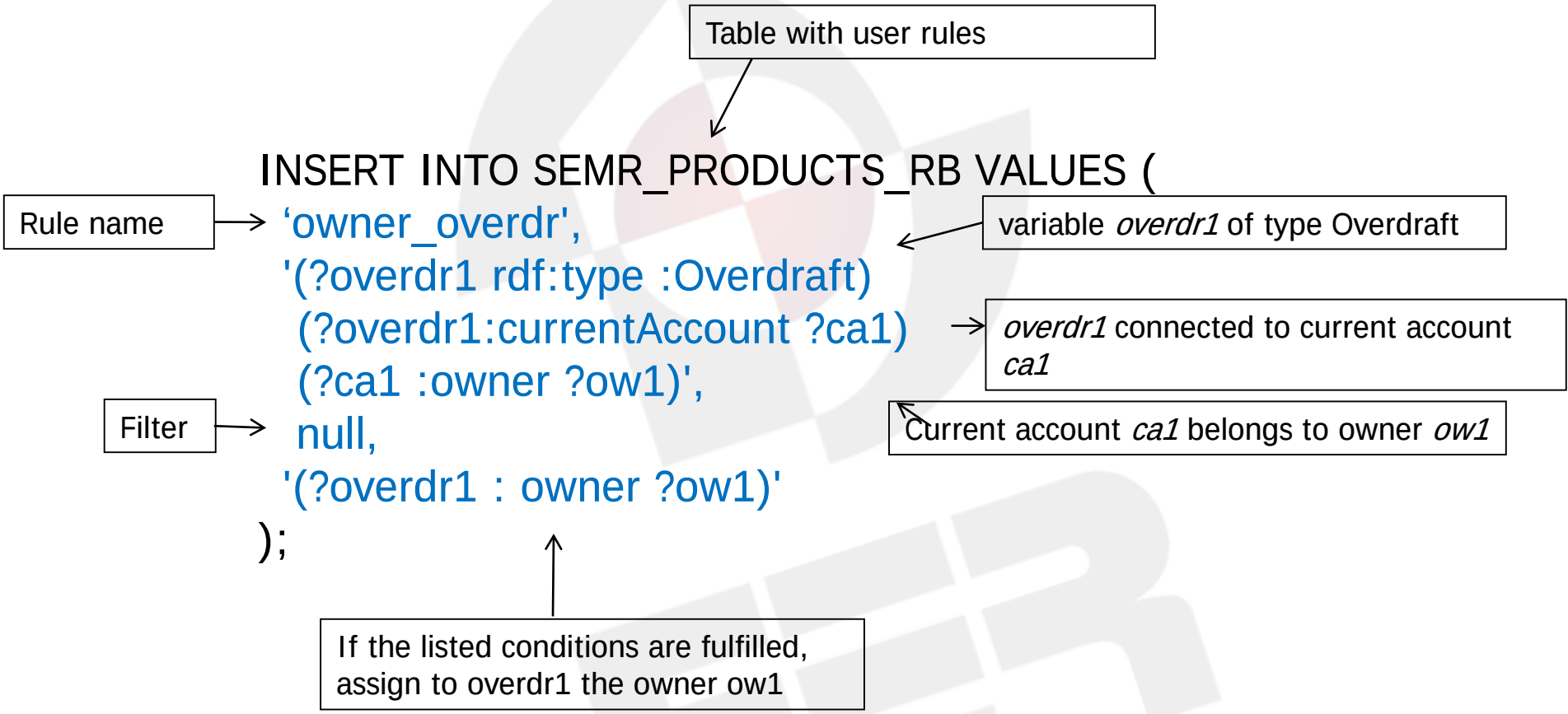
- Object's attributes

Subject	Predicate	Object
Example:currentAccount	rdf:type	owl:ObjectProperty
Example:currentAccount	rdf:type	owl:FunctionalProperty
example: currentAccount	rdfs:range	_:dummyNode
_:dummyNode	rdf:type	owl:Restriction
_:dummyNode	owl:allValuesFrom	example: CurrentAccount
example:CA_1	rdf:type	example: CurrentAccount
Example:OverDr_1	rdf:type	example:Overdraft
Example:OverDr_1	example: currentAccount	example:CA_1

SPARQL

- Query language for RDF
- Analogy to query language SQL
- Example of rules
  - If an overdraft is connected to a certain current account, the same owner is assigned to the overdraft.

