

# Object-Oriented and Object-Relational Databases

The Object-Relational Impedance Mismatch

# Knowledge Objectives

1. Explain the concept of impedance mismatch
2. Explain the historical background / needs behind object data models (ODMs) for databases
3. Enumerate seven desirable features an ODM must have
4. Enumerate ten of the OODBMSs golden rules
5. Name five standard object-oriented features from SQL:1999
6. Give two reasons why object methods may suit better than using attributes
7. Enumerate two pros and cons of choosing OIDs instead of PKs
8. Name two pros and cons of using REFs instead of FKs
9. Enumerate two pros and cons of using type inheritance in Oracle 11g

# Understanding Objectives

1. Discuss the performance issues the object-relational impedance mismatch may generate

# Motivation

THE OBJECT-RELATIONAL IMPEDANCE MISMATCH

# NOSQL Goals

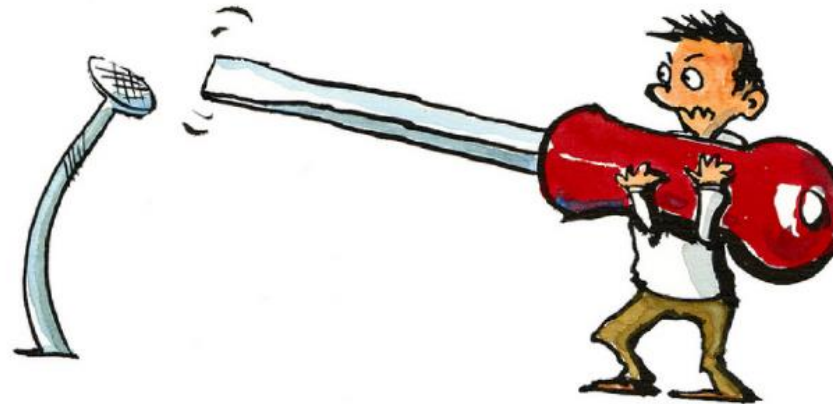
Recall the NOSQL Goals:

- Schemaless: Allow flexible (even runtime) schema definition [data structure]
- Reliability / availability: Keep delivering service even if its software or hardware components fail [distribution]
- Scalability: Continuously evolve to support a growing amount of tasks [distribution]
- Efficiency: How well the system performs, usually measured in terms of response *time* (latency) and *throughput* (bandwidth) [distribution]

# Impedance Mismatch: Some History

## Of hammers and nails...

### The Law of the Hammer



If the only tool you have is a hammer,  
everything looks like a nail.

Abraham Maslow - The Psychology of Science - 1966

Petra Selmer, Advances in Data Management 2012

# Impedance Mismatch: Some History

## The Law of the Relational Database



If the only tool you have is a relational database,  
everything looks like a table.

A Walk in Graph Databases - 2012

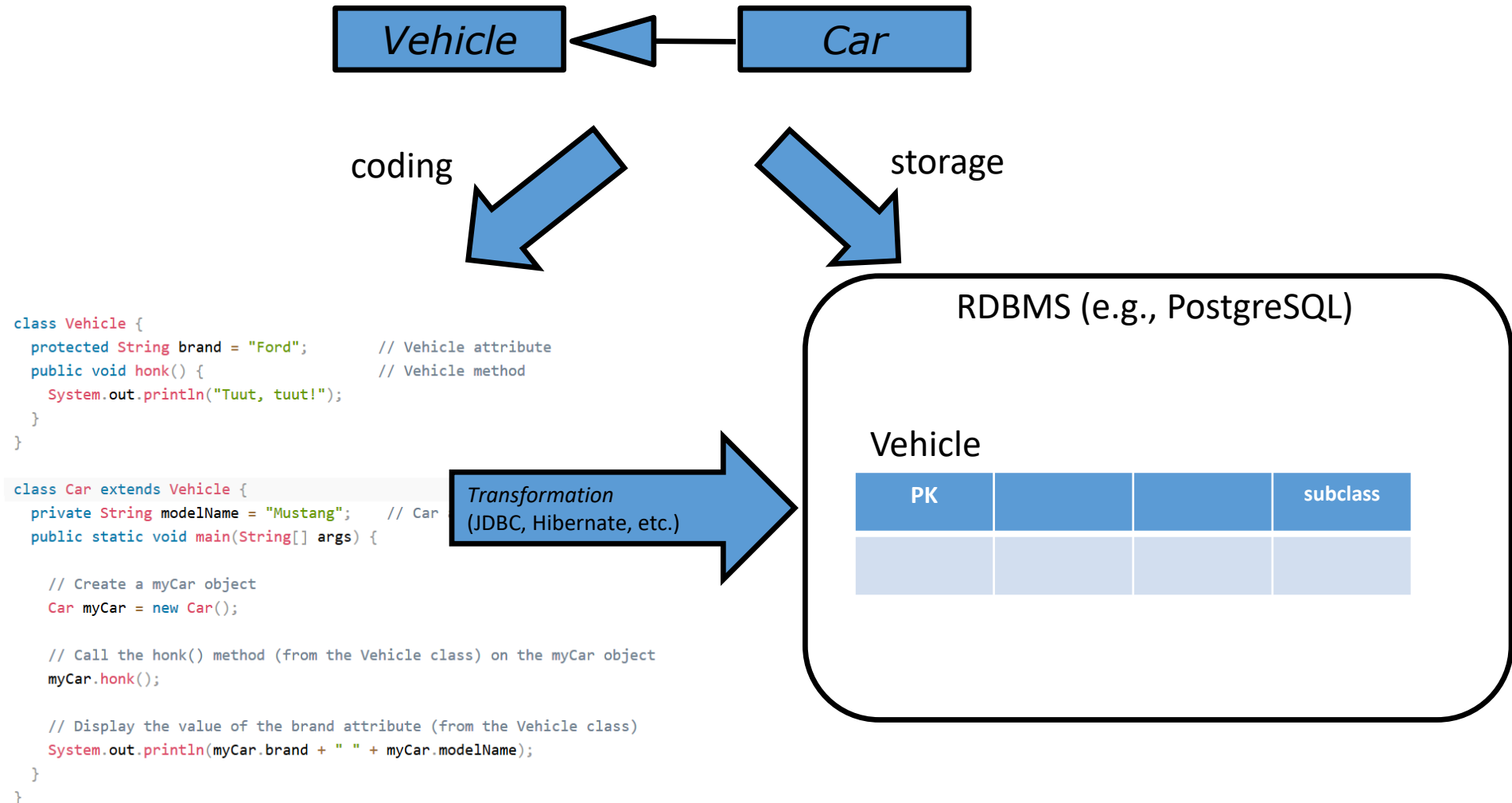
Petra Selmer, Advances in Data Management 2012

