Golang Programming

Working with SQL and NoSQL databases in Go

Where to Find The Code and Materials?

https://github.com/iproduct/coursego

Introduction to Databases and Distributed Data Processing

Databases, DBMSs and DB Models

- Database - an organized collection of data, generally stored and accessed electronically from a computer system. Can be developed using formal design and modeling techniques.
- DataBase Management System (DBMS) – software that interacts with end users, applications, and the database to capture and analyze the data, providing core facilities to create and administer databases.
- DBMSs can be classified according to the database models that they support:
  - In 1980s relational databases became dominant, modelling data as rows and columns in a series of tables, and the vast majority use Structured Query Language (SQL) for writing and querying data.
  - In the 2000s, non-relational databases became popular, referred to as NoSQL because they use different query languages.

Relational Databases

- "Relational database" term – invented by E. F. Codd at IBM in 1970, paper: "A Relational Model of Data for Large Shared Data Banks".
- Present the data to the user as relations (a presentation in tabular form, i.e. as a collection of tables with each table consisting of a set of rows and columns)
- Provide relational operators to manipulate the data in tabular form.
- As of 2009, most commercial relational DBMSs employ SQL as their query language.

```
dvdrental=# select title, release_year, length, replacement_cost from film
dvdrental-#   where length > 120 and replacement_cost > 29.50
dvdrental-#   order by title desc;
          title           | release_year | length | replacement_cost
--------------------------+--------------+--------+------------------
 West Lion                |         2006 |    159 |            29.99
 Virgin Daisy             |         2006 |    179 |            29.99
 Uncut Suicides           |         2006 |    172 |            29.99
 Tracy Cider              |         2006 |    142 |            29.99
 Song Hedwig              |         2006 |    165 |            29.99
 Slacker Liaisons         |         2006 |    179 |            29.99
 Sassy Packer             |         2006 |    154 |            29.99
 River Outlaw             |         2006 |    149 |            29.99
 Right Cranes             |         2006 |    153 |            29.99
 Quest Mussolini          |         2006 |    177 |            29.99
 Poseidon Forever         |         2006 |    159 |            29.99
 Loathing Legally         |         2006 |    140 |            29.99
 Lawless Vision           |         2006 |    181 |            29.99
 Jingle Sagebrush         |         2006 |    124 |            29.99
 Jericho Mulan            |         2006 |    171 |            29.99
 Japanese Run             |         2006 |    135 |            29.99
 Gilmore Boiled           |         2006 |    163 |            29.99
 Floats Garden            |         2006 |    145 |            29.99
 Fantasia Park            |         2006 |    131 |            29.99
 Extraordinary Conquerer  |         2006 |    122 |            29.99
 Everyone Craft           |         2006 |    163 |            29.99
 Dirty Ace                |         2006 |    147 |            29.99
 Clyde Theory             |         2006 |    139 |            29.99
 Clockwork Paradise       |         2006 |    143 |            29.99
 Ballroom Mockingbird     |         2006 |    173 |            29.99
(25 rows)
```

Examples: Oracle, MySQL, Microsoft SQL Server, PostgreSQL, IBM DB2, SQLite

NoSQL and NewSQL Databases

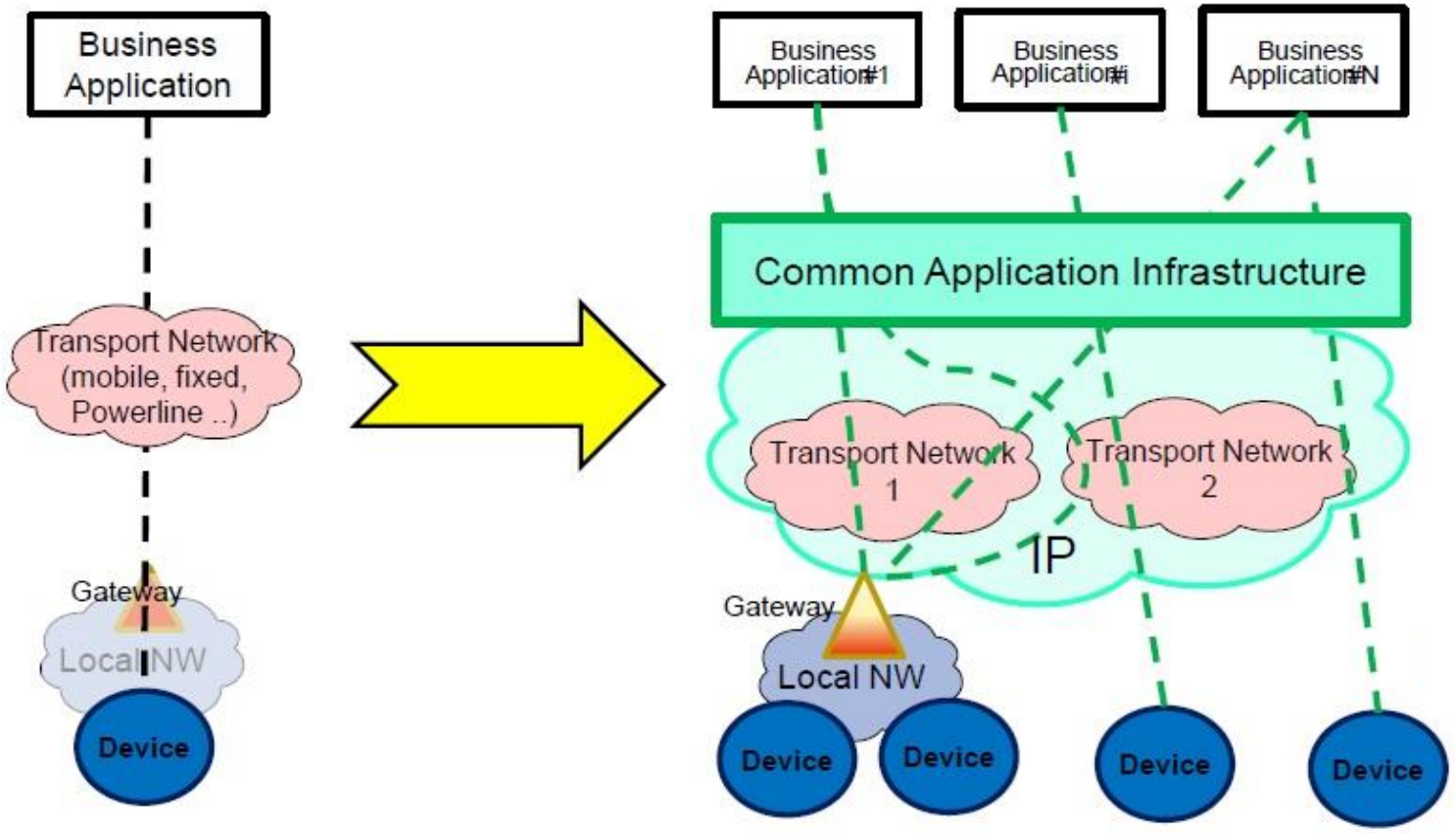
- NoSQL databases – massively distributed, horizontally scalable, fast, do not require fixed table schemas, avoid join operations by storing denormalized data.
- CAP theorem: it is impossible for a distributed system to simultaneously provide consistency, availability, and partition tolerance guarantees –> eventual consistency = high availability and partition tolerance with a reduced level of data consistency.
- NewSQL is a class of modern relational databases that aims to provide the same scalable performance of NoSQL systems for online transaction processing (read-write) workloads while still using SQL and maintaining the ACID guarantees of a traditional database system.

Source: Wikipedia - https://en.wikipedia.org/wiki/Database

Vertical vs. Horizontal Scaling

Pipe (vertical):
1 Application, 1 NW,
1 (or few) type of Device

Horizontal (based on common Layer)
Applications share common infrastructure, environments and network elements



http://www.iot-week.eu/overview_2013/iot-week-2012/programme-1/tuesday-1/presentations/semantic-interoperability/K1_ETSI-M2M-oneM2M-and-the-need-for-semantics-IoTWeek2012.pdf, By Joerg Swetina (NEC)- ETSI M2M / oneM2M and the need for semantics

NoSQL and NewSQL Database Examples

Type	Notable examples of this type
Wide column	Accumulo, Cassandra, Scylla, HBase
Document:	Apache CouchDB, ArangoDB, BaseX, Clusterpoint, Couchbase, Cosmos DB, eXist-db, IBM Domino, MarkLogic, MongoDB, OrientDB, Qizx, RethinkDB
Key–value:	Aerospike, Apache Ignite, ArangoDB, Berkeley DB, Couchbase, Dynamo, FoundationDB, InfinityDB, MemcacheDB, MUMPS, Oracle NoSQL Database, OrientDB, Redis, Riak, SciDB, SDBM/Flat File dbm, ZooKeeper
Graph:	AllegroGraph, ArangoDB, InfiniteGraph, Apache Giraph, MarkLogic, Neo4J, OrientDB, Virtuoso
New SQL	CockroachDB, Citus, Vitess

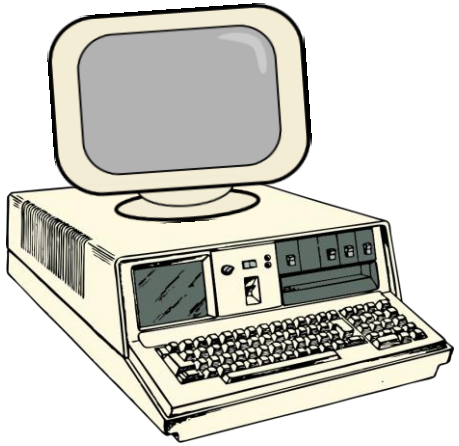
Source: Wikipedia - https://en.wikipedia.org/wiki/NoSQL

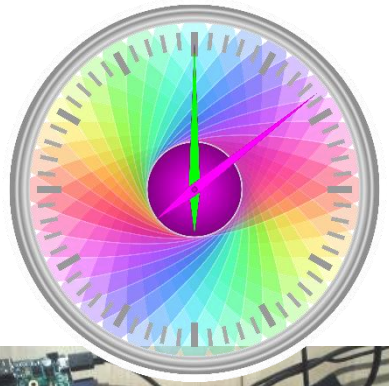
SQL and NoSQL Databases Comparison

Data model	Performance	Scalability	Flexibility	Complexity	Functionality
Key–value store	high	high	high	none	variable (none)
Column-oriented store	high	high	moderate	low	minimal
Document-oriented store	high	variable (high)	high	low	variable (low)
Graph database	variable	variable	high	high	graph theory
Relational database	variable	variable	low	moderate	relational algebra

Source: Wikipedia - https://en.wikipedia.org/wiki/NoSQL

Need for Speed :)





