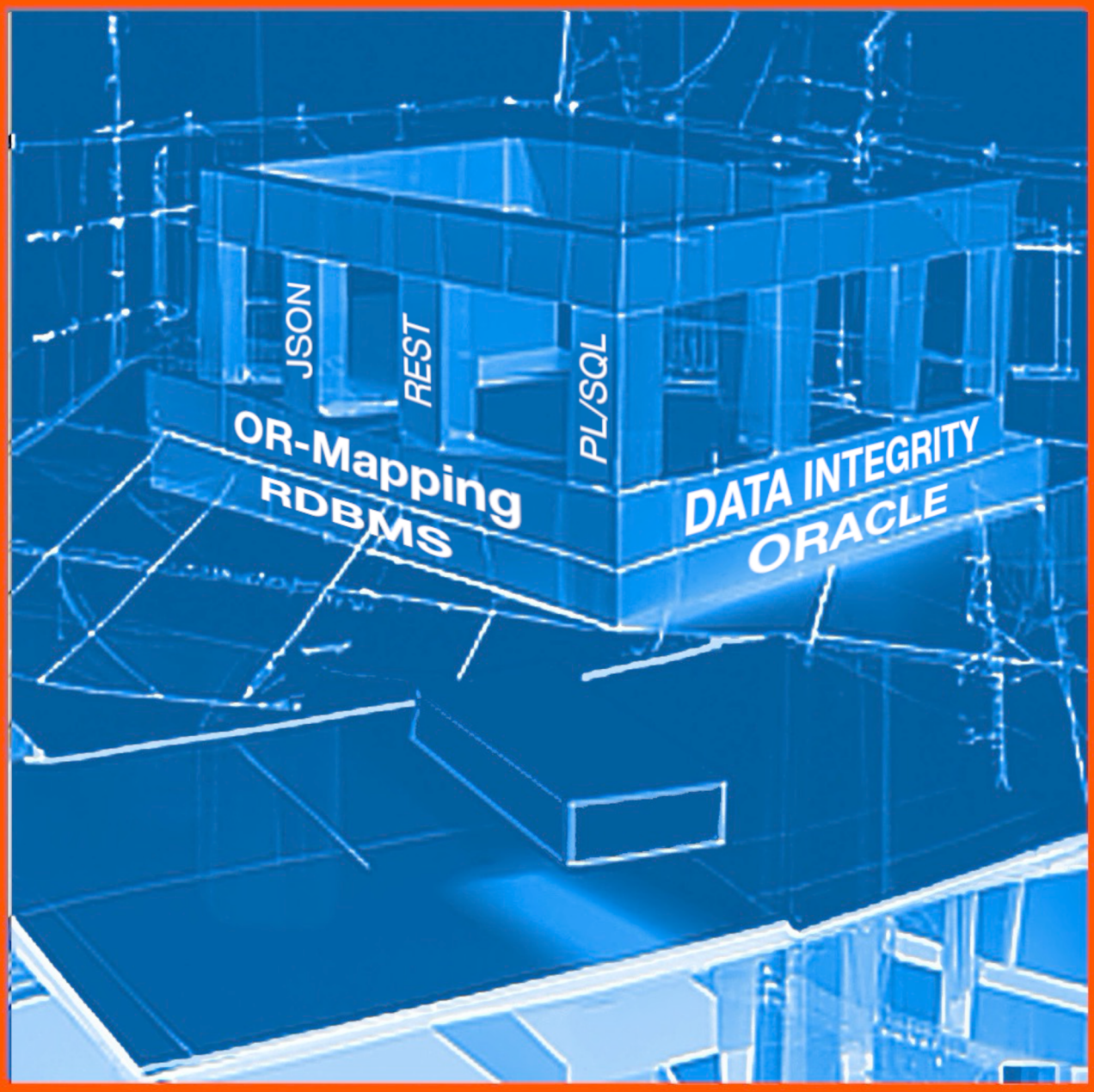
# The Oracle Database in Modern IT Architectures

by Peter de Vaal



# The Oracle database in modern IT architectures

## Intelligent Persistence for applications, microservices, business processes, data analytics, documents and more

Peter de Vaal

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# Contents

# Foreword

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# Preface

## Why this book and why now?

Having worked with Oracle technology since 1992 and having been involved in the design and development of very disparate systems and applications, I realised some time ago that people are still thinking very differently on how to apply the relational database technology in general and the Oracle database in particular. I have worked with people having different backgrounds, from hardcore SQL and PL/SQL developers to Java EE developers, web (Javascript) developers, integration engineers and data scientists. They all have a different view on the role of the database, and due to this some are looking for other solutions for the persistence of data, e.g. NoSQL databases or in-memory solutions. So I think it is about time to go back to basics, and explain again why and how a relational database should be used. And this is also a good opportunity to explain how the Oracle database (and other relational databases) have evolved into multi-purpose solutions.

