Zawansowane Modelowanie i Analiza Systemów Informatycznych

(wykład 1)

Polsko-Japońska Wyższa Szkoła Technik Komputerowych
Katedra Systemów Informacyjnych
2013

Welcome to
Advanced Modeling and Analysis of Information Systems

Lecturer

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Reguły zaliczania przedmiotu w 2013

- **Zwolnienia z egzaminu na życzenie studenta od oceny 4,0 za projekt;**
- **Osoby, które dostały 2,0 z projektu nie zaliczają ćwiczeń i nie maja prawa pisać egzaminu;**
- **Osoby, które dostały 3,0 lub 3,5 mogą pisać egzamin w terminie podstawowym (06-02-2013) i, w razie potrzeby, w terminie poprawkowym (13-02-2013).**

We will cover

- **Introduction**
  - Administrative issues
  - Hints how to study this course

- **Introduction to Advanced Modeling and Analysis of Information Systems**
  - Motivation
  - Historical perspective

- **Overview Topics and Modules**

Lectures

- **5 lecture sessions;**

17:00 – 20:00

- **Lecture will be delivered using PowerPointXP presentation**
- **Lecture Notes will be available online**

mdrabik/ZMA on the school's FTP

  - view as HTML, Download as PPT
  - print out <u>will not be</u> produced and distributed

- ZMA – final assessment **-** Project at the end of the semester, submission date: 26/01/2013
- **Exam - 06-02-2013, a potem poprawkowy 13-02-2013.**

Text

- **1) Terry Halpin, Information Modeling and Relational Databases, Morgan Kaufmann Publishers, 2001,**
- **2) Wil van der Aalst and Kees van Hee, Workflow Management – Models, Methods and Systems, The MIT Press, 2004**

Recommended Additional Readings:

http://www.orm.net/

http://www.tonymarston.net/php-mysql/workflow.html

Course Objectives

- **To provide a deep understanding of the issues involved in advanced modeling of data and processes.**

- **Equip the students with advanced conceptual and practical knowledge in (Object-Role Modeling) for data modeling and specification, also process modeling techniques and languages used for this purpose.**

- **To provide an advanced assessment of Model Driven Architecture (MDA) and existing international standards governing the specification unification. (Optional)**

Course Schedule 2012

Data	Sesja	Treść	Uwagi
		Admin, Introduction, Motivation, Plan	
14/01/13	1	Conceptual schema representation Some examples to illustrate the principles of ORM sentence construction Steps 1-4 of CSDP	
		Steps 4-6 of CSDP	
15/01/13	2	Step 6: Add value, set comparison and subtyping constraints (cont) Step 7; final checks	
		Some observations on schema transformations	
16/01/13	3	Transformation of ORM schema to the RDB	
		UML vs ORM (on overview of comparison)	
17/01/13	4	Workflows solutions, motivation	
		Process Modeling and verification	
18/01/13	5	Process evolution and hard problems in BMP Introduction to Model Driven Architecture (MDA) • Concepts • Overview of Current Work • Promises and Challenges	

Modules

- **Module 1 – Data Modeling**
- **Module 2 – Process Modeling - Workflows Technology**
- **Module 3 – Model Driven Architecture (optional)**

Module 1 – Data Modeling

- **Understanding of the role of data modeling,**
- **Identify, recognize and get practical skills in different languages and their suitability (pros and cons),**
- **Understanding of the role of abstraction, generalisation and specialisation,**

Module 2 – Process Modeling (Workflows Technology)

- **Understanding of typical functionality of workflow systems,**
- **Ability to reason about different specifications BPs – types of languages,**
- **Basic skills in designing process specification,**
- **Ability to reason about specification's versification issues,**
- **Basic knowledge of international standards in BPM area,**
- **Understanding of scientific workflows**

Expected Outcome

- **Module 3 – Model Driven Architecture (MDA)**

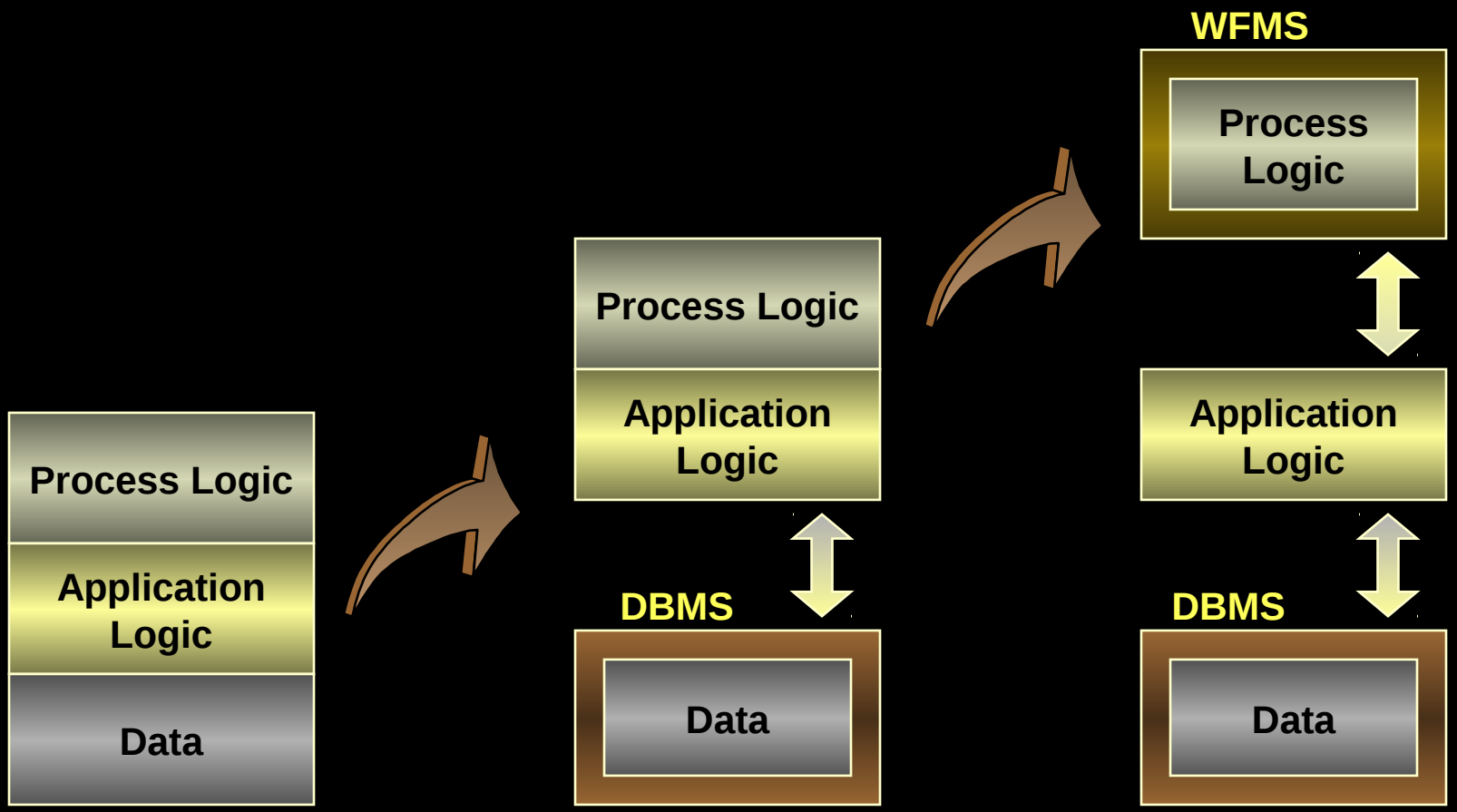
- **Understanding of principles of ‘MDA’,**
- **Knowledge of existing international standards governing the specification unification,**
- **Ability to reason about complexity of such systems and their practical applicability,**

Background Requirements

Assumed background and knowledge - courses offered by PJWSTK:

- **Projektowanie Systemów Informacyjnych (PRI)**
- **Modelowanie i Analiza Systemów Informatycznych (MAS)**
- **Relacyjne Bazy Danych (RDB)**

Key motivation - Separation of Data and Process Logic in Software Engineering



Module 1
Data Modeling

- Introduction
- Practical needs for data modeling
- Historical prespective – very briefly
- Object Role Modeling methodology (ORM)

Introduction - The aim

- **This module offers a general introduction to data modeling, its role and practical skills in data analysis, modeling and mappings to ralational and other data types..**

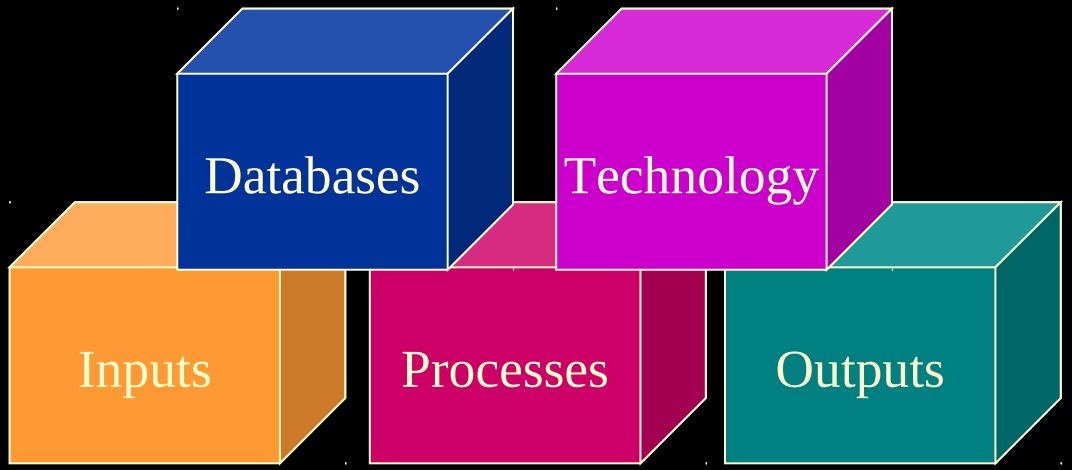
- **The aim is to provide the background to the basic principles and architectures of information sharing systems, to understand and realize importance of the ‘good’ practise – modeling first before any implementation.**