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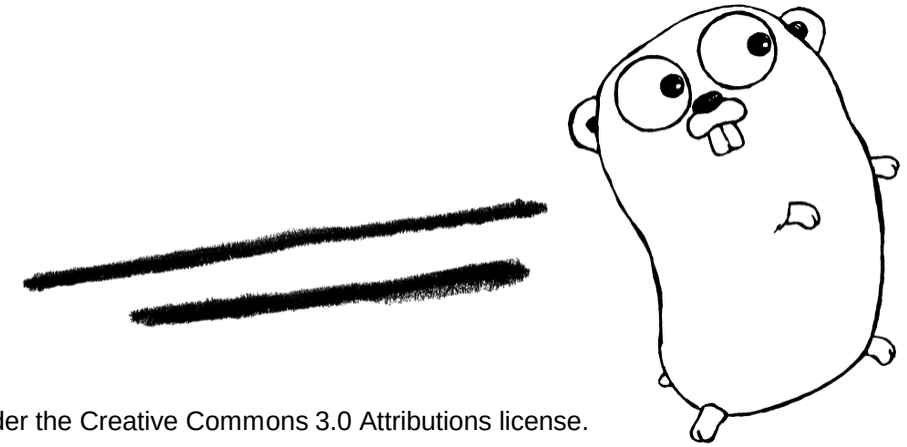
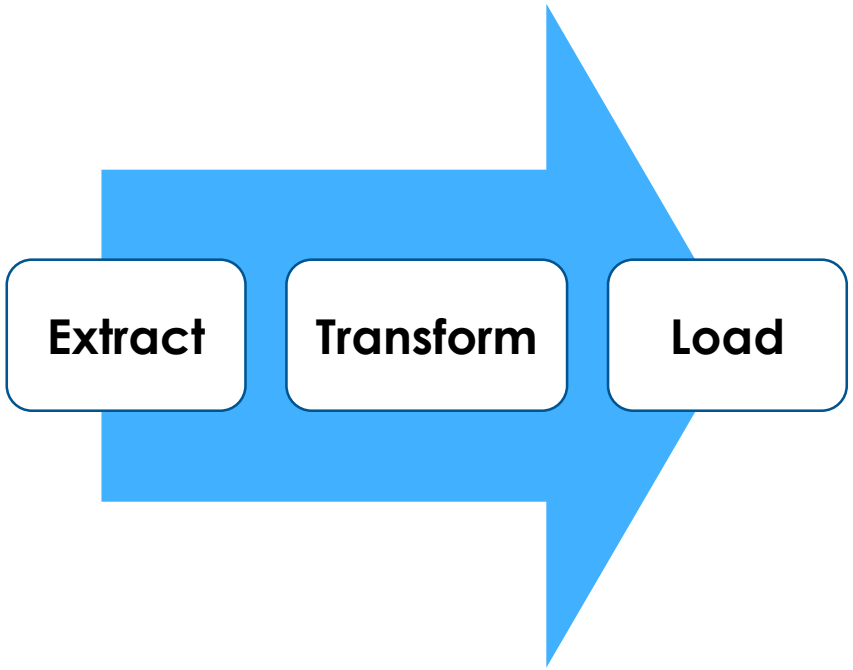
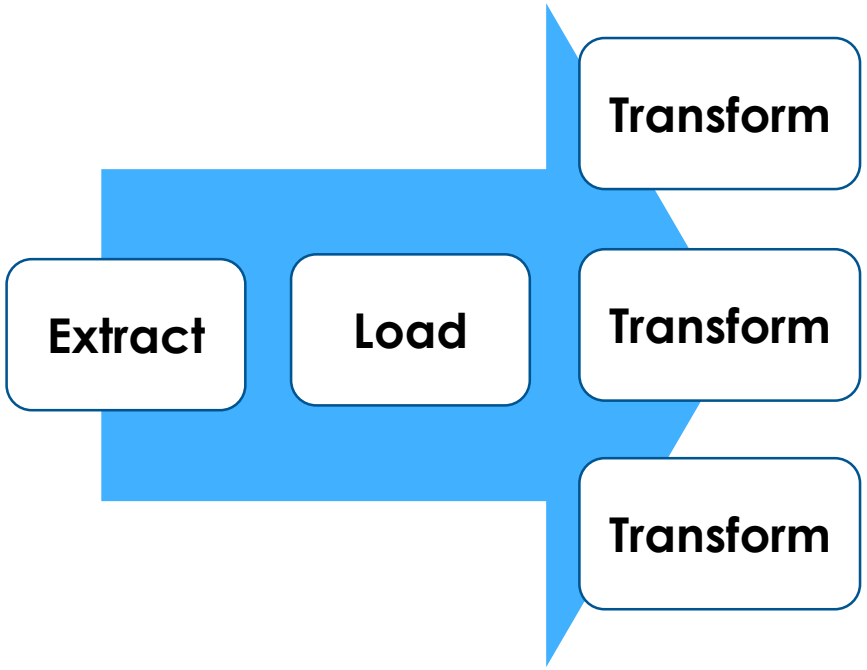


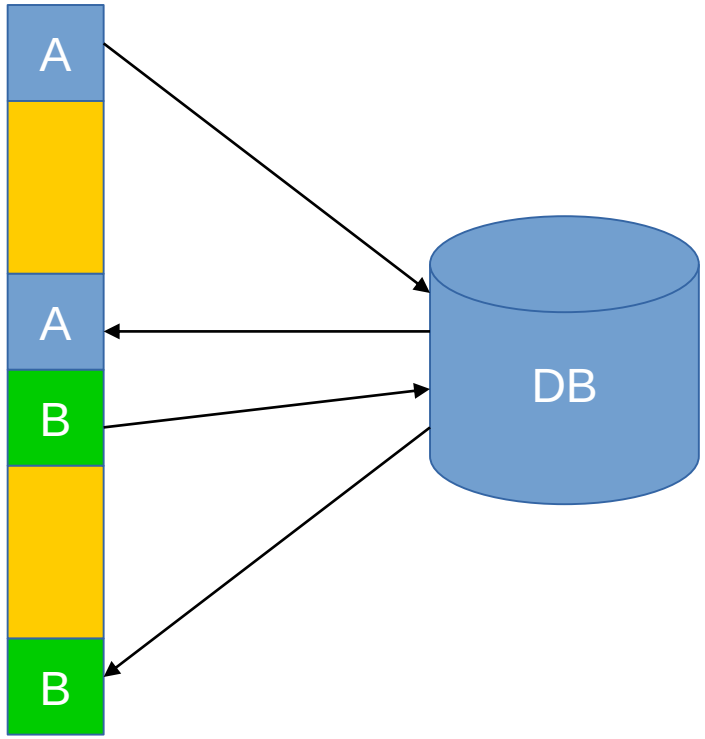
Batch Processing



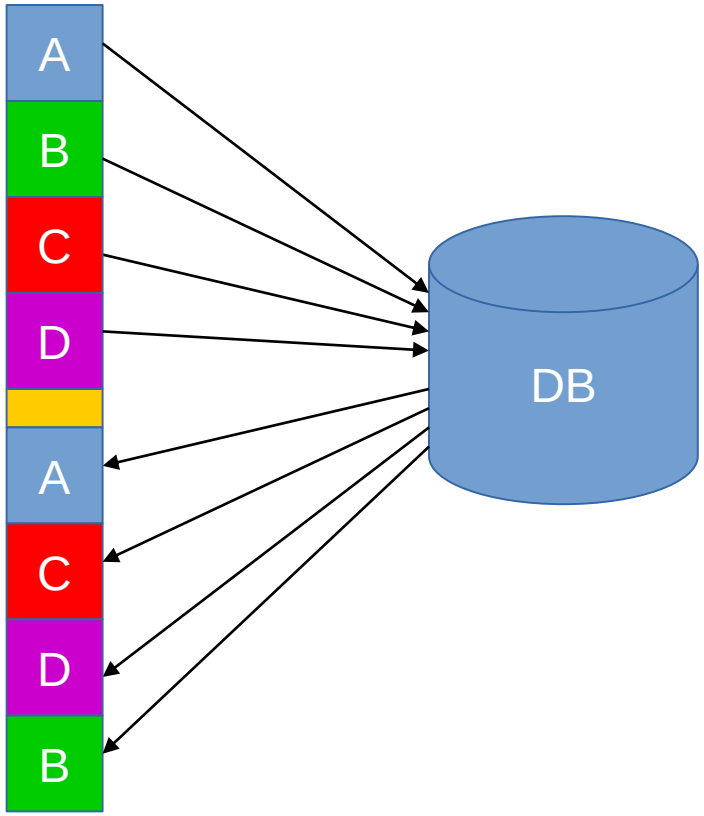


Synchronous vs. Asynchronous IO

Synchronous

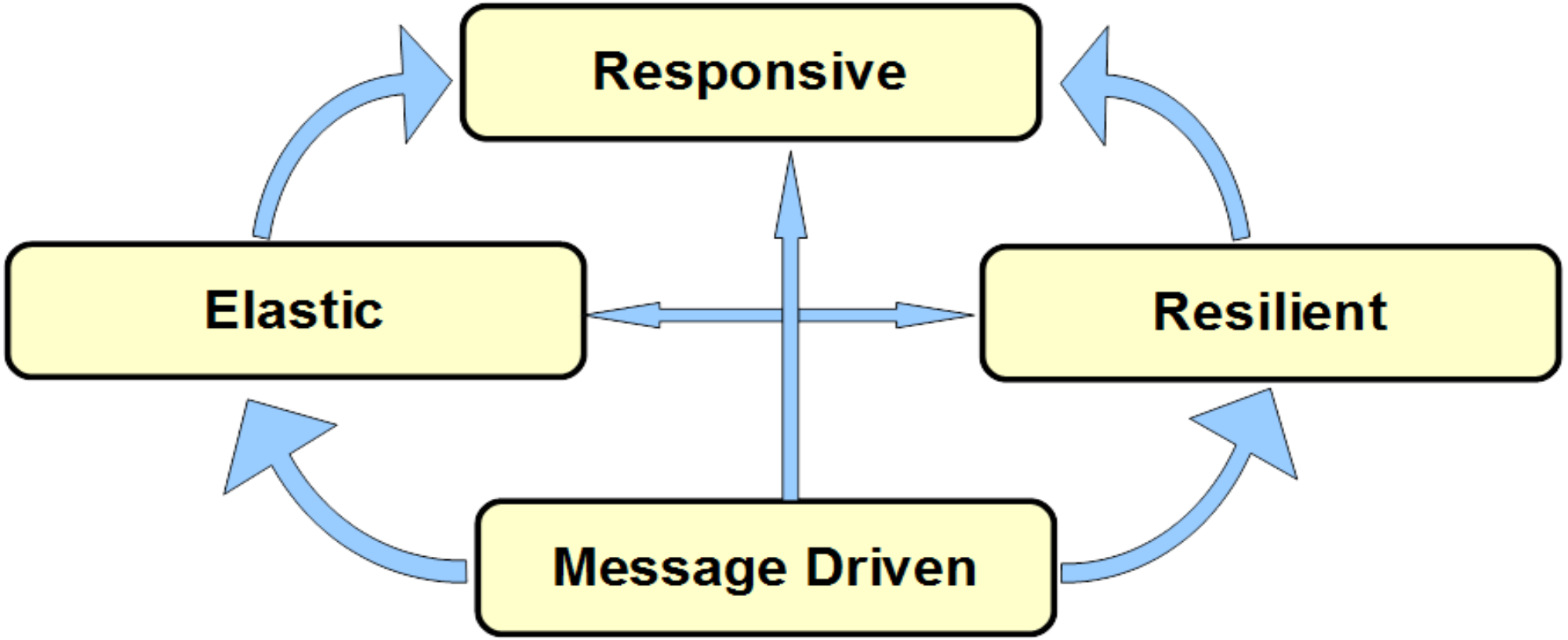


Asynchronous



Reactive Manifesto

http://www.reactivemanifesto.org



Scalable, Massively Concurrent

- **Message Driven** – asynchronous message-passing allows to establish a boundary between components that ensures loose coupling, isolation, location transparency, and provides the means to delegate errors as messages [Reactive Manifesto].
- The main idea is to separate concurrent producer and consumer workers by using **message queues.**
- **Message queues** can be **unbounded** or **bounded** (limited max number of messages)
- **Unbounded** message queues can present memory allocation problem in case the producers outrun the consumers for a long period → **OutOfMemoryError**

Data / Event / Message Streams

“Conceptually, a stream is a (potentially never-ending) flow of data records, and a transformation is an operation that takes one or more streams as input, and produces one or more output streams as a result.”