Entering of business rules



Application of the defined rule

Subject	Predicate	Object
example:CA_1	rdf:type	example:CurrentAccount
example:CA_1	example:owner	John Smith
example:OverDr_1	rdf:type	example:Overdraft
example:OverDr_1	example:currentAccount	example:CA_1
example:OverDr_1	example:owner	John Smith

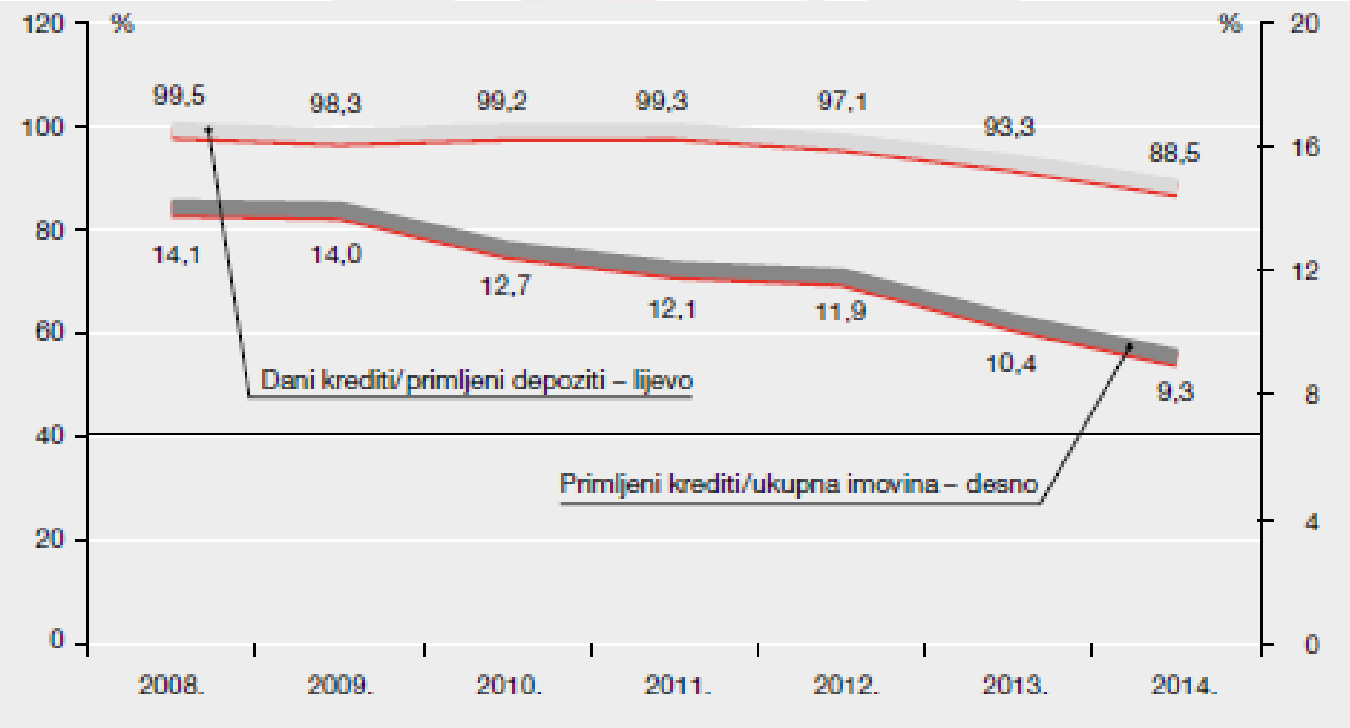
- Explicitely defined hierarchical and associative relationships

Research

- As a rule, the technology is not a problem
- Understanding of data
- Volatile system parts
  - Flexibility
  - Agility
- Ontology
  - Compulsory understanding of the topic before modelling of relationships
  - Triplets – flexibility
  - Domain description is not separated to the data dictionary
- A complex business problem – Report of maturity of assets and liabilities
  - Applicability of the described technology
  - Justification for introduction into the system
  - Into which parts of the system