Introduction

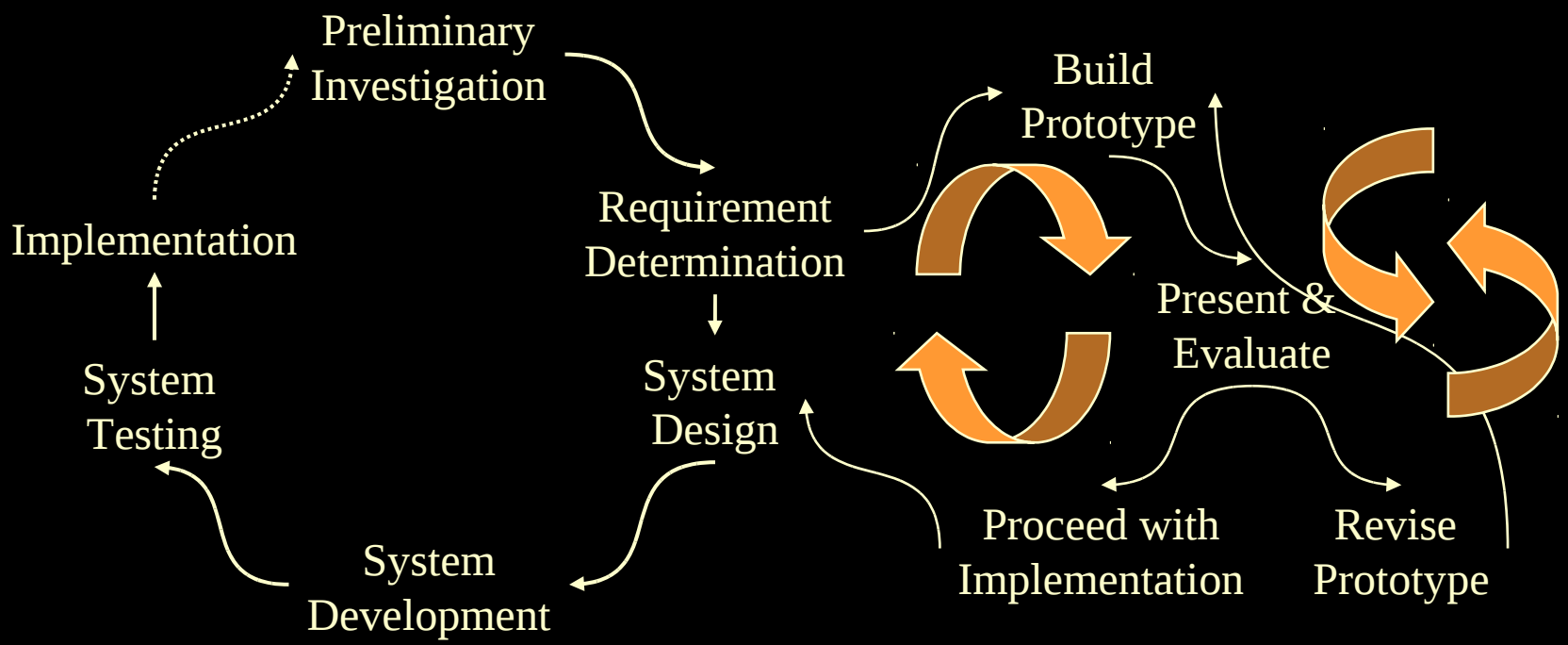
Information Systems

- **IS manages the key resource of business systems**

  - Typical building blocks

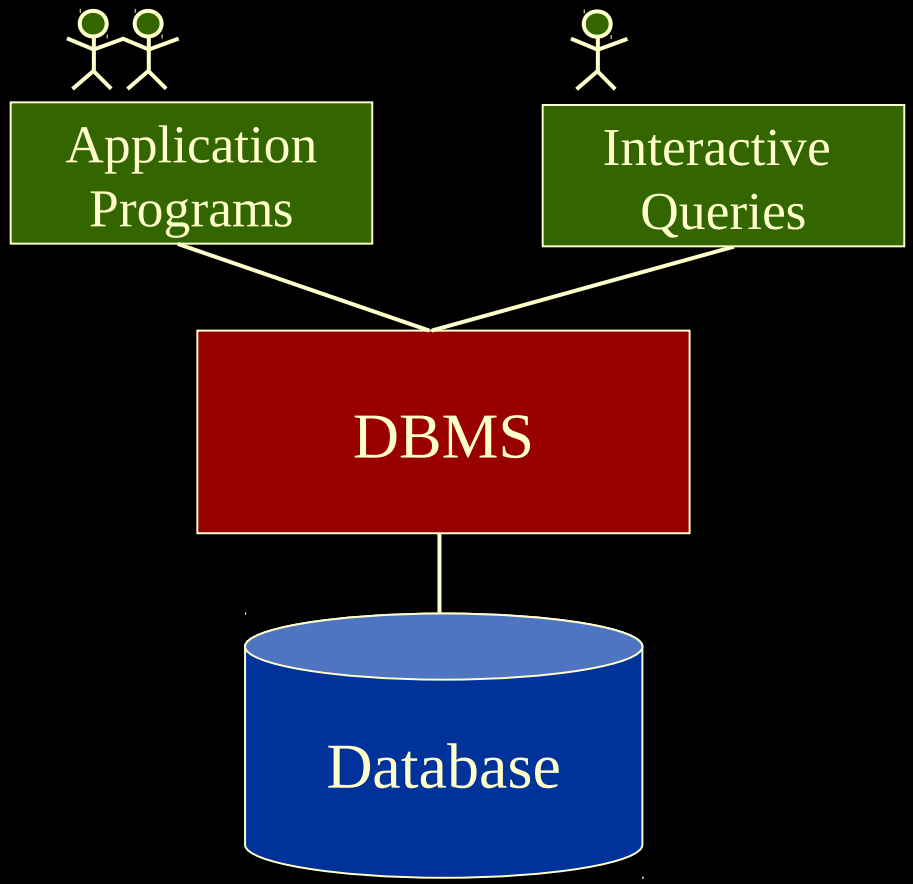


Information Systems Development



Iterative Prototyping

A Database System



Database Systems Technology

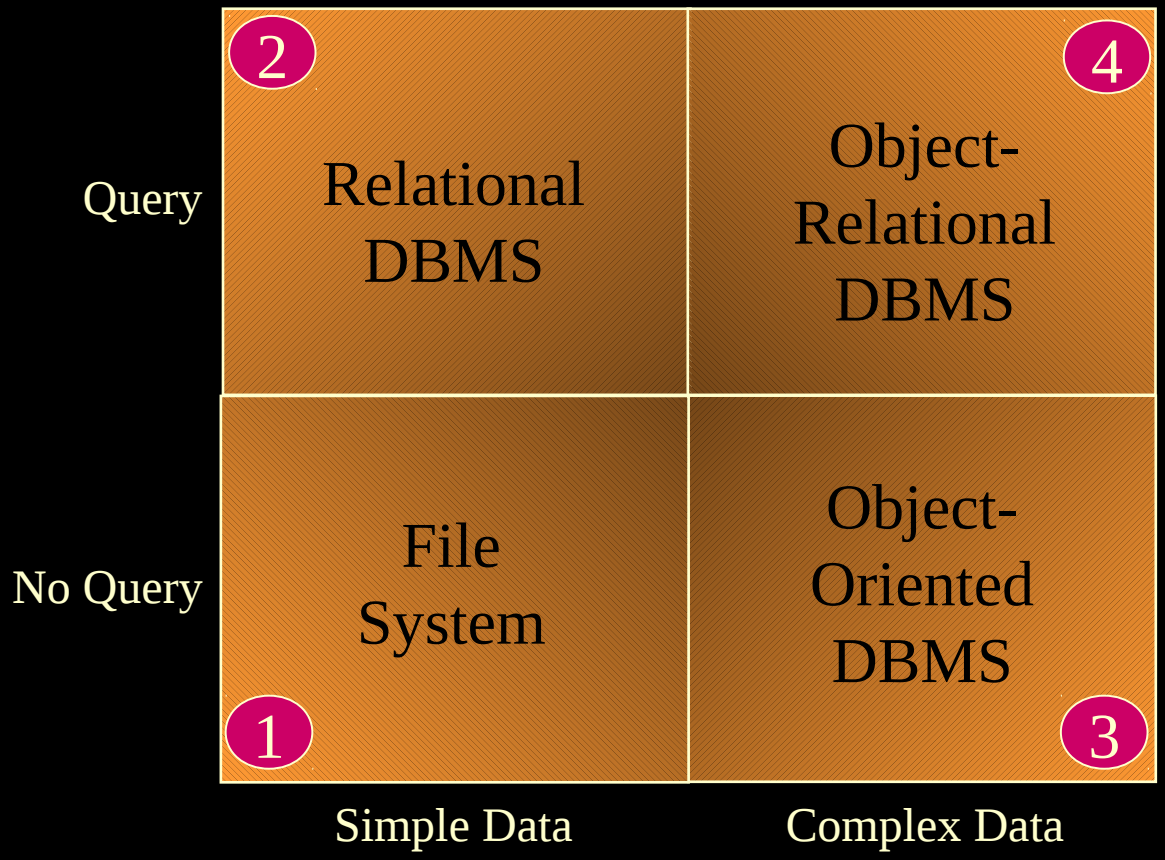
- **Historical Perspective**
- **Data Model Perspective**
- **Architectural Perspective**

Historical Perspective

- **Generation 1: File Systems (1960s)**
- **Generation 2: Hierarchical Database Systems (1970s)**
- **Generation 3: CODASYL Database Systems (1975)**
- **Generation 4: Relational Database Systems (1980) (System R)**
- **Generation 5: Beyond business data processing(1990)**