Apache Flink: Dataflow Programming Model

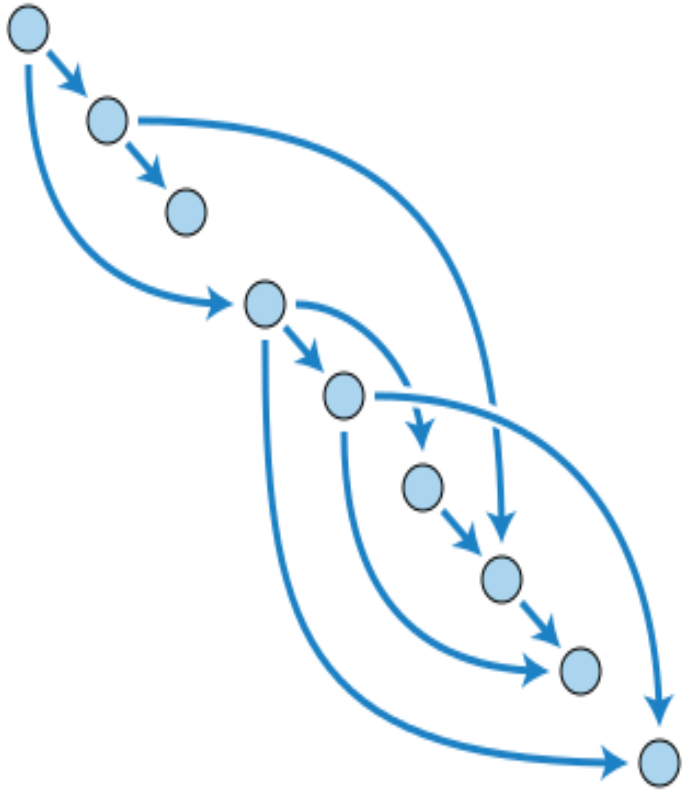
Data Stream Programming

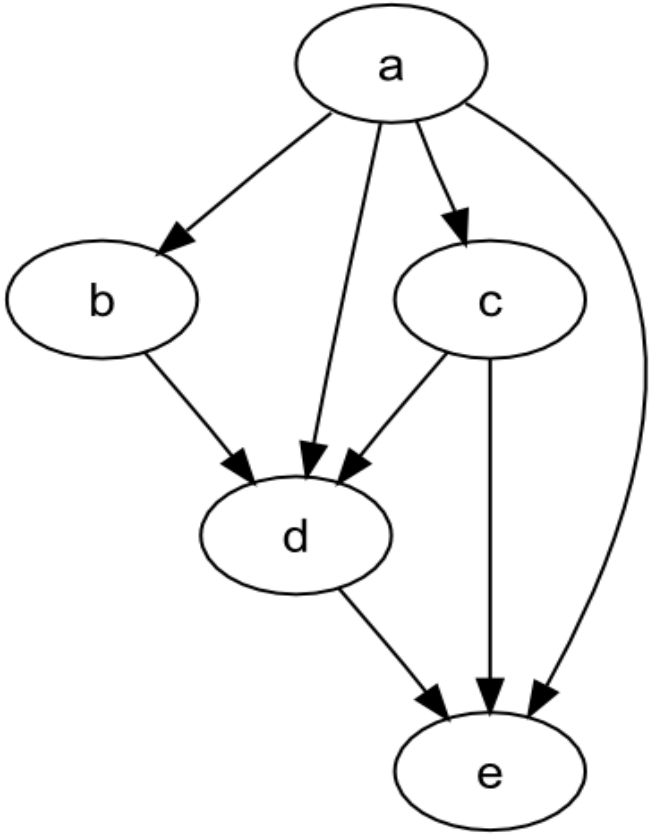
The idea of abstracting logic from execution is hardly new -- it was the dream of SOA. And the recent emergence of microservices and containers shows that the dream still lives on.

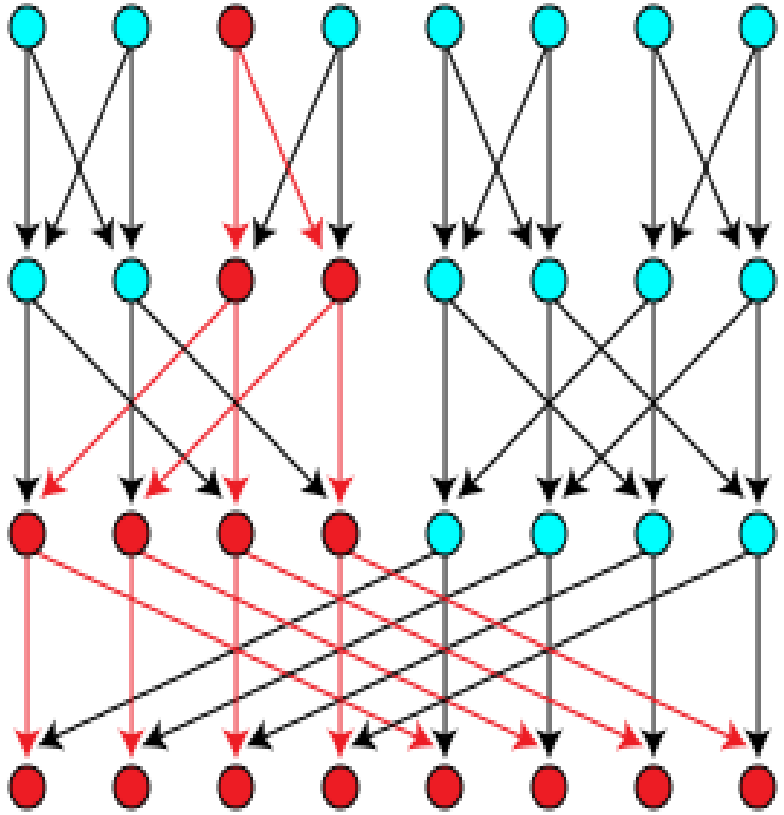
For developers, the question is whether they want to learn yet one more layer of abstraction to their coding. On one hand, there's the elusive promise of a common API to streaming engines that in theory should let you mix and match, or swap in and swap out.

Tony Baer (Ovum) @ ZDNet - Apache Beam and Spark: New coopetition for squashing the Lambda Architecture?