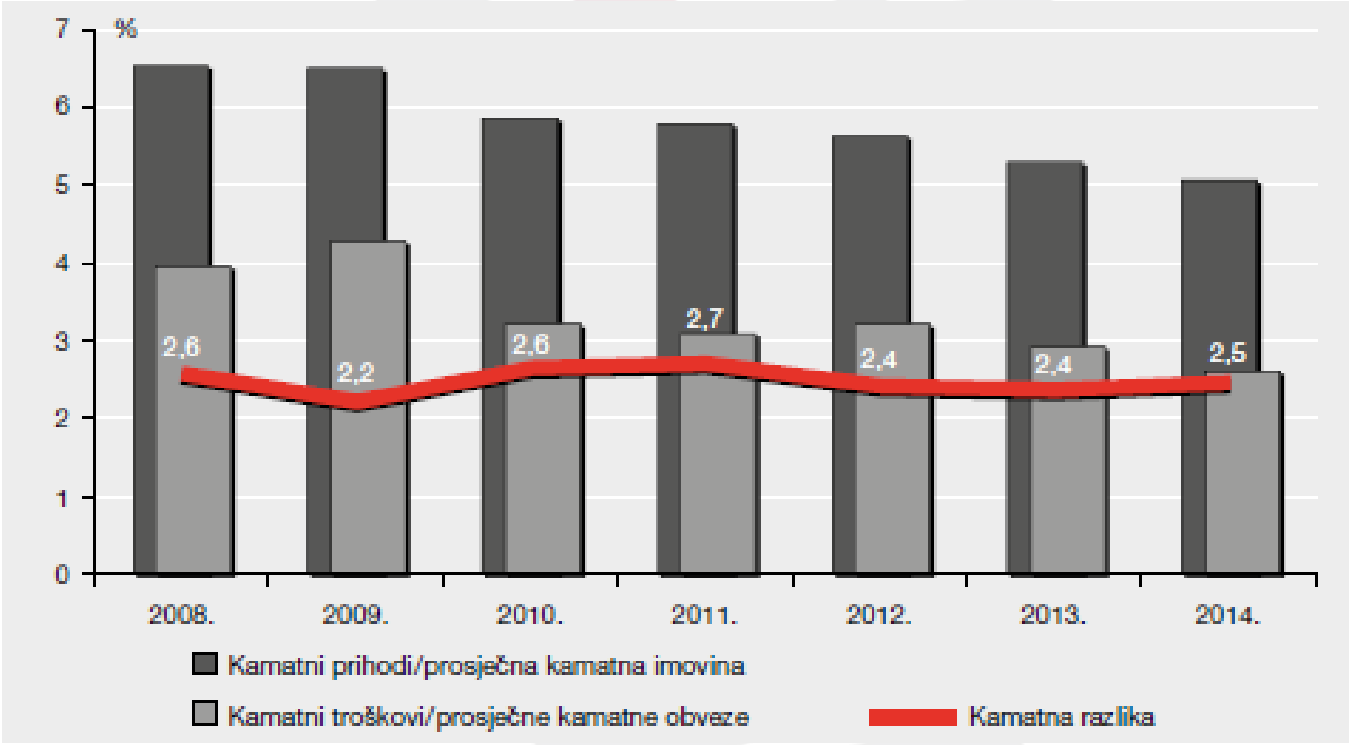
Assets and liabilities

- Collecting and placing of funds
  - Liabilities - deposits and received loans
  - Credit lines