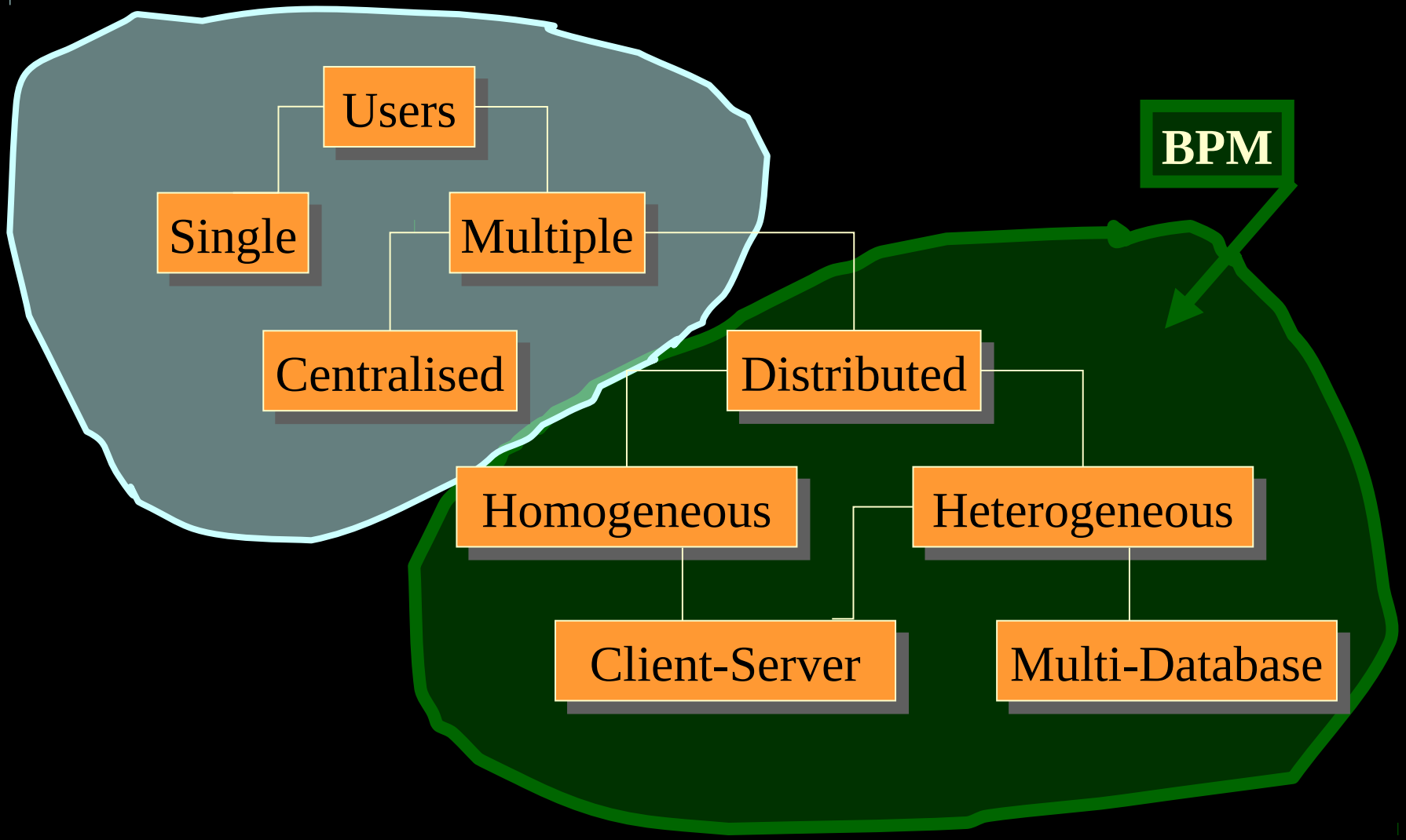
Regardless of data types adopted – data modeling reminds the big problem

Data Model Perspective



The DBMS Classification Matrix

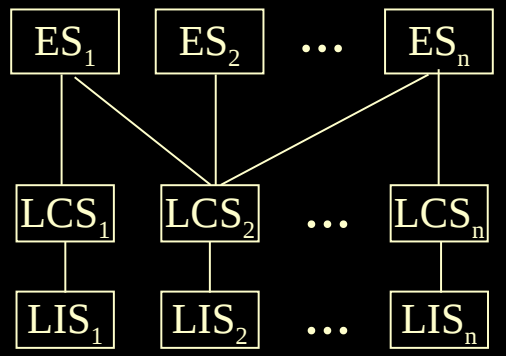
Architectural Perspective



Integrated Systems - Multi-databases

- **Designed bottom-up**
- **Fully autonomous, heterogeneous local systems**
- **No global schema**
- **Local systems have no concept of entering into a federation**

- **MDBMS: A system that manages multi-databases without a global schema**
  - Only prototypes exist
- **Need to establish a *common interface* ...**



Interoperability

- **Interoperability**

  Ability of an application to access multiple distinct systems

- **Interoperable Systems**

  Beyond database interoperability …

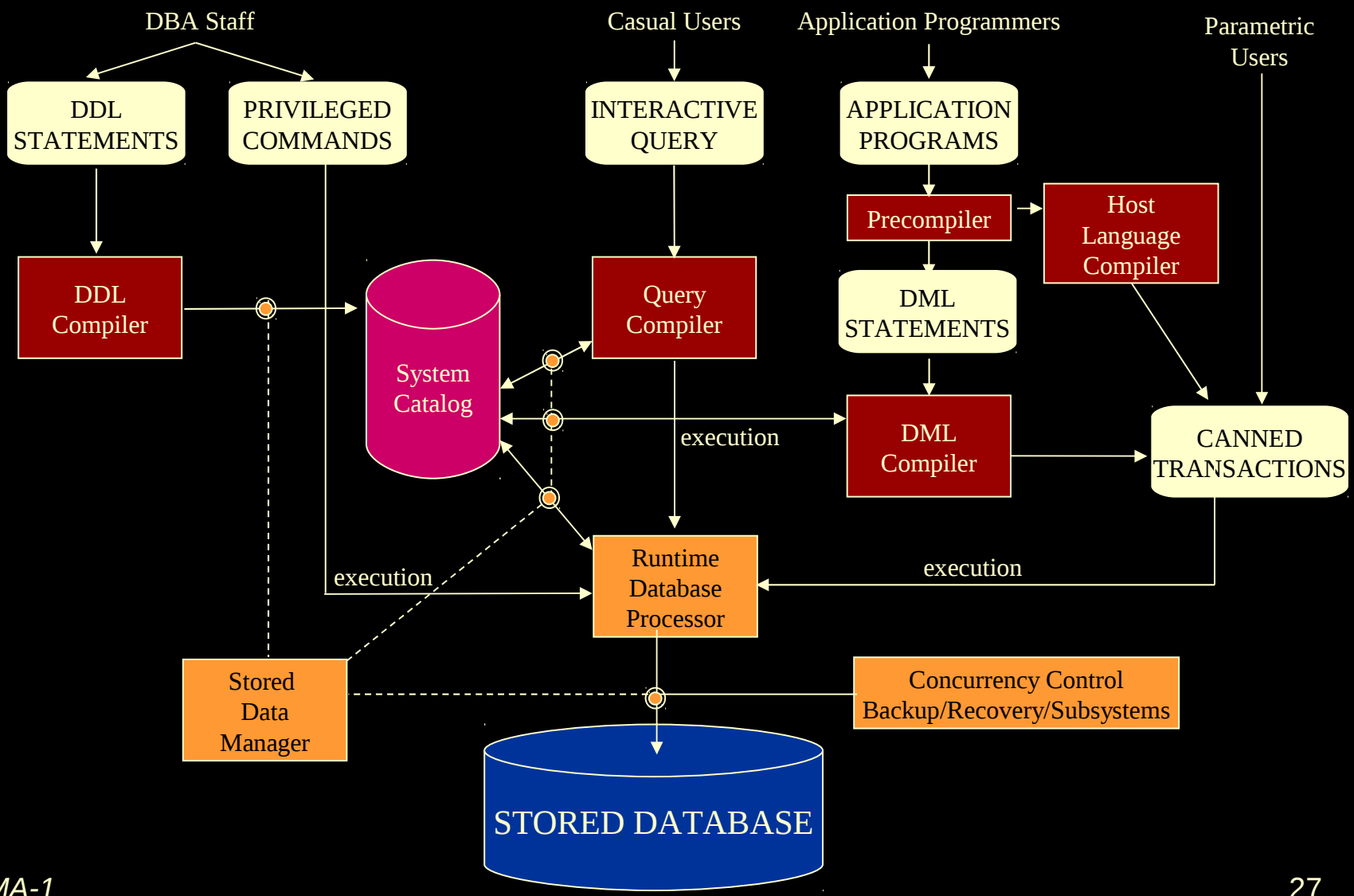
  – Exchange messages and requests

  – Receive services and operate as a unit in solving a common goal

DBMS Capabilities and Services

- **Data storage, retrieval and update**
- **A user accessible catalog**
- **Transaction support**
- **Concurrency control services**
- **Recovery services**
- **Authorization services**
- **Data integrity check services**
- **Support for data communication**
- **Utility services**

DBMS Component Modules



Data Modeling Historical Perspective

- **Over 40 years efforts in establishing acceptable, powerful modelling concepts,**
- **For data:**
  - ER (P. Chen 1976)
  - NIAM (E. Falkenberg, G. M. Nijsen, 1976-1977)
  - ORM (T.Halpin, 1980 – 2008)
  - UML (Grady Booch, James Rumbaugh, Ivar Jacobson, in 1990-2000)

Young and Kent (1958)

"Abstract Formulation of Data Processing Problems"