# Impedance Mismatch: Definition

- When two technologies interact but they are grounded in different models or paradigms, a translation between the elements of both models is then mandatory to enable **interoperability**. This overhead (in performance) to execute the map between both models is known as **impedance mismatch**
- In this course, we will study the potential impedance mismatch **between an application and the database**
  - In this lab, we will exemplify the impedance mismatch problem with the relational and object-oriented data models



# Example



# Object-Relational Impedance Mismatch

- The first impedance mismatch identified and studied, back in the late 70s, was **the object-relational impedance mismatch** between object-oriented programming languages and relational databases. To overcome it, there was a huge amount of work to map object-oriented concepts to relational concepts. We will focus on two approaches (OO-RDBMS and OO-OODMS).
  - OO-RDBMS: The relational model must prevail, yet adapt and evolve to cover all requirements introduced by the OO model, but they were keen on paying the overhead introduced by the impedance mismatch between both models or even sacrifice some OO features
  - OO-OODMS: Databases should natively deal with the OO model
- **Being aware of such mappings is important to acknowledge their impact**
  - More code to execute (performance), expressiveness conflicts (semantics), etc.

# Objectives

- Understand the position of the main communities (back to the 70s) with regard to the object-relational impedance mismatch
  - The object-oriented (OO) community that advocated for object-oriented databases (OODBMS) to minimize the impedance mismatch
  - The object-relational community that advocated to preserve the benefits of the relational model and define and agree a mapping between both models (ORDBMS)
- Compare the mappings they propose (i.e., OO-RDBMS and OO-ODDMS) for the main elements of the object and relational models. Discuss if such proposals are equivalent, compatible or remain in conflict:
  - Equivalent (or very similar) and straightforwardly mapped,
  - Conflicting with each other and no direct mapping could be established – i.e., an inherent contradiction between both models remain,
  - Not equivalent, yet compatible, and the proposed solutions could be mapped in such a way we can avoid contradiction
- Understand the consequences, performance and semantics-wise, of the decisions made by each community and their proposals

# Other Types of Impedance Mismatch

- NOSQL has introduced new data models
  - Graph data model
  - Document-oriented databases
  - Key-value (~hash tables)
  - Streams (~infinite vectors and matrixes)
- Other programming paradigms have also appeared or become trendy
- As such, we may have impedance mismatch between any programming paradigm and any database data model
- The impedance mismatch is accordingly a complex issue that may compromise the performance of any [Big Data] system
  - During this course we will learn how to model the NOSQL databases to reduce the impedance mismatch

# Summary

- Impedance mismatch
- Two main approaches for object data modeling for databases: OODBMSs Vs. ORDBMSs
- The object-relational impedance mismatch as example
  - Agreements
  - Disagreements
  - Conflicts
- The object-relational layer was mostly built on top of the relational layer (the impedance mismatch still holds, even if hidden by automatic processes)
  - PostgreSQL was the first object-relational DBMS, since then, most RDBMS followed

# Bibliography

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- Stonebraker M., Rowe L., Lindsay B., Gray J., Carey M., Brodie M., Bernstein P., and Beech D. Third generation database system manifesto. ACM SIGMOD Rec., 19(3), 1990.
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