Direct Acyclic Graphs - DAG

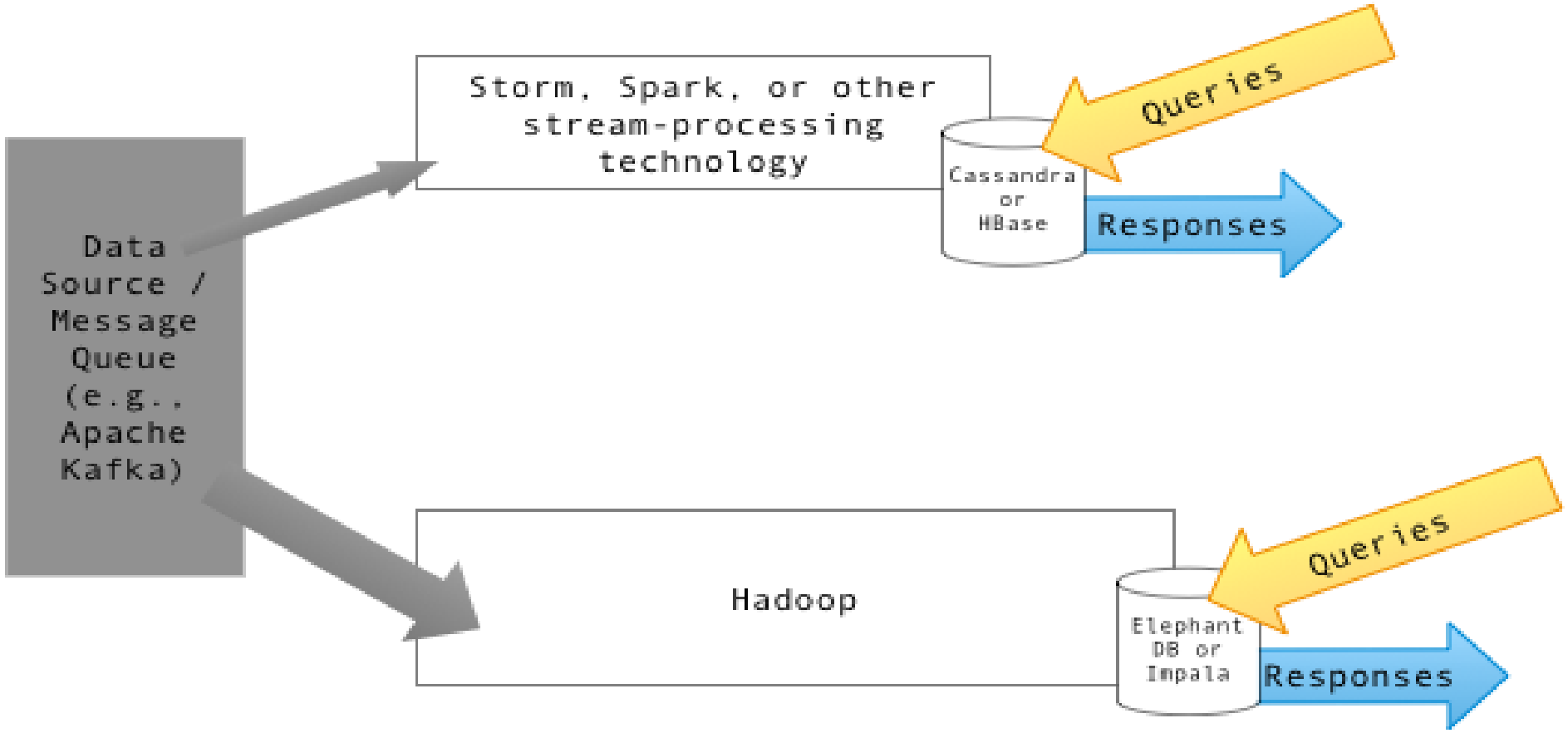






Lambda Architecture - I

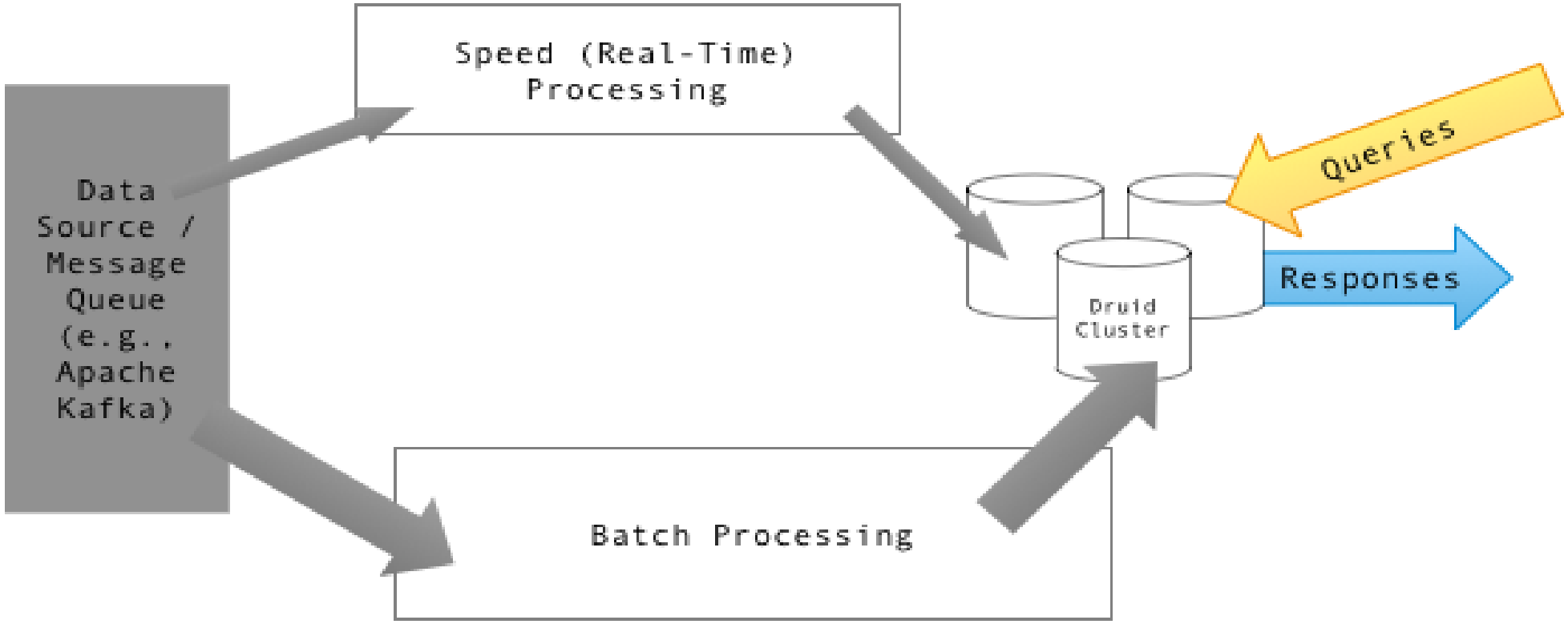
Query = λ (Complete data) = λ (live streaming data) * λ (Stored data)



https://commons.wikimedia.org/w/index.php?curid=34963987, By Textractor - Own work, CC BY-SA 4

Lambda Architecture - II

Query = λ (Complete data) = λ (live streaming data) * λ (Stored data)



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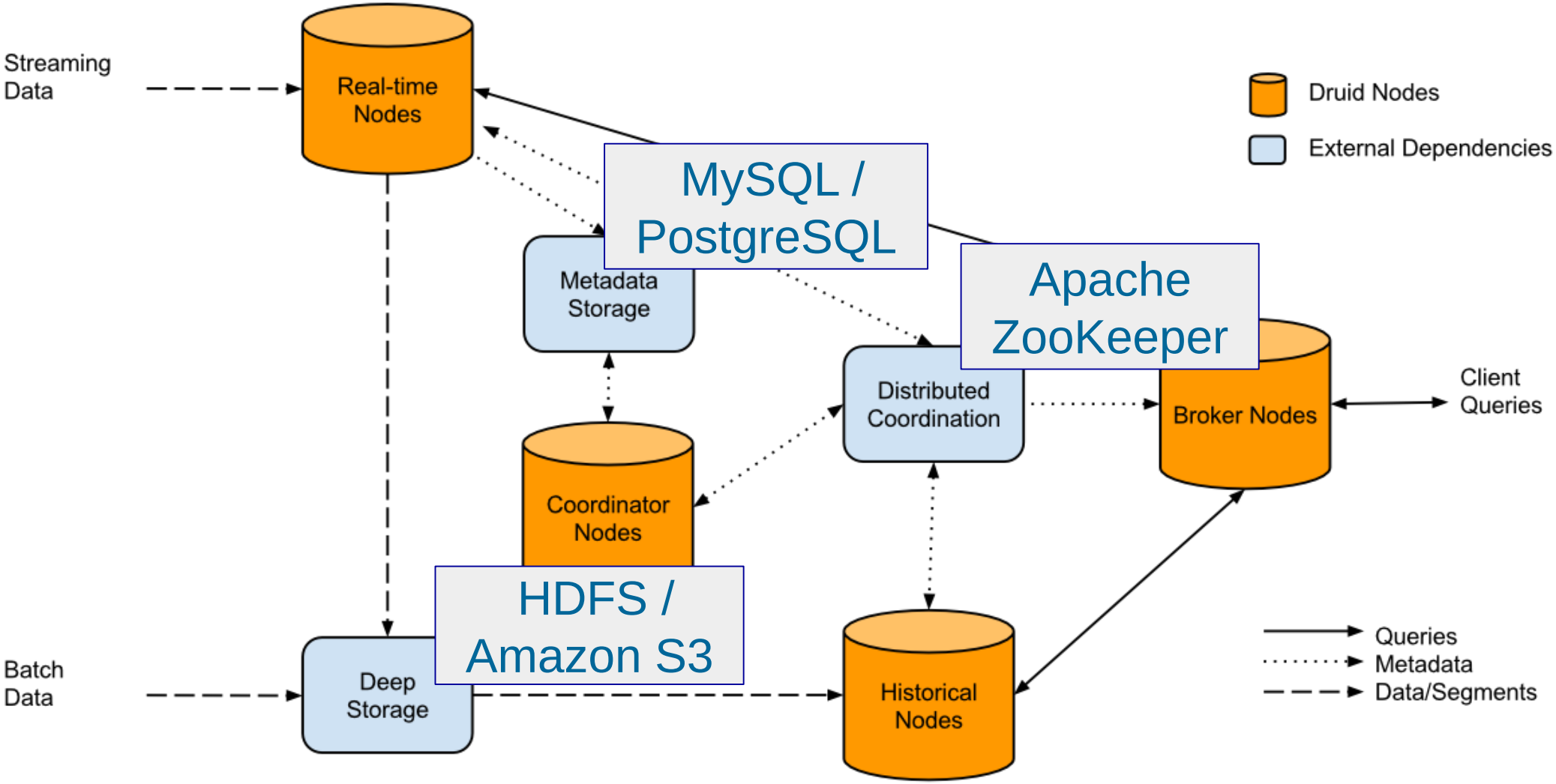
Lambda Architecture - Druid Distributed Data Store



https://commons.wikimedia.org/w/index.php?curid=33899448 By Fangjin Yang, GFDL

Kappa Architecture

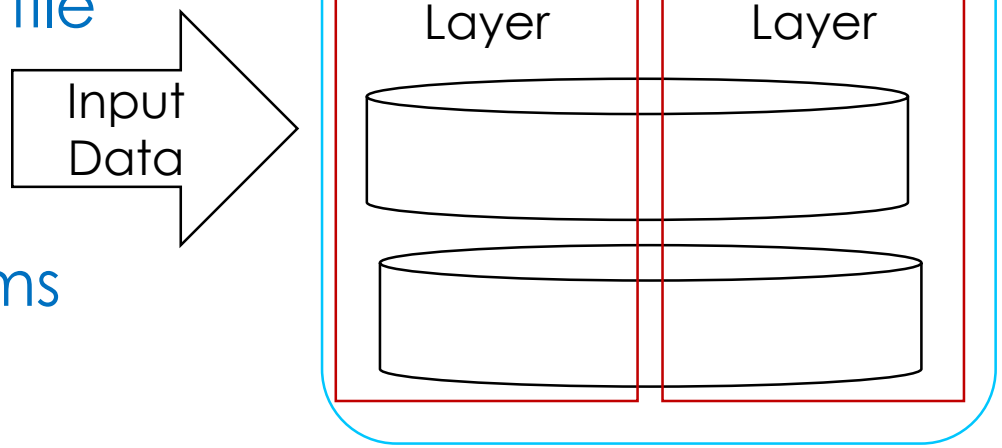
Query = K (New Data) = K (Live streaming data)

- Proposed by Jay Kreps in 2014
- Real-time processing of distinct events
- Drawbacks of Lambda architecture:
  - It can result in coding overhead due to comprehensive processing
  - Re-processes every batch cycle which may not be always beneficial
  - Lambda architecture modeled data can be difficult to migrate
- Canonical data store in a Kappa Architecture system is an append-only immutable log (like Kafka, Pulsar)

Kappa Architecture II

Query = K (New Data) = K (Live streaming data)

- Multiple data events or queries are logged in a queue to be catered against a distributed file system storage or history.
- The order of the events and queries is not predetermined. Stream processing platforms can interact with database at any time.
- It is resilient and highly available as handling terabytes of storage is required for each node of the system to support replication.
- Machine learning is done on the real time basis



Zeta Architecture

- Main characteristics of Zeta architecture:
  - file system (HDFS, S3, GoogleFS),
  - realtime data storage (HBase, Spanner, BigTable),
  - modular processing model and platform (MapReduce, Spark, Drill, BigQuery),
  - containerization and deployment (cgroups, Docker, Kubernetes),
  - Software solution architecture (serverless computing – e.g. Amazon Lambda)
- Recommender systems and machine learning
- Business applications and dynamic global resource management (Mesos + Myriad, YARN, Diego, Borg).

Distributed Stream Processing – Apache Projects:

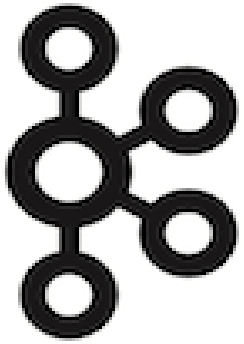
- Apache Spark is an open-source cluster-computing framework. Spark Streaming, Spark Mllib

- Apache Storm is a distributed stream processing – streams DAG

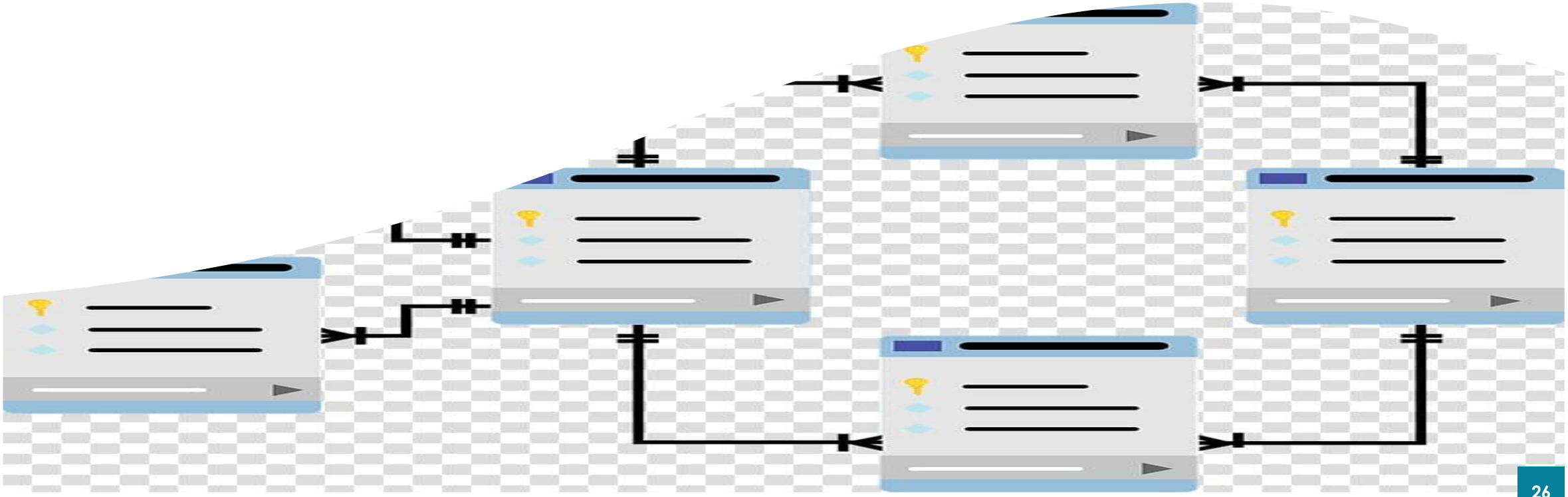
- Apache Samza is a distributed real-time stream processing framework.