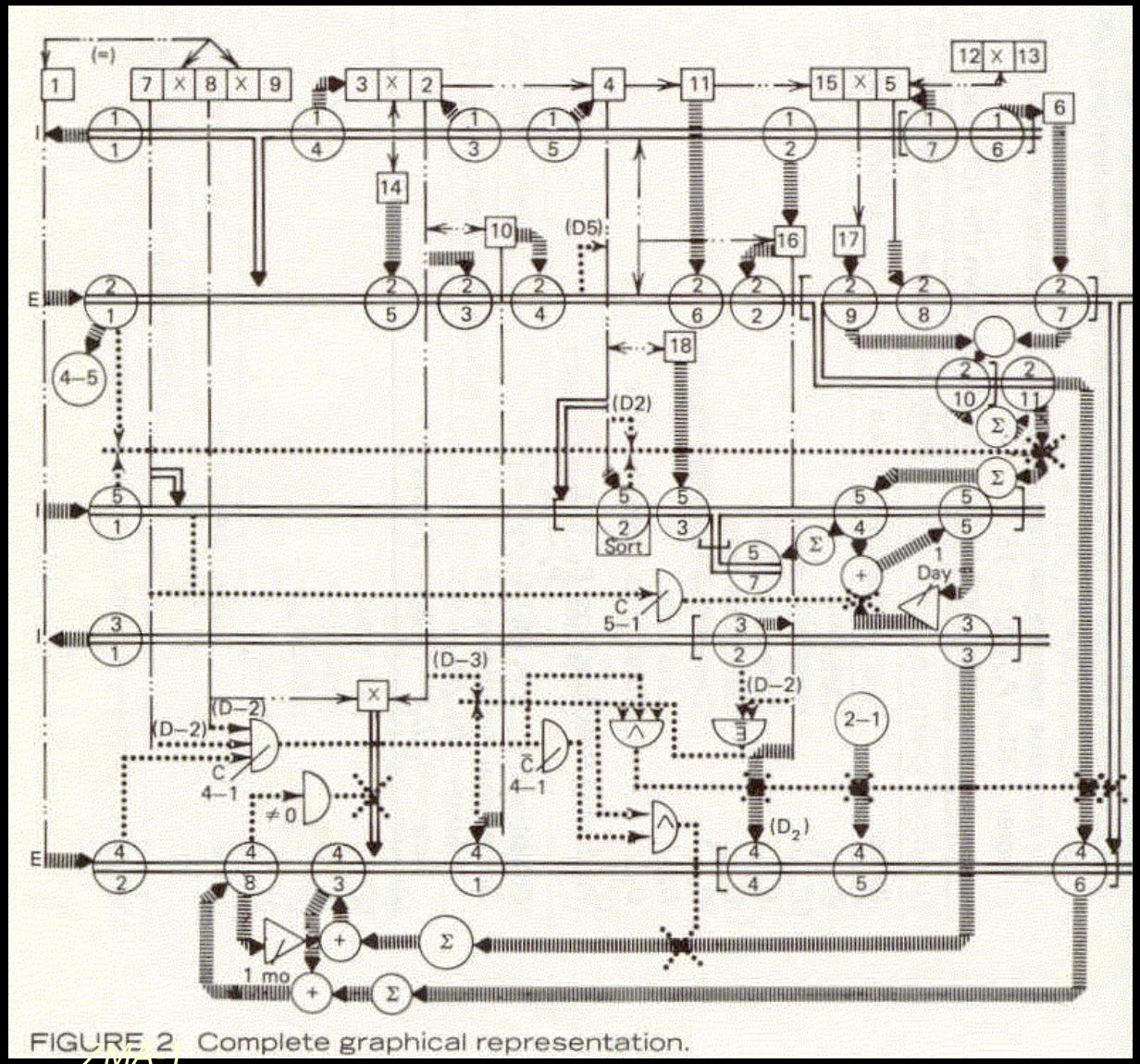


FIGURE 2 Complete graphical representation.

- Information set/item
- Defining relationship
- Producing relationship
- Conditions
- Temporal aspects

Why the need for an abstract formalism?

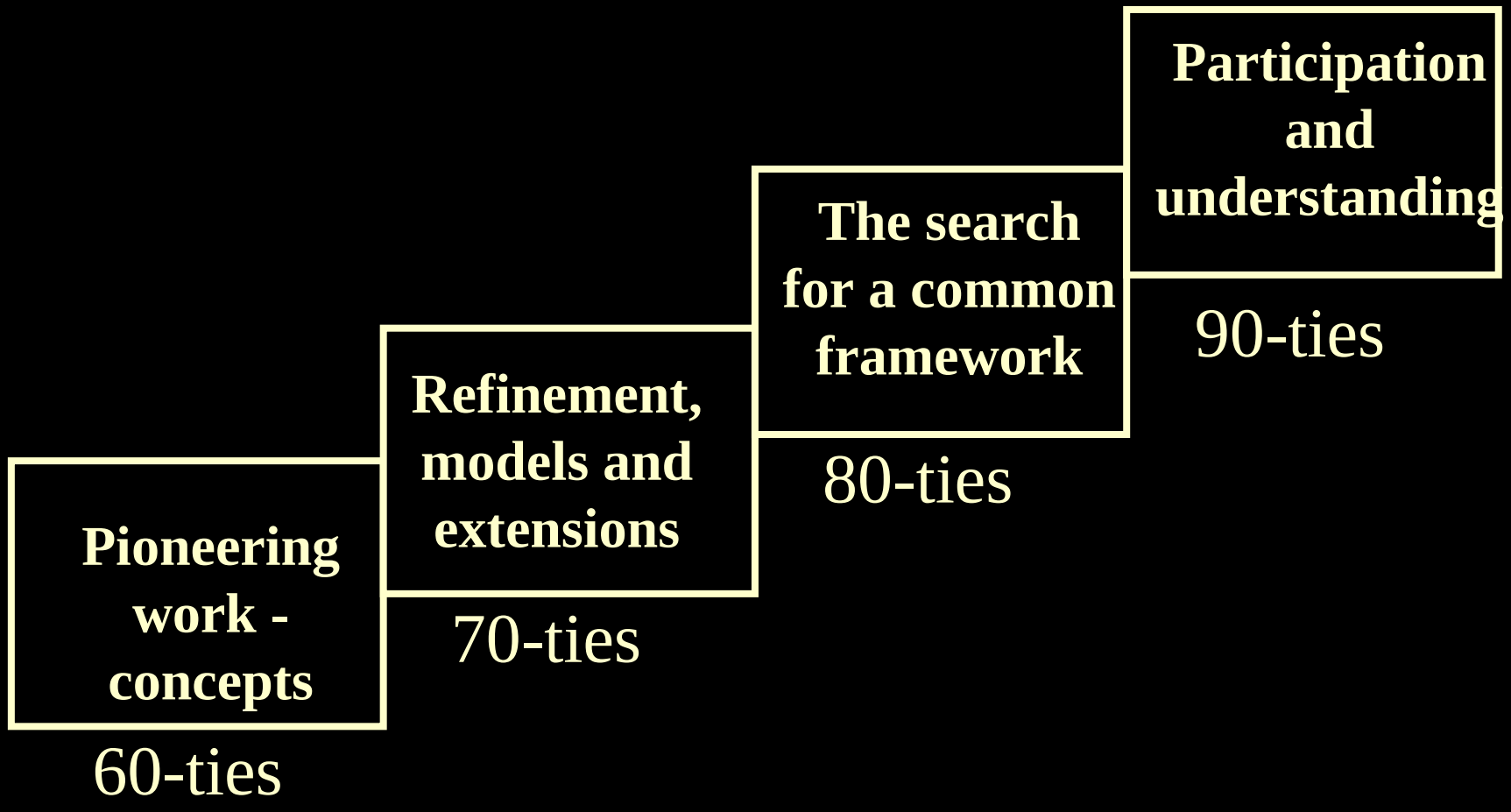
- **Since we may be called upon to evaluate different computers or to find alternative ways of organizing current systems it is necessary to have some means of precisely stating a data processing problem independentaly of mechanization *).**

*) Young and Kent, Journal of Industrial Engineering, Nov. – Dec. 1958, pp. 471-479

Why Conceptual Modelling in Information Systems work

- **to contribute to the acquisition and description of knowledge needed in the development and maintenance of information and software systems which will become, or are, active components of real world infrastructures.**

Modelling during four decades



Pioneers in IS modelling: 1959-70

Young and Kent 1959

CODASYL: Information Algebra 1963

"The Scandinavian School"
Langefors 1965:
Theoretical Analysis of Inf.Systems

USA: D Teichroew, J. Nunamaker: PSL/PSA and optimisation of Information Processing Systems

Information Algebra, basic concepts

- **Entity (e)**
- **Property (q)**
- **Property value (v)**
- **Property value set (V)**
- **Coordinate set (Q) e.g. Q = (q1, q2, q3)**
- **Property space (P) of a coordinate set (Q) e.g. P=V1 x V2 x V3**
- **Datum point of P: d = (a1, a2, a3)**
- **Line, Area, Glump, ….**

Every entity has exactly one datum point in a property space.

A discriminatory property space for a set of entities no datum point represents more than one entity.