Another thing that I wanted to write about is the way database code is being developed and deployed. Although many tools are available to support both development and deployment, it is amazing how often database objects are built using badly managed scripts, that are run manually and are not optimal for repeated deployments. It often leads to differences between instances in different environments. So it is time to write something about DevOps for database developers. Some time ago I read an article on LinkedIn, written by a former colleague, Gert-Jan Paulissen, who I had not spoken for some time, and who mentioned exactly that problem. He proposed writing a book about the subject together. So we started brainstorming about content, and after some time we decided it would be better to make it a series of books about best practices in Oracle database development. Gert-Jan would work out the DevOps book, while I would focus on the database architecture and new features.

This book should enable you to design and build Oracle database architectures for any purpose, using best practices and the newest features. After design you can go hands-on using Gert-Jan's book for a guide to use the right tooling and methodology to develop the assets described here, and to develop GUI applications.

## This book is a work-in-progress

The nicest feature of on-line publishing is that the buyer of a book does not get content that might be out-of-date after a few years. Instead, the buyer is entitled to get new editions when these are published. This enables the writer to publish a book that is in fact work-in-progress, and that might be enhanced later with new chapters or updated information when a new version of the discussed software is released.

At the time of writing of the first edition of this book Oracle brought out the first beta-version of the Oracle 23c database. I was lucky to be in the beta-testing program of this release. This

new release contains a number of new features that may deserve revised and additional chapters. The second edition appeared after the 23c developer release was launched, and aspects of some new features, such as Boolean columns and JSON Duality views, have been added.

Moreover, I plan to add some more chapters in the next 1 or 2 years. Anyone who bought this book will be able to download the updated versions for free. Each version will get a 'What's new' section, so the reader will be able to find added and updated information quickly. A few subjects that are in planning are:

- Best practices using JSON (and XML) for storing and processing data
- Best practices for using pipelined functions
- Best practices for writing SQL, including new 23c features
- Using in-memory column store for fast analytics
- Setting-up a secure database with Real Application Security

# Who is this book for?

This book is meant for architects and database developers alike who'd like to design and build better Oracle database applications and integrations. They will learn to get the best out of the Oracle database and to optimally integrate the Oracle database in any technology.

# How to read this book?

Sometimes, asides are added to highlight further information about a specific topic:

Informational asides will provide extra information.

Warning asides will warn about common pitfalls and how to avoid them.

Tip asides will give tips for deepening your understanding or optimising your use of the information presented.

# Please help improve this book!

New revisions of this book are published on a regular basis. If you think a particular section needs improvement, please post an issue in the Leanpub forum[1], or contact me via Twitter [@pdevaal]:(https://twitter.com/pdevaal).

[1] https://community.leanpub.com/c/the-oracle-database-in-modern-it-architectures/forum

# About the author

Peter de Vaal has been working as an Oracle professional since 1992, after having worked in science (1989 PhD physical organic chemistry at Leiden University, the Netherlands, and chimie quantique at the university of Strasbourg, France). It brought him to places such as Mumbai (India), Minneapolis (MI) and Greenville (SC) in the USA and many European countries. And the industries where he could apply his skills ranged from airport baggage handling to chemistry, food industry, hospitals, banking and insurance, governmental institutions etc. Outside his working hours Peter has two other passions: riding bicycles (MTB and race) and playing the card game bridge.

# I Best practices for the relational model

# 1. Introduction

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## 1.1 Why a new book about the relational database?

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## 1.2 Is the RDBMS becoming less relevant?

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## 1.3 The foundation of the RDBMS revisited

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# 2. A common question of life: What makes me unique?

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## 2.1 The database recognises all its rows: Internal unique identifiers

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## 2.2 The unchallenged unique identifier: Primary key constraints

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## 2.3 Being more unique than just a number: Unique Key constraints

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## 2.4 Uniqueness as inheritance: Unique indexes

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## 2.5 Some examples of unique identifiers

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## 2.6 Best practices when defining unique identifiers

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## 2.7 Best practices for sequences and identity columns

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# 3. A foreigner is not a stranger

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## 3.1 Happy together: The pure Master-detail relationships

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## 3.2 When relationships break up

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## 3.3 Join the club: Many-to-many relationships

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## 3.4 Click for more information : A one-to-many relationship for look-up data

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## 3.5 Limiting the choice: Restricted foreign keys

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## 3.6 The family tree: Self-references, tree-structures and networks

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## 3.7 To whom do I belong? The exclusive-arc relation

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## 3.8 Without relations data will not be coherent

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# II Implementing Data Integrity

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# 4. A brief history of business rule implementation

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## 4.1 Java rules the world!