Interest incomes and costs

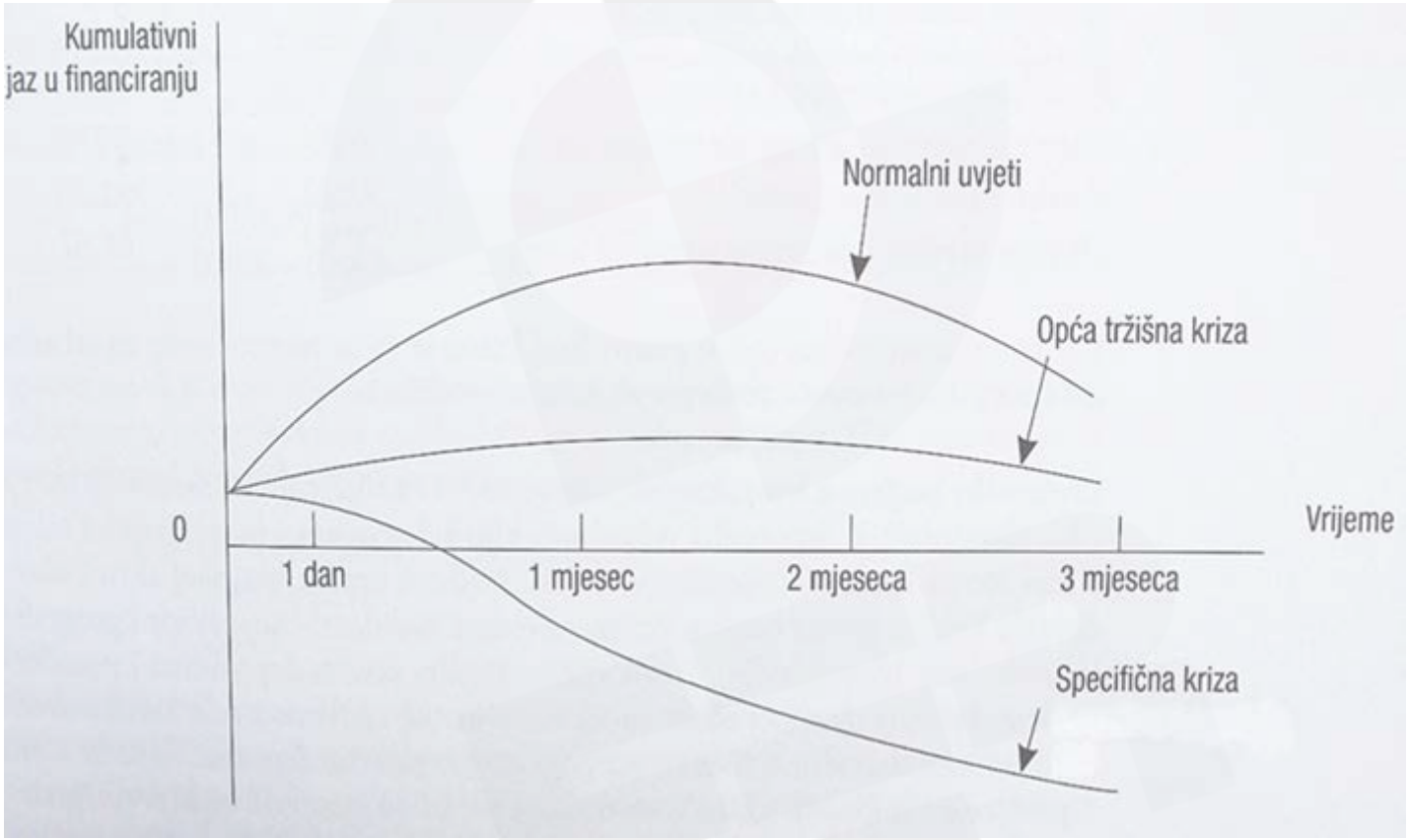
- Asymmetric forming of interest rates
  - Interest margin – about 2.5%



Maturity mismatch

- Maturity
  - Liabilities – short
  - Assets – long
  - Transformation of short term liabilities into long term assets
- Liquidity risk
  - Lack of assets within a certain perion of time
  - Market, operational and credit risks
  - Endangers the reputation
  - Overcomes single institutions