The Scandinavian School: Langefors

* the infological and the datalogical realms

* the “elementary message”

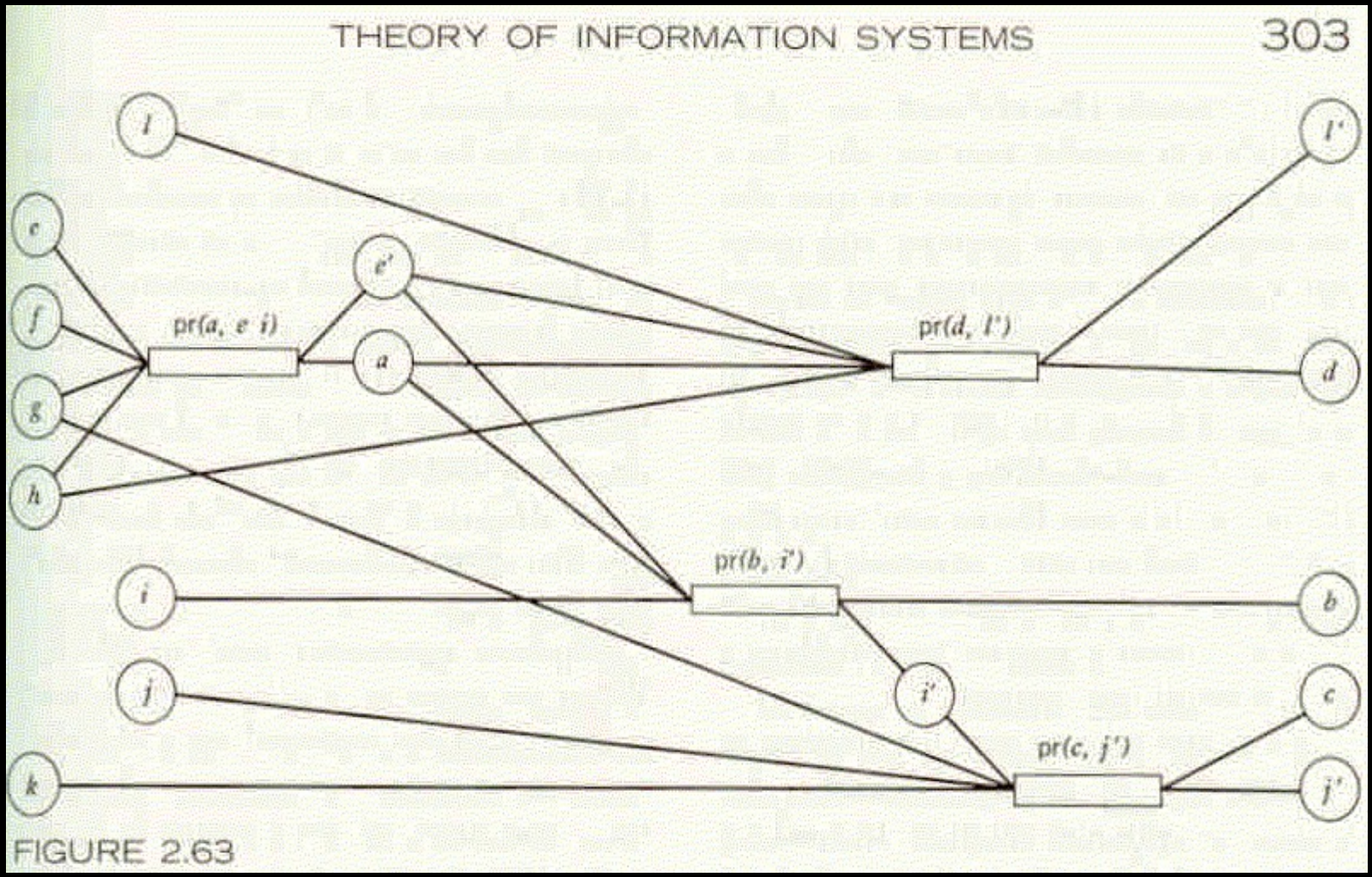
* the “elementary file”

e = <s, a, v, t>

s	system point
a	attribute
v	value
t	time

Langefors, 1963

Langefors 1966



Langefors 1966 (cont)

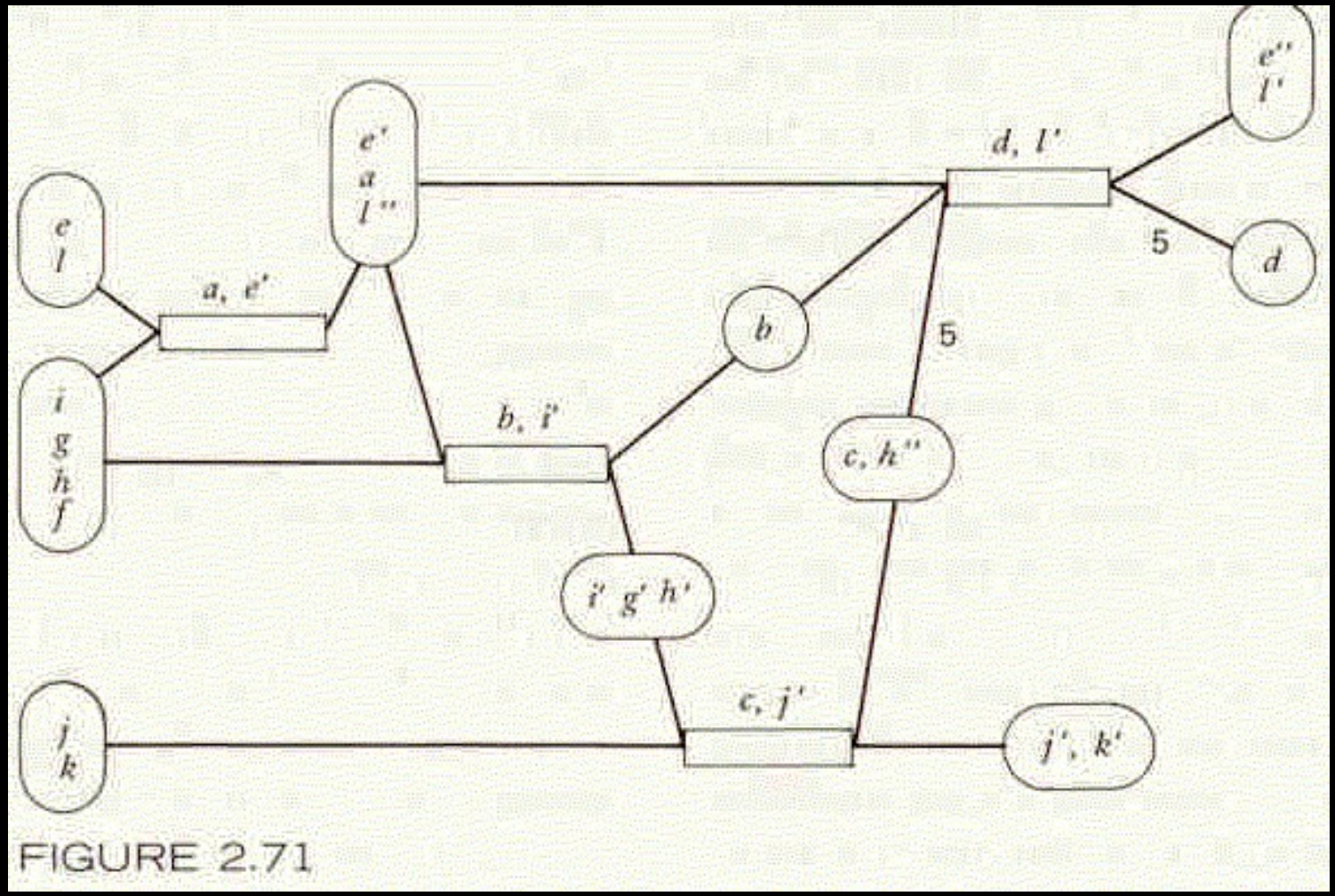


FIGURE 2.71

THE PERIOD: 1970-80
”REFINEMENT AND EXTENSIONS"

- **The 1975 ANSI/X3/SPARC (Standards Planning and Requirements Committee) report: the three schema approach**

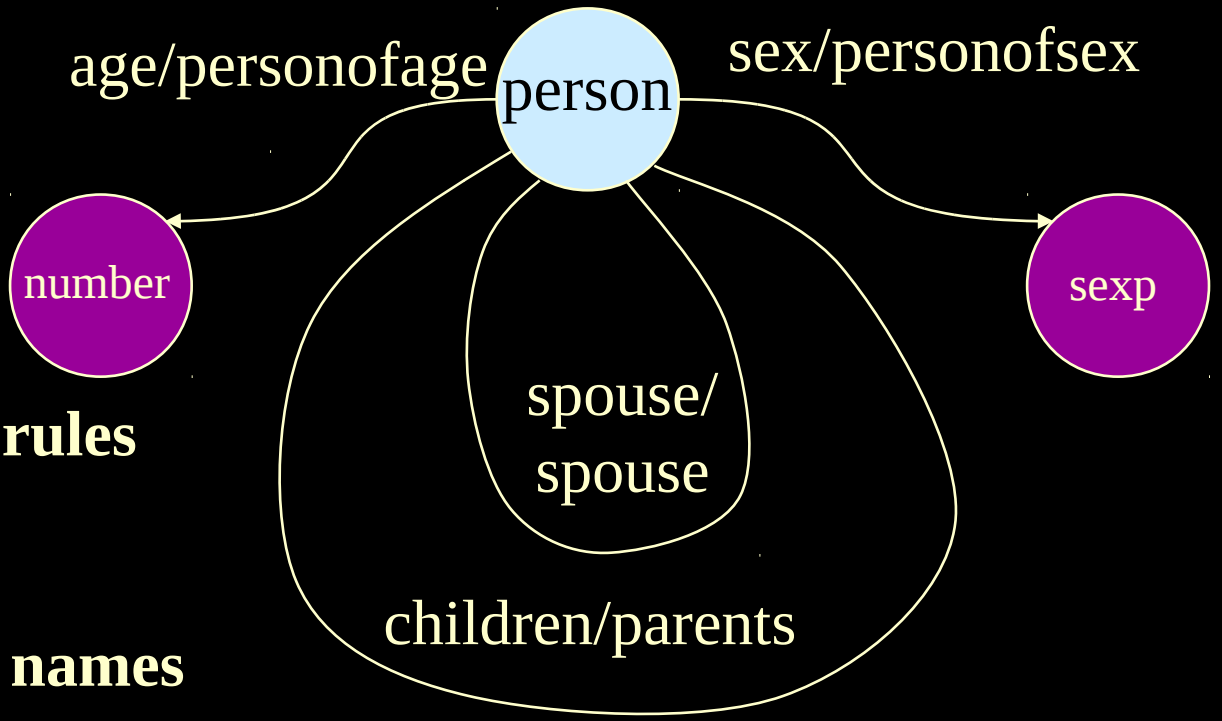
- **IFIP WG 2.6 series: "Modelling in Database Management Systems” (1974)**

- **IFIP TC 8 on Information Systems (1976)**

Jean-Raymond Abrial: ”Data Semantics” (1974)