Distributed Stream Processing – Apache Projects II

- Apache Flink - open source stream processing framework – Java, Scala
- Apache Kafka - open-source stream processing (Kafka Streams), real-time, low-latency, high-throughput, massively scalable pub/sub
- Apache Beam – unified batch and streaming, portable, extensible

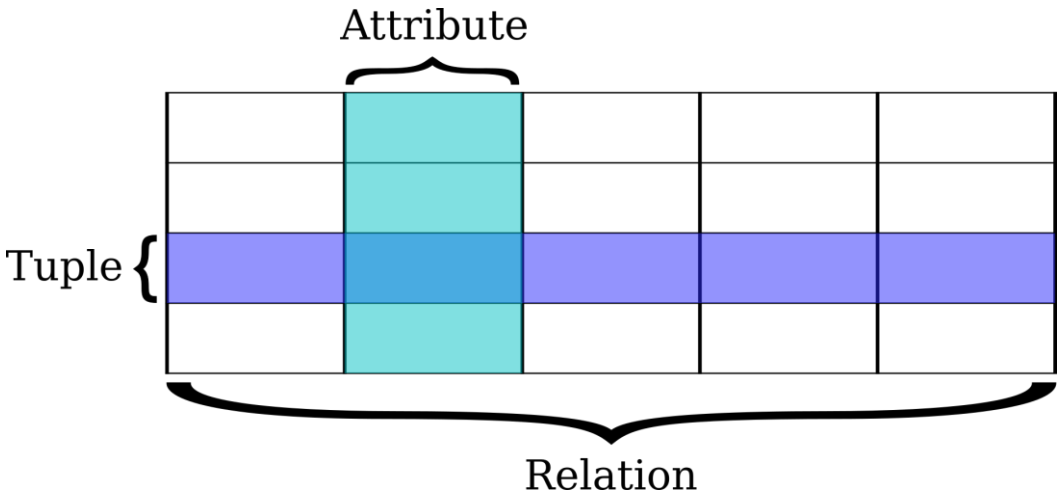


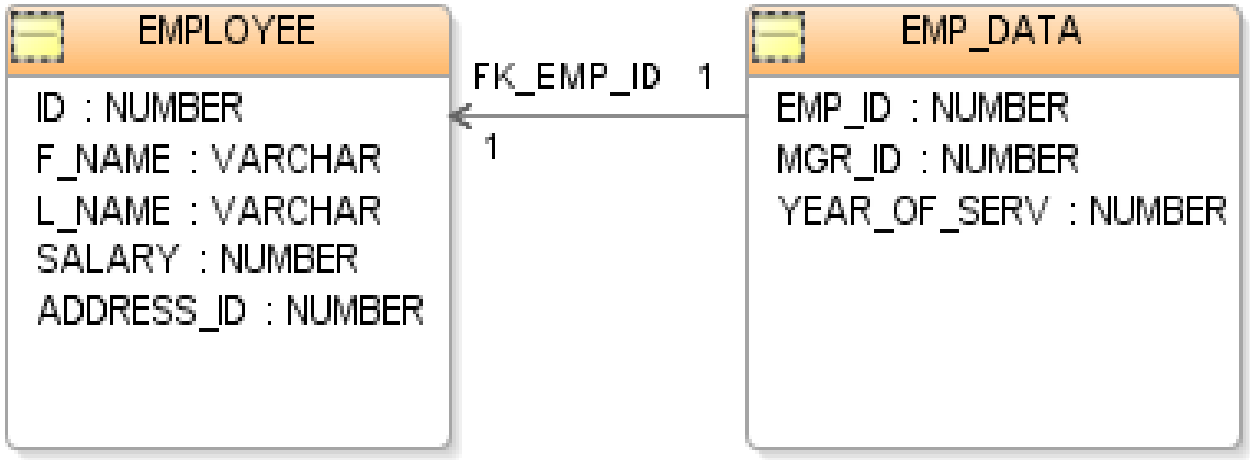
Relational Databases



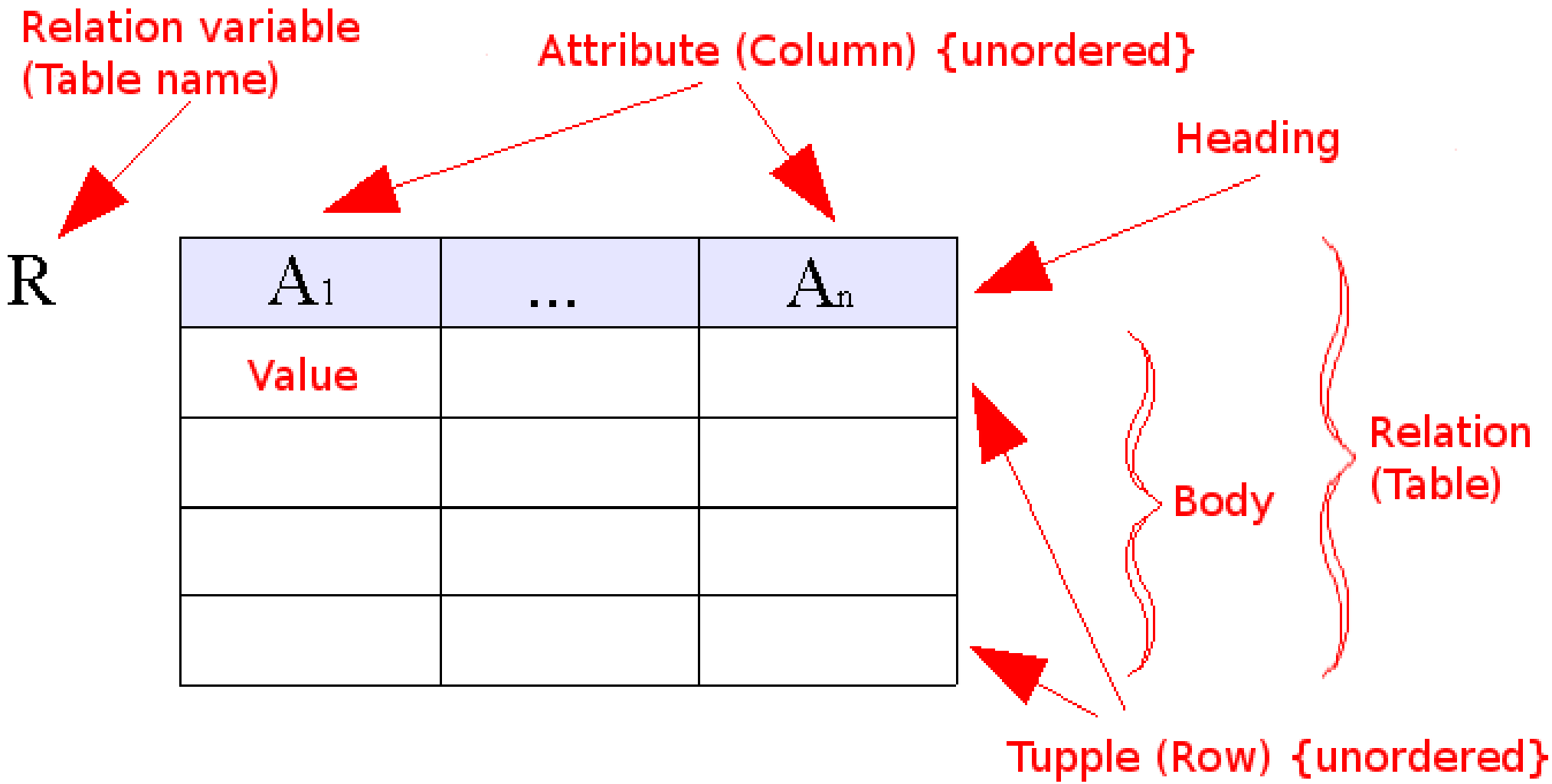
Relational Model

- relation ↔ table
- record, tuple ↔ row
- attribute ↔ column





Relational Model



Views. Domains. Constraints

- Def: Relations which store primary data are called **base relations** or **tables**. Other relations, which are derived from primary relations are **queries** and **views**.

- Def: **Domain** in database is a set of allowed values for a given attribute in a relation – an existing constraint about valid the type of values for given attribute.

- Def: **Constraints** allow more flexible specification of values that are valid for given attribute – e.g. from 1 to 10.

Keys

- **Key** consists of one or more attributes, such that:
  - 1) relation has no two records with the same values for these attributes
  - 2) there is no proper subset of these attributes with the same property
- **Primary Key** is an attribute (less frequently a group of attributes), which uniquely identifies each record (tupple) in the relation
- **Foreign key** is necessary when there exists a relation between two tables – usually it is an attribute in second table referring to primary key of the first table