Example for projected liquidity dynamics



Analytics of residual maturity

Date	Product	Contract	Client	Account	Maturity	Amount
31.08.2016	Consumer loan	Contract 1	Client1	The principal of consumer loan maturity of up to two years	10.09.2016	630 €
31.08.2016	Consumer loan	Contract 1	Client1	Accrued interest on consumer loan	10.09.2016	58 €
31.08.2016	Consumer loan	Contract 1	Client1	Specific reserves for potential cumulative losses	01.09.2016	15 €
31.08.2016	Consumer loan	Contract 1	Client1	The principal of consumer loan maturity of up to two years	10.10.2016	625 €
31.08.2016	Consumer loan	Contract 1	Client1	Specific reserves for potential cumulative losses	01.10.2016	14 €
...	...	...	...	...	...	...
31.08.2016	Consumer loan	Contract 1	Client1	The principal of consumer loan maturity of up to two years	10.06.2017	620 €
31.08.2016	Consumer loan	Contract 1	Client1	Specific reserves for potential cumulative losses	01.06.2017	14 €
31.08.2016	Consumer loan	Contract 1	Client1	Interest income on long-term domestic currency cash loans		480 €

Business rules

- Retrieval of amount
  - BALANCE_OFF-BALANCE
  - MATURITY
  - DEBIT_CREDIT
  - PRINCIPAL_INTEREST_....
- Retrieval of products and contracts
  - N catalogues of products
  - Different granularity
- Parameterisation of accounts, products, contracts

Business rules

- Unification
  - Tens of thousands of accounts
  - Heterogeneous catalogues of products
- Regulatory reporting
  - Hundreds of amount types
  - Several hundred instrument types
- Maturity ladder
  - Manifold hierarchical and associative relationships (accounts, amount types, products, instrument types, contracts, grouped bookkeeping items, algorithm paths, ...)

Development methodologies

- Steps and methods
- Iterative development
- Definition of the business field and terms; design of classes, hierarchies, associative relationships, instances, ontology
- Five methodologies
  - Methontology
  - Methodology by Gruninger and Fox
  - Methodology by Uschold and King
  - Ordnance Survey
  - On-To-Knowledge

Construction of ontology

- Activities preceding conceptualisation
- Non-formal conceptualisation
- Formal conceptualisation

Activities preceding conceptualisation

- Motivating scenario
  - Defined by third parties (management, regulator, owners group)
  - Different levels of detail
    - General set of specifications
    - Non-formal concept descriptions
    - Possible solutions
- Competence questions
  - Which articles enter into the computation of the maturity ladder?
  - Which accounts create the bank's liabilities?
  - Which amount types and instrument types form the bank's claims?
  - Into which time intervals the analytical bank data should be aggregated?
  - What interest amount matures for payment within a week?
  - How many clients are dealing only with liability products?
  - What is the liquidity coefficient on date 31.12.2015?

Formal conceptualisation

- Coding of dictionary and relationships into a formal language
- On-To-Knowledge
  - Middle-out approach
- Database Oracle 12c
  - Supports OWL
- The same instance
  - Ontology
  - Fact and dimension tables
  - Retrieval from both modules within the same query

Dimensional model

- Size
  - Clients dimension – millions of rows
  - Contracts dimension – 5 million rows
  - Statuses fact table – 50 million rows monthly
  - Accounts dimension – 30 thousand rows
  - Destination table of accrued maturity – 100 million rows daily
- Optimisation
  - Partitioning of tables
  - Different merging techniques
  - Decomposing of queries into smaller units
  - Optimisation of ETL procedures scheduling
    - Assignment and scheduling of *n* jobs to *m* processors
      - Flow shop problem of considerable size
    - Non-standard goal function
      - Application of genetic algorithm