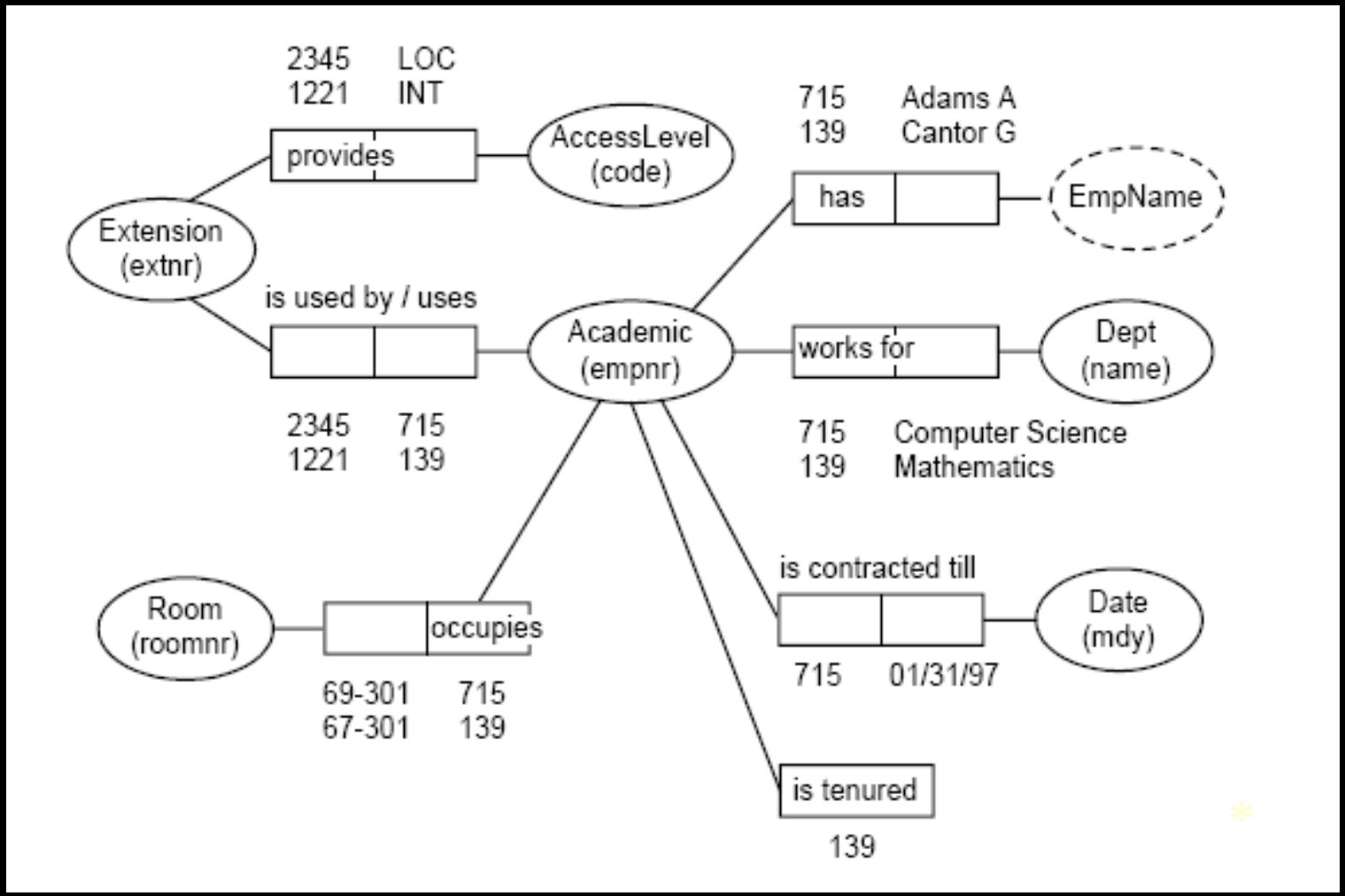
Influenced by: GDBMS, Codd’s Relational Model, AI-techniques,

Binary model



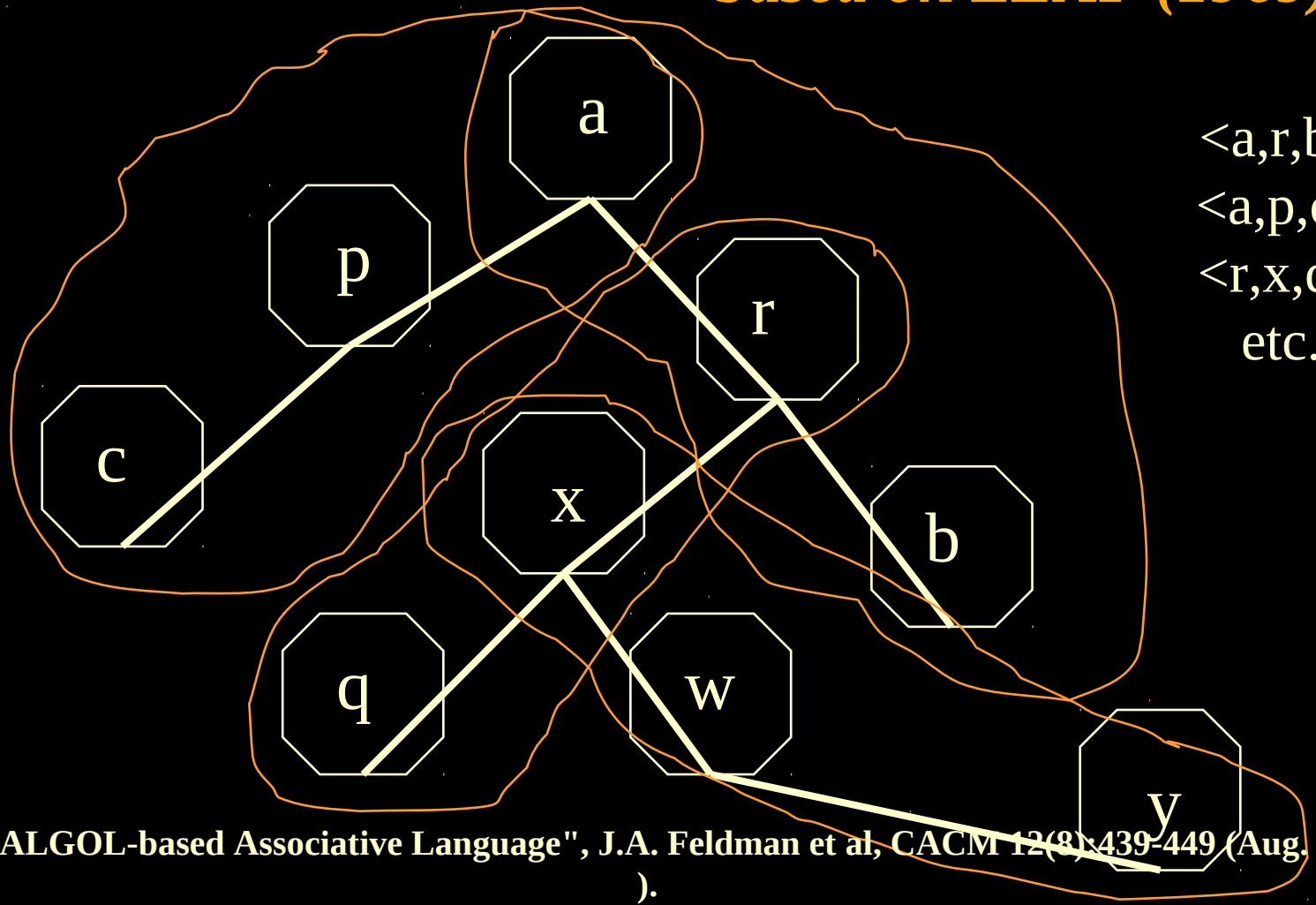
Schema: fact types, rules
Rules: constraints,
derivation rules
Internal vs external names

A sample NIAM schema (Nijssen)



* Source: Terry Halpin, Object-Role Modeling (ORM/NIAM)

*CADIS**:The associative data model based on LEAP (1969)**



<a,r,b>
<a,p,c>
<r,x,q>
etc.

•"An ALGOL-based Associative Language", J.A. Feldman et al, CACM 12(8):439-449 (Aug. 1969).

•** J.A. Bubenko jr, O.Källhammar, CADIS: Computer Aided Design of Information Systems, in Bubenko, Langefors, Sölvberg (Eds.) Computer-Aided Information Systems Analysis and Design, Studentlitteratur, 1971.

Modelling research issues in the eighties

- **improving the expressive power of semantic data models and adding the temporal dimension**
- **”semantic modelling” vs relational data modelling**
- **what are we modelling?**
  The DB? The IS?, the real world? …?
- **the operational vs the deductive & temporal approach**

ISO TC97/SCS/WG3
Concepts and Terminology for the Conceptual Schema and the Information Base, Preliminary Report, 1981

edited by J.J. van Griethuysen et al.