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## 4.2 It's the process, stupid!

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## 4.3 Keep it simple: everything in the database!

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## 4.4 The proper way: Use all three methods

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# 5. Implementing Data Integrity Rules

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## 5.1 What is a data integrity rule?

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## 5.2 Why data integrity rules should always be implemented in the database

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## 5.3 Specifying business rules

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## 5.4 Categories of business rules

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## 5.5 Implicit Data Integrity Rules of table definitions

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### 5.5.1 Data type, length, precision, scale and semantics

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#### 5.5.1.1 NUMBER (and its subtypes)

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#### 5.5.1.2 DATE, TIMESTAMP and TIMESTAMP WITH TIME ZONE

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#### 5.5.1.3 VARCHAR2, CHAR, NVARCHAR2, NCHAR

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#### 5.5.1.4 Spatial types

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#### 5.5.1.5 RAW and LONG RAW

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#### 5.5.1.6 CLOB, BLOB and BFILE

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#### 5.5.1.7 XMLTYPE and JSONTYPE

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#### 5.5.1.8 BOOLEAN

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#### 5.5.1.9 User-defined data types

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### 5.5.2 Collation

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### 5.5.3 Optionality

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### 5.5.4 Auto-increment property

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### 5.5.5 Default Value

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## 5.6 Implementing Data Integrity using constraints

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### 5.6.1 VALIDATE/NOVALIDATE

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### 5.6.2 DEFERRABLE constraints

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### 5.6.3 Collation

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## 5.6.4 The purpose of check constraints

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## 5.6.5 Advantages of check constraints over other implementations of attribute and tuple rules

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## 5.6.6 Disadvantages of check constraints

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## 5.6.7 Examples of check constraints

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### 5.6.7.1 Constraint example 1 Testing dates

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### 5.6.7.2 Constraint example 2 The exclusive arc relation

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### 5.6.7.3 Constraint example 3 Testing on limit values

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### 5.6.7.4 Constraint example 4 Validating JSON

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#### 5.6.7.5 Constraint example 5 Checking domain values

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#### 5.6.7.6 Constraint example 6 Conditional optionality

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### 5.6.8 Summary of using database constraints

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## 5.7 Implementing Data Integrity Rules using database triggers

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### 5.7.1 Examples of implementing data integrity rules in database triggers

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#### 5.7.1.1 Trigger example 1 Conditional optionality

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#### 5.7.1.2 Trigger example 2 Restricted foreign keys

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#### 5.7.1.3 Trigger example 3 Conditional updatability

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#### 5.7.1.4 Trigger example 4 Domain checks against a table

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#### 5.7.1.5 Trigger example 5 Preventing overlapping value ranges and gaps between ranges

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### 5.7.2 Summary using database triggers

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## 5.8 Implementing business rules and functionality using APIs

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### 5.8.1 An API for creating an Order

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# III The relational database in an Object Oriented world

# 6. Which language do we speak? Communicating with the database

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## 6.1 Application development frameworks using Object Relational Mapping

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## 6.2 Why objects are not tables and vice versa

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## 6.3 Integration, what integration?

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## 6.4 Choosing between object type, XML or JSON for data manipulation APIs

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## 6.5 Choosing between object type, XML, JSON or SQL methods for data retrieval APIs

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# 7. PL/SQL APIs for data manipulation and retrieval

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## 7.1 Using PL/SQL functions with object type parameters

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## 7.2 Using PL/SQL functions with JSON parameters

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## 7.3 Using PL/SQL functions with XML parameters

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# 8. Database APIs for data retrieval

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## 8.1 Using database views as APIs

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## 8.2 Using Pipelined PL/SQL functions for data retrieval

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## 8.3 Using PL/SQL functions that return a ref cursor

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# 9. Using Oracle REST Data Services (ORDS) for database APIs

# 10. Using JSON Duality Views as database APIs

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## 10.1 Declarative ORM Mapping using JSON Duality Views

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### 10.1.1 Using the duality view for querying data

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### 10.1.2 Using duality views for updates

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### 10.1.3 Using duality views for inserts

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## 10.2 Using JSON Duality Views for ACID compliant transactions

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# 11. Summary of best practices for Object-Relational mapping

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# Afterword

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