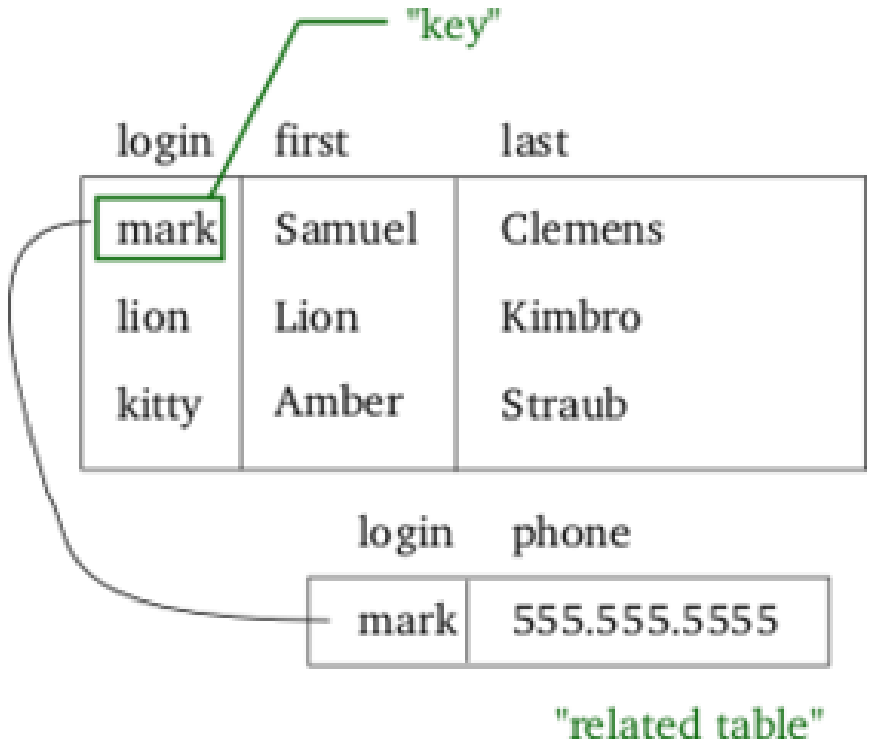
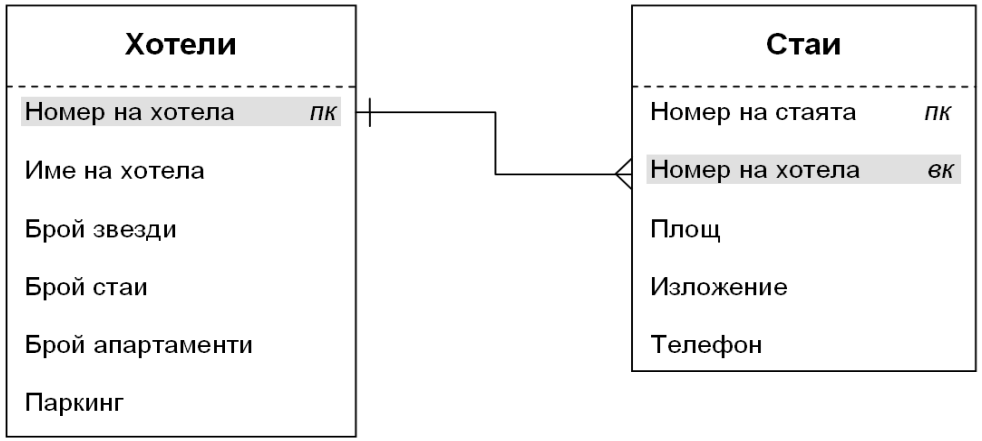
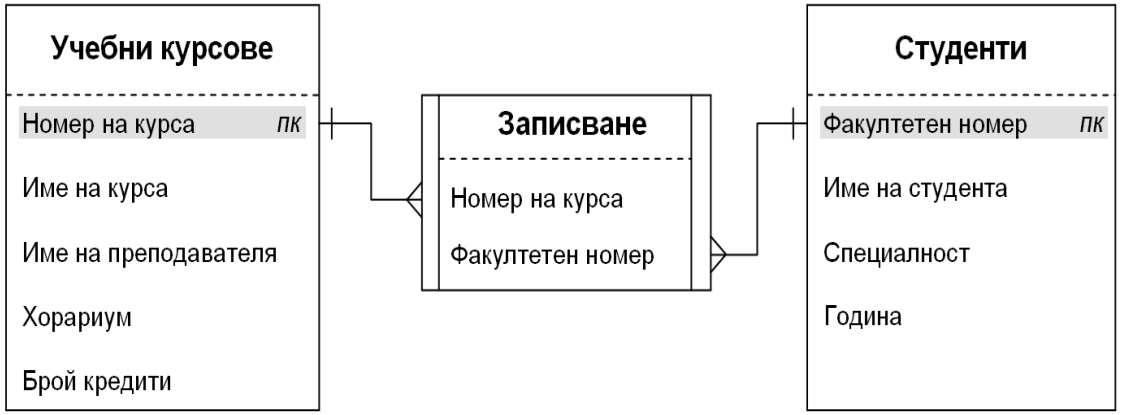


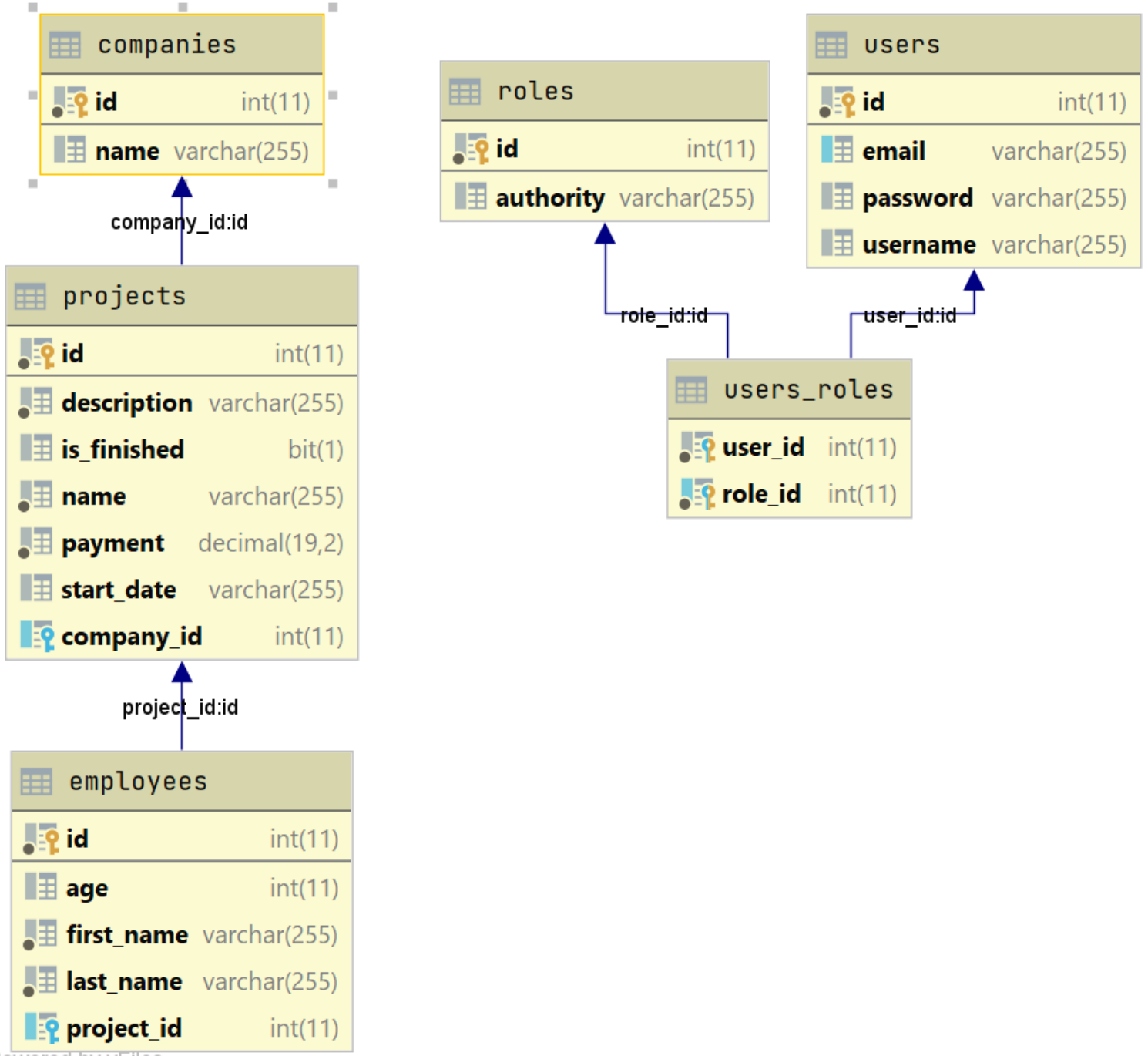
Table Relations. Cardinality

- Relationship is a dependency existing between two tables, when the records from first table can be connected somehow with records from second one.
- Cardinality:
  - One to one (1:1),
  - One to many (1:N),
  - Many to one (N:1)
  - Many to many (M:N)