- **Assumes the ANSI/SPARC three-schema approach**
- **Ambitions:**

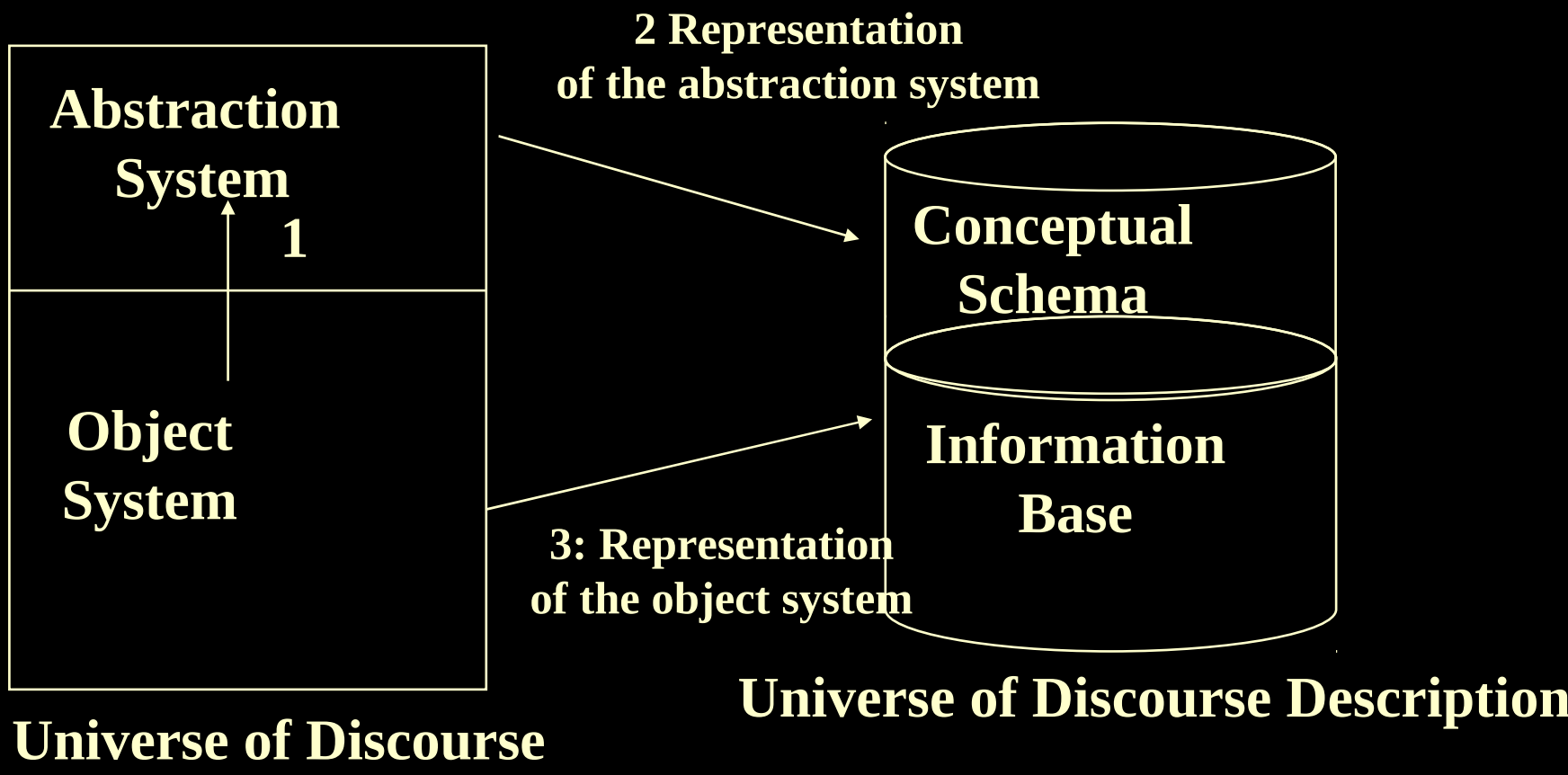
  - to define concepts for conceptual schema languages

  - to develop a methodology for assessing proposals for conceptual schema languages

  - to assess candidate proposals for conceptual schema languages

  - etc.

Describing the Universe of Discourse



Classification, abstraction, generalization, establishing rules, ….

ISO TC97/SCS/WG3
Concepts and Terminology for the Conceptual Schema and the Information Base, Preliminary Report, 1981

- **General notions and principles**
- **Four ”conceptual schema language candidates” analyzed using an example Universe of Discourse**
  - **The Entity-Attribute-Relationship approaches**
  - **The Entity-Relationship approaches**
  - **The Binary Relationship approaches**
  - **The Interpreted Predicate Logic approaches**

On business rules

Many business rules are deeply imbedded in programs of a company's information system

Rule A: If employee x has salary y and if y is greater than z then employee x is also a manager
Rule B: All managers work full time

Vx,y (employee(x) & salary(x,y) & y > z --> manager(x))
Vx manager(x) --> worksfulltime(x)

Modelling in the nineties: focus on organisational aspects, participation and understanding

… "the understanding and support of

i) human activities at all levels in an organisation,
ii) change, be it of the product, of the process or of the organisation, and
iii) complex user organisations, and individual users"

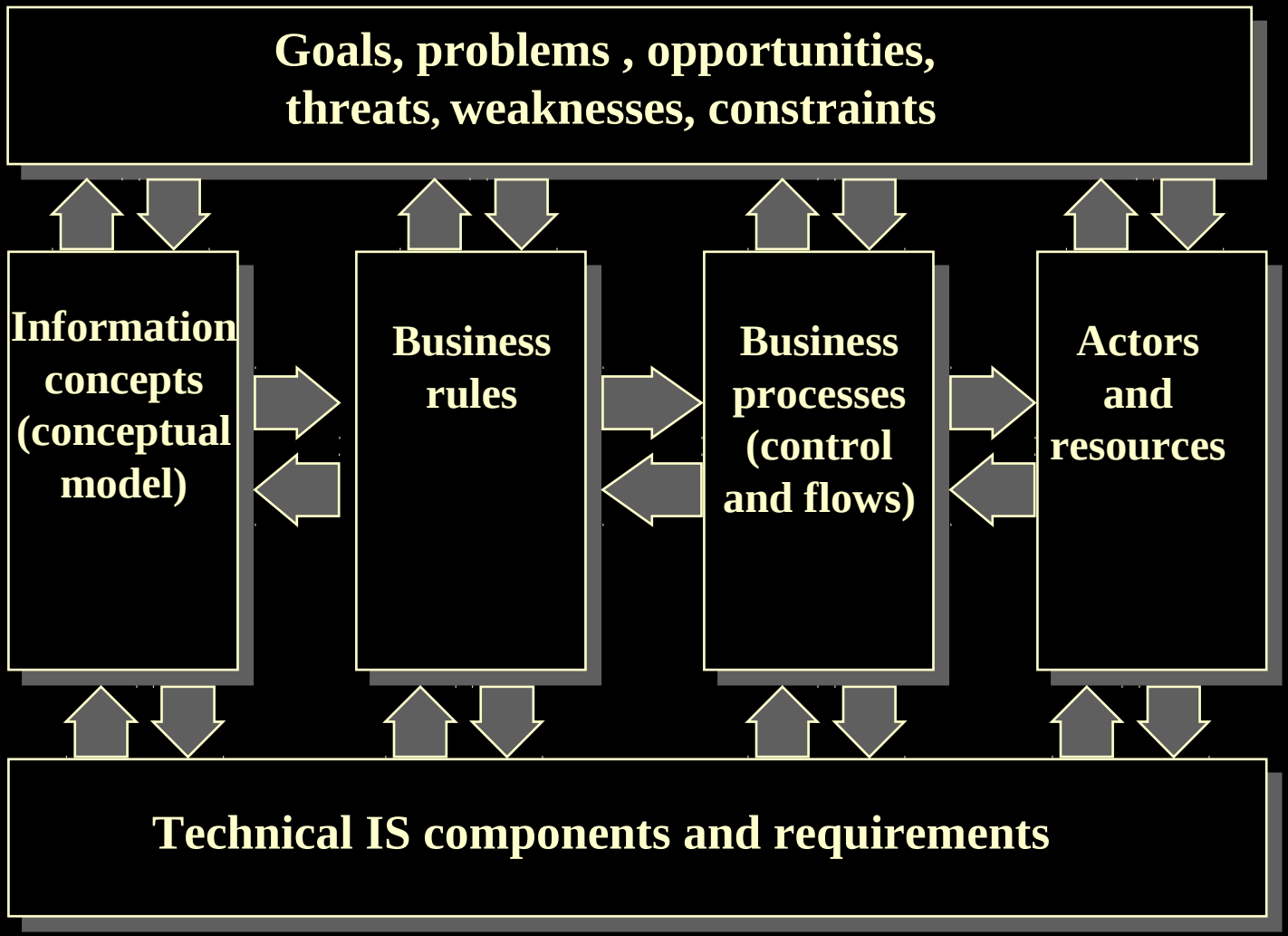
(ESPRIT 91)

The nineties: Widening the scope

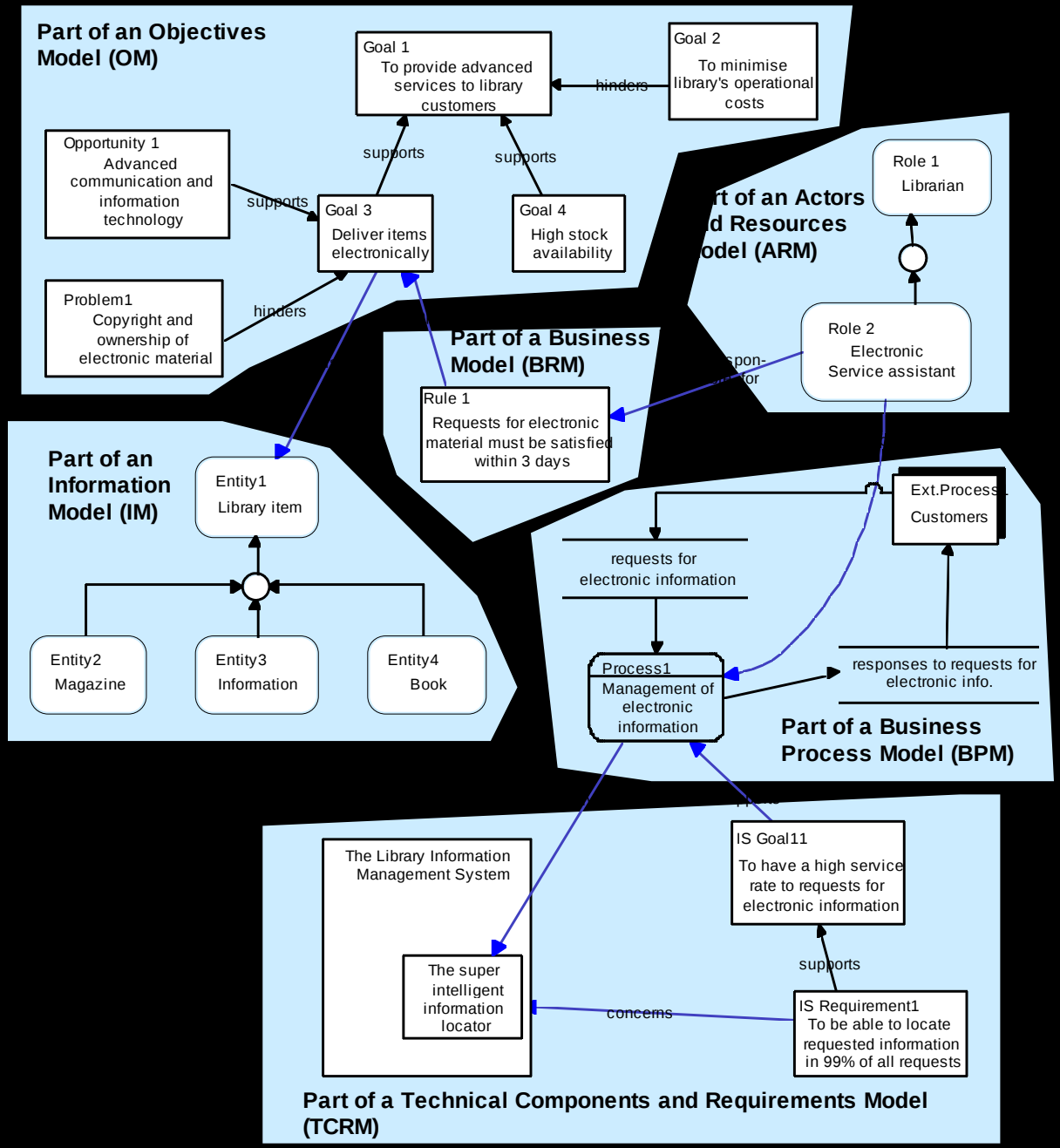
Interoperable systems
Semantic heterogeneity
Non-functional requirements
Business modelling/engineering
Modelling of intentions and actors
Participative modelling
”Method knowledge” *)
”Patterns”