Application of the genetic algorithm

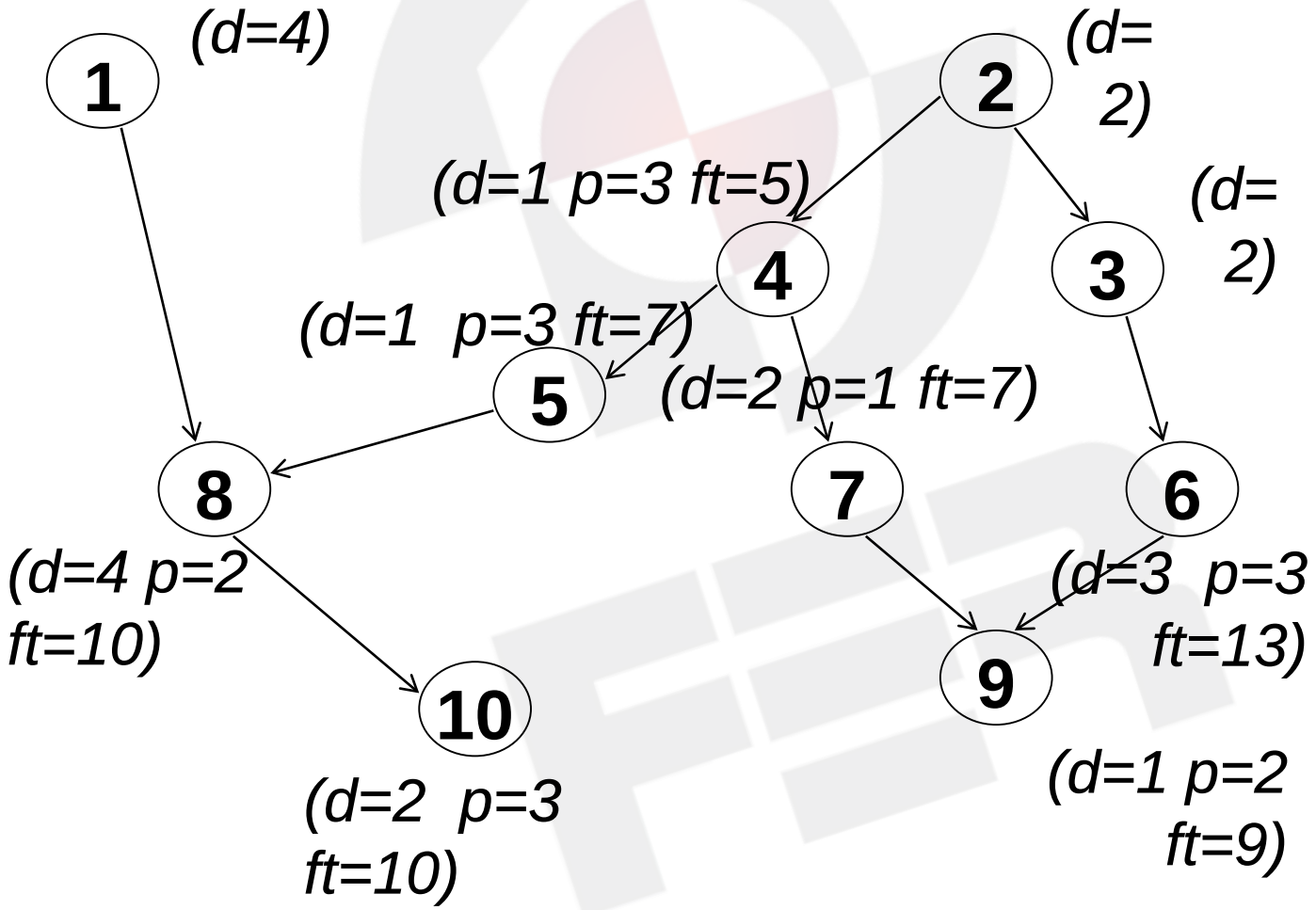
- What is the objective function?
  - Minimum all-over processing time?
  - MiniMax – Minimisation of the longest procedure?
- The objective is to provide maximum reliability for timely indispensable reports to
  - regulatory authorities
  - operational services
- Incomparable in importance to other in-house requirements

Priorities

Priority	Weighting Factor	Description
1	∞	Regulatory authorities; Operational service provisions
2	10	Data used for trend analysis across departments
3	1	Other data

Scheduling of Extract, Transform, and Load (ETL) Procedures

Procedures graph (d is Duration, p is Priority, ft is Required completion time)
Default $ft_i = \infty$ (cannot be delayed; omitted from the fitness calculation)



Conclusion

- Ontology integration into data warehouse
  - increase clarity
  - simplify the programmers' job
- Optimisation of ETL scheduling
  - increase the timeliness of reporting

Reference list reduced to authors' publications

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