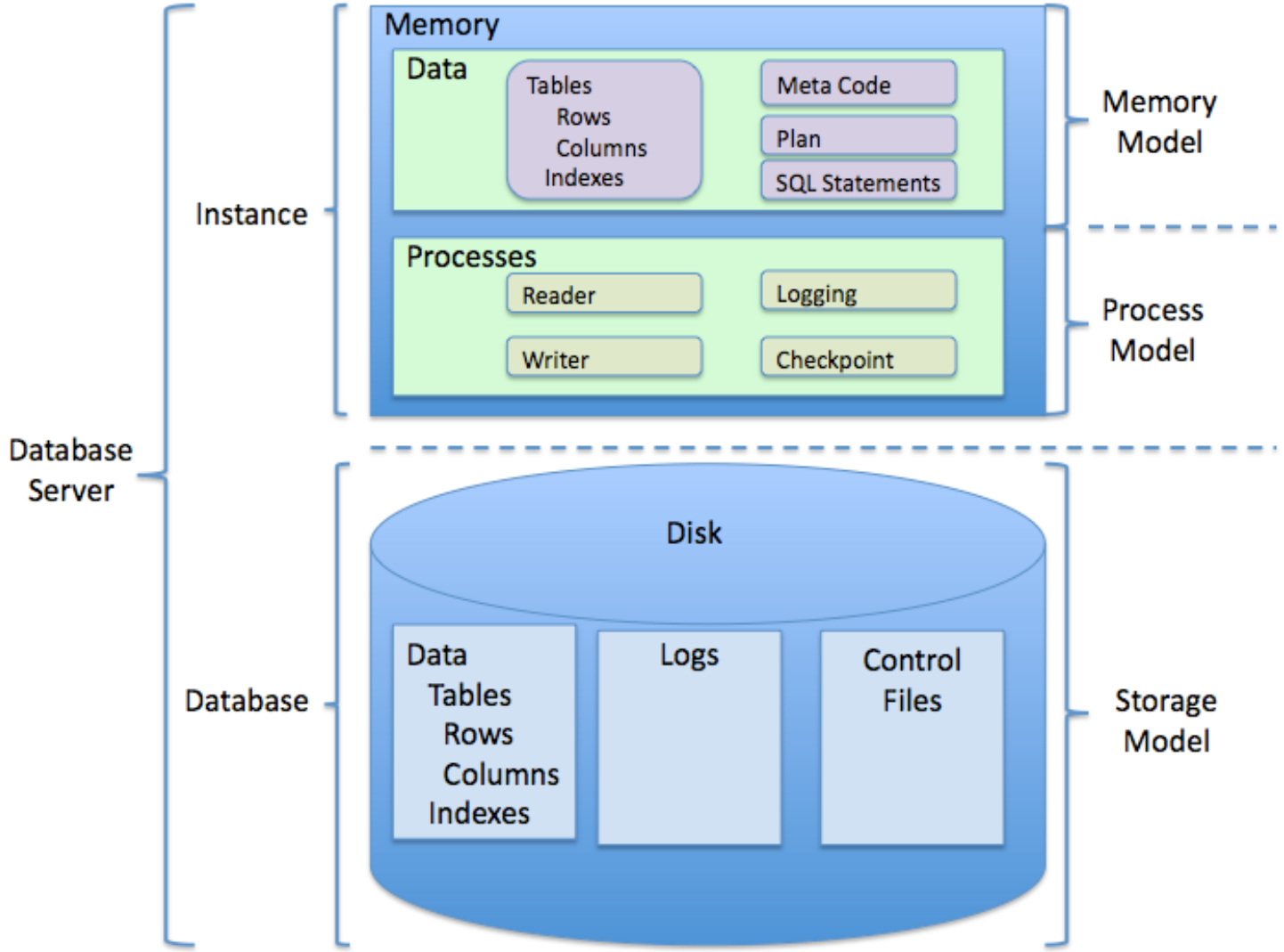




Relational Schema Example ER Model



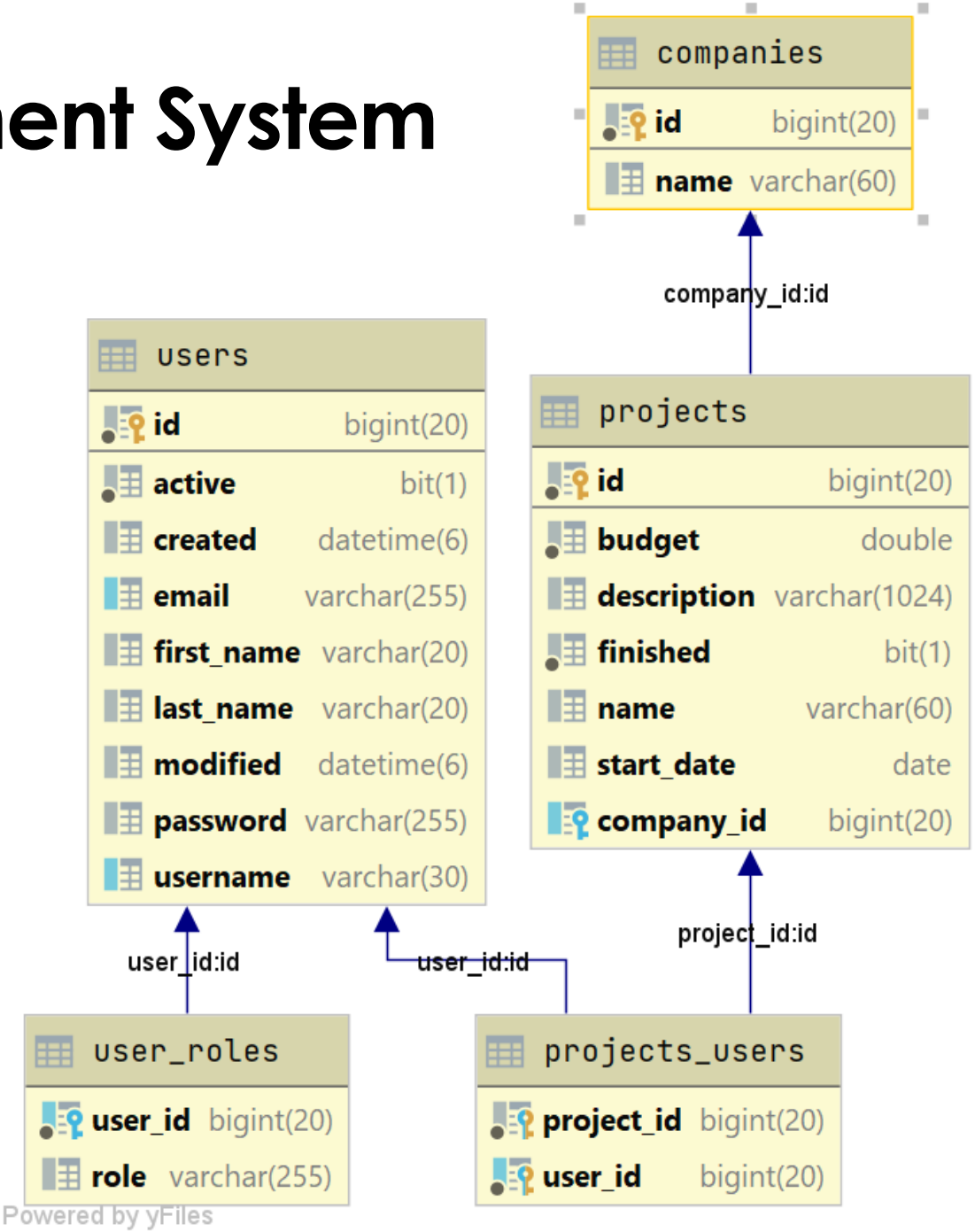
Relational Database Management System (RDBMS)

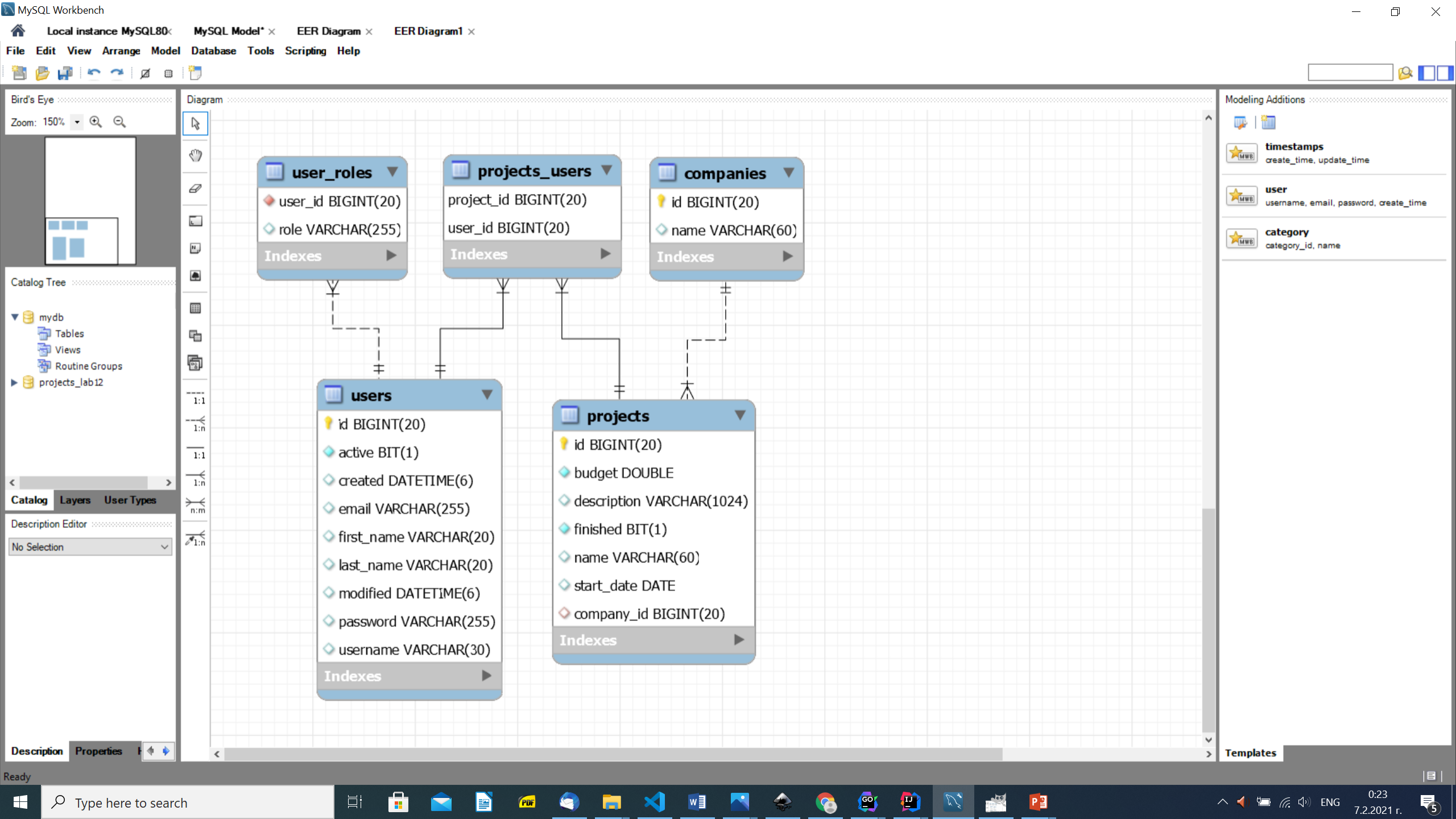


Accessing Relational Databases with Go – database/sql

Simple Project Management System

- Companies can develop multiple projects
- Each project can involve multiple users (employees)
- Users can have multiple roles in the project management system and can work on multiple projects
- Users should have unique username used for logging in the system together with a password




MySQL Workbench
Local instance MySQL80
MySQL Model*
EER Diagram
EER Diagram1
File Edit View Arrange Model Database Tools Scripting Help
Bird's Eye
Zoom: 150%
Catalog Tree
mydb
Tables
Views
Routine Groups
projects_lab12
Catalog Layers User Types
Description Editor
No Selection
Description Properties
Diagram
user_roles
user_id BIGINT(20)
role VARCHAR(255)
Indexes
projects_users
project_id BIGINT(20)
user_id BIGINT(20)
Indexes
companies
id BIGINT(20)
name VARCHAR(60)
Indexes
users
id BIGINT(20)
active BIT(1)
created DATETIME(6)
email VARCHAR(255)
first_name VARCHAR(20)
last_name VARCHAR(20)
modified DATETIME(6)
password VARCHAR(255)
username VARCHAR(30)
Indexes
projects
id BIGINT(20)
budget DOUBLE
description VARCHAR(1024)
finished BIT(1)
name VARCHAR(60)
start_date DATE
company_id BIGINT(20)
Indexes
Modeling Additions
timestamps
create_time, update_time
user
username, email, password, create_time
category
category_id, name
Templates
Ready
Type here to search
ENG
0:23
7.2.2021 г.

SQL Tutorials and Resources

- W3Schools SQL Tutorial – https://www.w3schools.com/sql/sql_select.asp
- MySQL 8.0 reference Manual – https://dev.mysql.com/doc/refman/8.0/en/
- MySQL Tutorial – https://www.mysqltutorial.org/basic-mysql-tutorial.aspx
- W3Resource MySQL Tutorial – https://www.w3resource.com/mysql/mysql-tutorials.php

database/sql: https://golang.org/pkg/database/sql/

- Create a connections pool to MySQL DB:

```
db, err := sql.Open("mysql", "root:root@/golang_projects?parseTime=true")
if err != nil {
        log.Fatal(err)
}
defer db.Close()
```

- Can add more settings to *sql.DB:

```
db.SetConnMaxLifetime(time.Minute * 5) // ensure connections are closed by the
//driver safely before MySQL server, OS, or other middlewares, helps load ballancing
db.SetMaxOpenConns(10) // maximum size of connection pool
db.SetMaxIdleConns(10) // maximum size of idel connections in the pool
db.SetConnMaxIdleTime(time.Minute * 3) // maximum time connection is kept if idle
```

database/sql: Ping the DB:

```
ctx, cancel := context.WithTimeout(context.Background(), 1*time.Second)
defer cancel()

status := "up"
if err := db.PingContext(ctx); err != nil {
        status = "down"
}


log.Println(status)
```

database/sql: Simple SELECT Query

```
func FindAllProjects(db *sql.DB) (projects []entities.Project, err error) {
	rows, err := db.Query("SELECT * FROM projects")
	if err != nil {
		return
	}
	defer rows.Close()
	for rows.Next() {
		p := entities.Project{}
		err = rows.Scan(&p.ID, &p.Name, &p.Description, &p.Budget, &p.Finished, &p.StartDate,&p.CompID)
		if err != nil {
			return
		}
		projects = append(projects, p)
	}
	if err = rows.Err(); err != nil {
		return
	}
	return
}
```

database/sql: Better SELECT Query

```
func FindAllProjects(db *sql.DB) (projects []entities.Project, err error) {
	rows, err := db.Query("SELECT * FROM projects")
	if err != nil { return }
	defer rows.Close()
	for rows.Next() {
		p := entities.Project{}
		err = rows.Scan(&p.ID, &p.Name, &p.Description, &p.Budget, &p.Finished, &p.StartDate,&p.CompID)
		if err != nil { return }
		projects = append(projects, p)
	}
	// If the database is being written to ensure to check for Close errors that may be returned from the driver. The
	// query may encounter an auto-commit error and be forced to rollback changes.
	err = rows.Close()
	if err != nil {
		return
	}
	// Rows.Err will report the last error encountered by Rows.Scan.
	if err = rows.Err(); err != nil { return }
	return
}
```

database/sql: Prepared Statement – INSERT

```
stmt, err = db.Prepare(`INSERT INTO projects(name, description , budget, start_date, finished, company_id)
                                VALUES( ?, ?, ?, ?, ?, ? )`)
if err != nil { log.Fatal(err) }
defer stmt.Close() // Prepared statements take up server resources and should be closed after use.

for i, _ := range projects {
      projects[i].Finished = true
      result, err := stmt.Exec(projects[i].Name, projects[i].Description, projects[i].Budget, projects[i].StartDate,
            projects[i].Finished, projects[i].CompanyId);
      if err != nil { log.Fatal(err) }
      numRows, err := result.RowsAffected()
      if err != nil ||  numRows != 1 { log.Fatal("Error creating new Project", err) }
      insId, err := result.LastInsertId()
      if err != nil { log.Fatal(err) }
      projects[i].Id = insId
}
```