***) e.g. the EMMSAD (Evaluation of Modelling Methods in Systems Analysis and Design) workshop series, start 1996.**

Enterprise Modelling with EKD - integrated descriptions



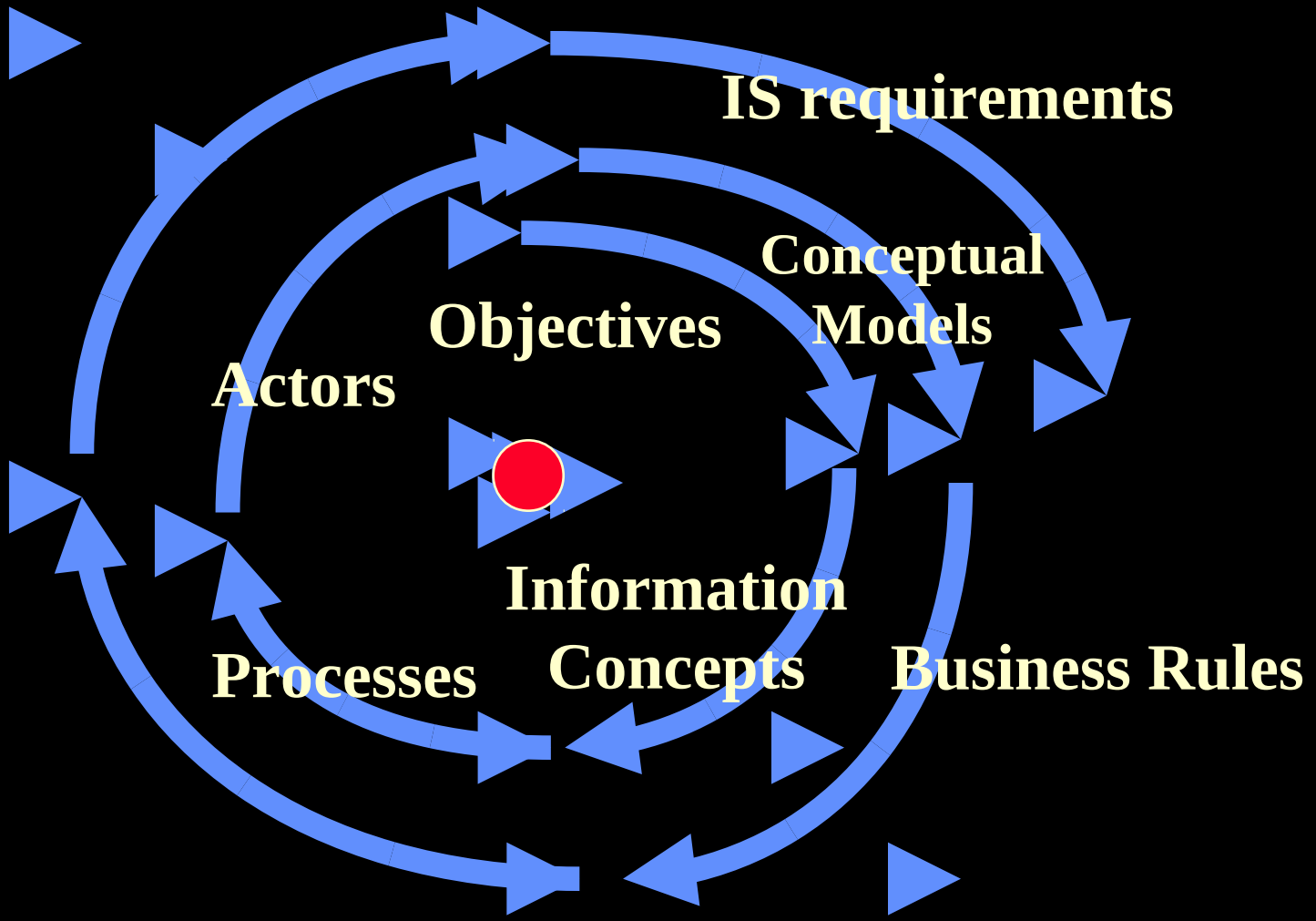
Sample of an Enterprise Model (EKD) instance



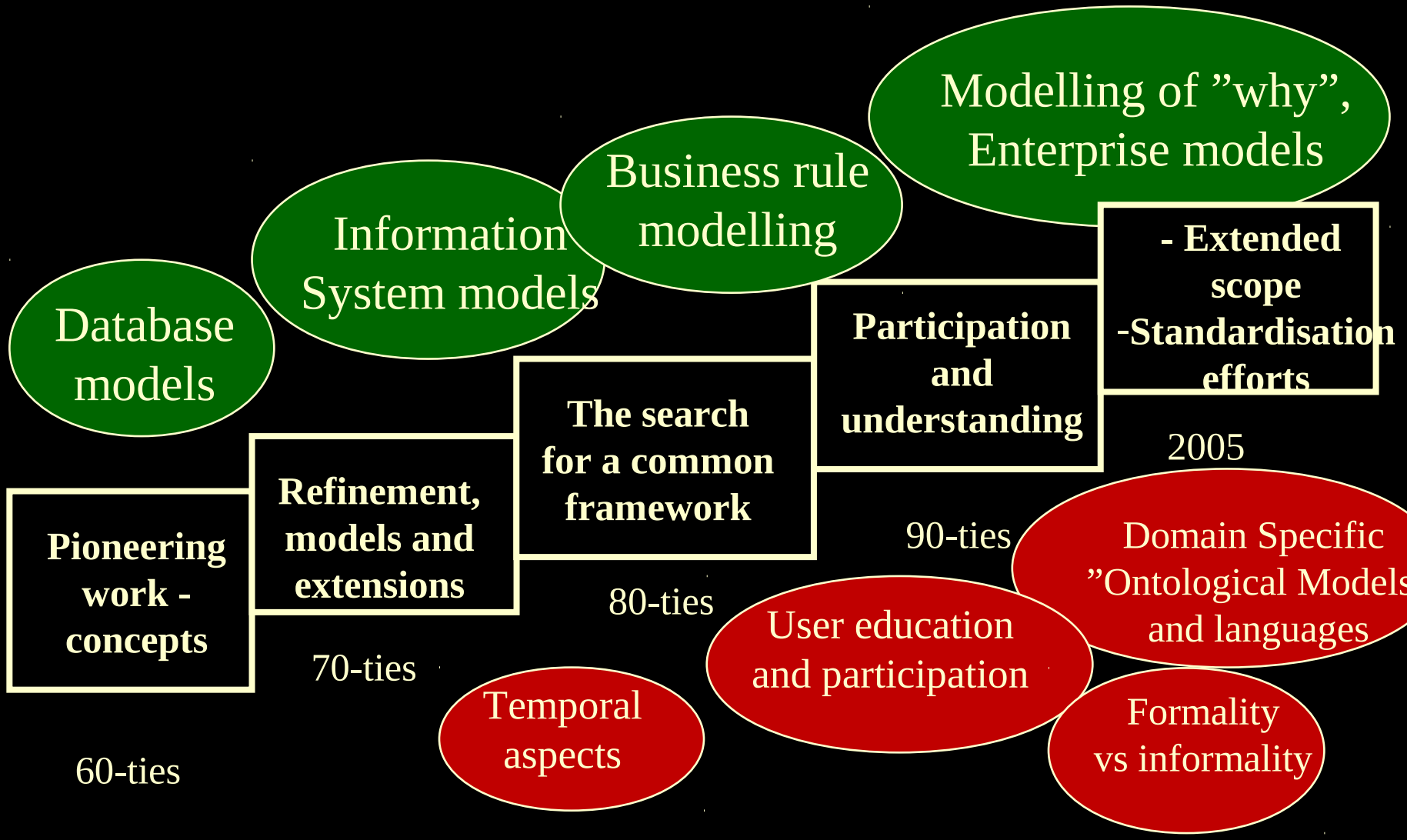
Enterprise Modelling

- **Purpose of modelling: not only IS design**
- **Models not only “what” but also “why”**
- **Integrates conceptual and process models of the business with objectives, actors, business rules and information system requirements**
- **Makes information system solutions traceable to objectives**
- **Makes conceptual modelling a “participatory” activity**

Iterative development of knowledge and models



Modelling during four+ decades



Summary

- **Modelling is a critical phase of any software engineering project,**
- **Modelling is NOT easy – requires logical, clear thinking and agreement with future users,**
- **Separation of data and process from application is the way to go,**

Recommendation

- **Review your understanding and skills in ER technique**