Transactions and Concurrency

- **Transaction** = **Business Event**
- **ACID rules:**
- **Atomicity** – the whole transaction is completed (commit) or no part is completed at all (rollback).
- **Consistency** – transaction should presetve existing integrity constraints
- **Isolation** – two uncompleted transactions can not interact
- **Durability** – successfully completed transactions can not be rolled back

Transaction Isolation Levels

- DEFAULT - use the default isolation level of the underlying datastore
- READ_UNCOMMITTED – dirty reads, non-repeatable reads and phantom reads can occur
- READ_COMMITTED – prevents dirty reads; non-repeatable reads and phantom reads can occur
- REPEATABLE_READ – prevents dirty reads and non-repeatable reads; phantom reads can occur
- SERIALIZABLE – prevents dirty reads, non-repeatable reads and phantom reads

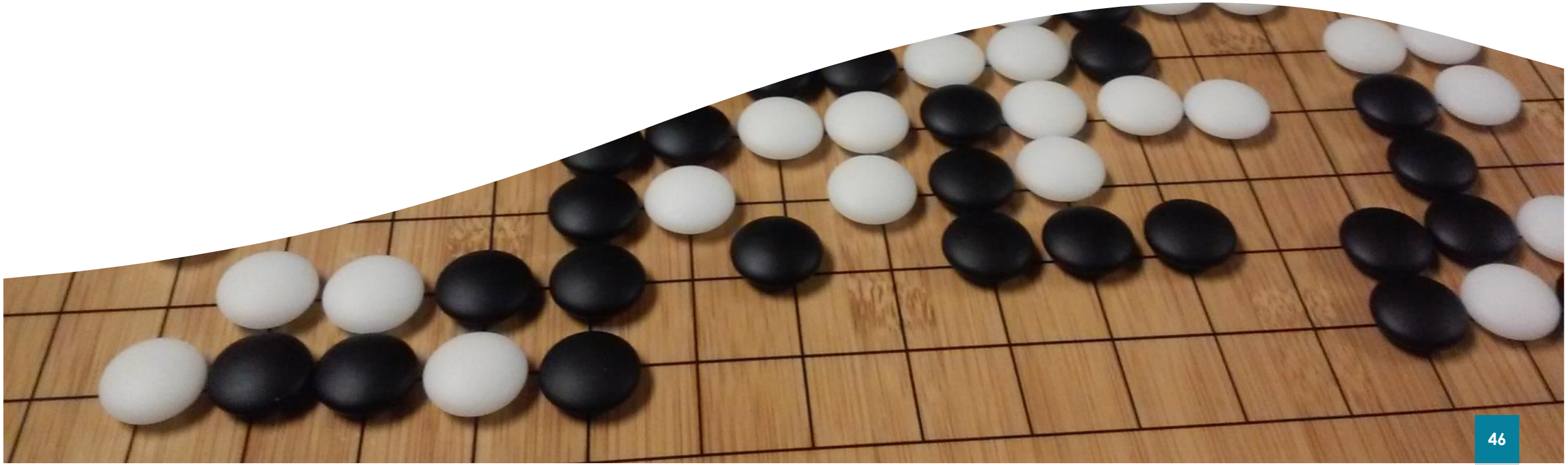
Source: https://docs.spring.io/spring-framework/docs/

database/sql: Update Project Budgets in Transaction

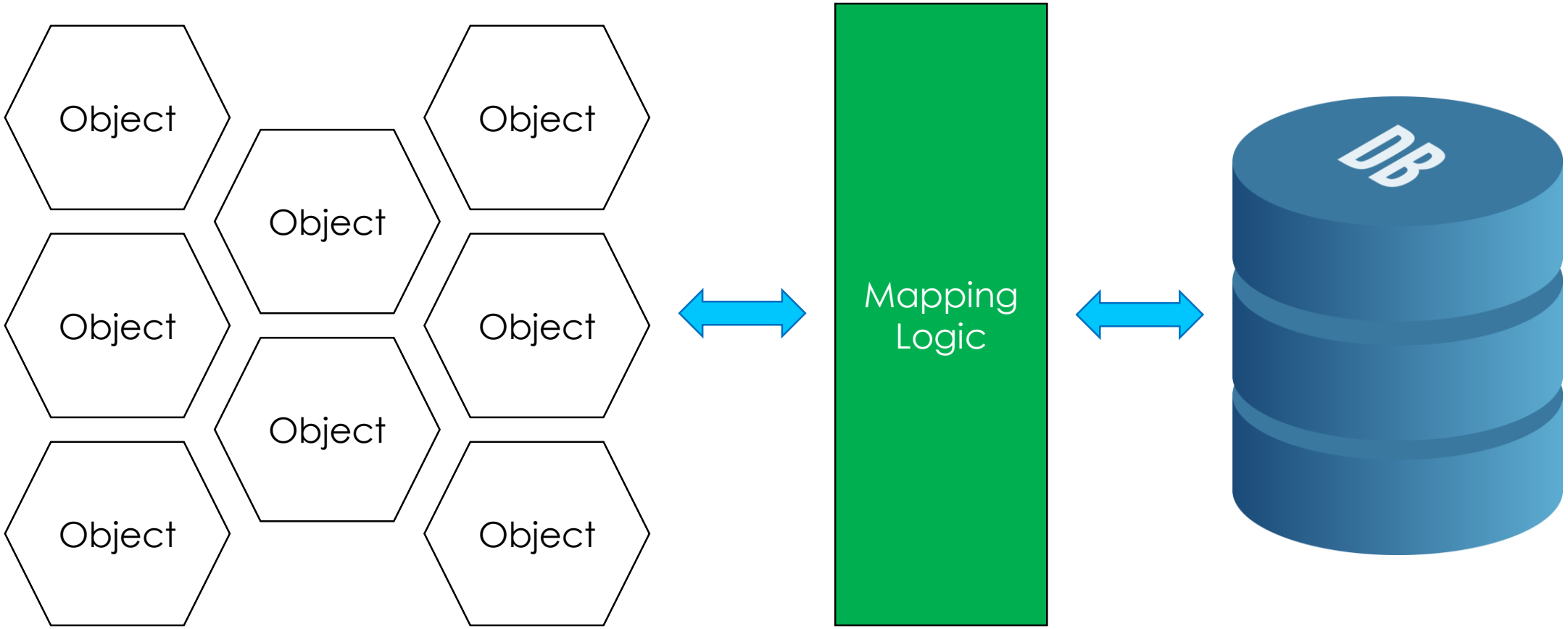
```
tx, err := conn.BeginTx(ctx, &sql.TxOptions{Isolation: sql.LevelSerializable}) // or db.BeginTx()
if err != nil { log.Fatal(err) }
result, execErr := tx.ExecContext(ctx, `UPDATE projects SET budget = ROUND(budget * 1.2)
                                                    WHERE start_date > ?;`, startDate)
if execErr != nil {
        if rollbackErr := tx.Rollback(); rollbackErr != nil {
                log.Fatalf("update failed: %v, unable to rollback: %v\n", execErr, rollbackErr)
        }
        log.Fatalf("update failed: %v", execErr)
}
rows, err := result.RowsAffected()
if err != nil { log.Fatal(err) }
log.Printf("Total budgets updated: %d\n", rows)

if err := tx.Commit(); err != nil {
        log.Fatal(err)
}
```

Go Object to Relation Mapping with GORM



Object To Relational Mapping (ORM)



gorm.io/gorm: https://gorm.io/

```
dsn := "root:root@tcp(127.0.0.1:3306)/gorm_projects?charset=utf8mb4&parseTime=True&loc=Local“

db, err := gorm.Open(mysql.Open(dsn), &gorm.Config{})

if err != nil { log.Fatal(err) }

user := entities.User{FirstName: "Rob", LastName: "Pike2", Email: "pike2@golang.com", Username: "rob2",
        Password: "rob", Active: true, Model: gorm.Model{CreatedAt: time.Now(), UpdatedAt: time.Now()}}

result := db.Create(&user) // pass pointer of data to Create

if result.Error != nil {
        log.Fatal(result.Error) // returns error
}

fmt.Printf("New user created with ID: %d -> %+v\nRows afffected: %d\n",
        user.ID, // returns inserted data's primary key
        user,
        result.RowsAffected, // returns inserted records count
)
```

gorm.io/gorm: Detiled Configuration

```
db, err := gorm.Open(mysql.New(mysql.Config{
    DSN: "root:root@tcp(127.0.0.1:3306)/golang_projects?charset=utf8&parseTime=True&loc=Local",
    DefaultStringSize: 256, // default size for string fields
    DisableDatetimePrecision: true, // disable datetime precision, which not supported before MySQL 5.6
    DontSupportRenameIndex: true, // drop & create when rename index (not supported before MySQL 5.7)
    DontSupportRenameColumn: true, // `change` when rename column (not supported before MySQL 8)
    SkipInitializeWithVersion: false, // auto configure based on currently MySQL version
}), &gorm.Config{})
```

gorm.io/gorm: Batch User Creation

```
db.AutoMigrate(&entities.User{})        // Automatically create database schema – all the tables
db.AutoMigrate(&entities.Company{})
db.AutoMigrate(&entities.Project{})
users := []entities.User{
    {FirstName: "Linus", LastName: "Torvalds", Email: "linus@linux.com", Username: "linus", Password: "linus",
                    Active: true, Model: gorm.Model{CreatedAt: time.Now(), UpdatedAt: time.Now()}},
    {FirstName: "Rob", LastName: "Pike", Email: "pike@golang.com", Username: "rob", Password: "rob",
                    Active: true, Model: gorm.Model{CreatedAt: time.Now(), UpdatedAt: time.Now()}},
}
result := db.Create(&users) // pass pointer of data to Create
//db.CreateInBatches(users, 100) // batch size 100
if result.Error != nil { log.Fatal(result.Error) } // returns error
fmt.Printf("New users created with IDs: ")
for _, user := range users { fmt.Printf("%d, ", user.ID) }
```

gorm.io/gorm: … and Query

```
result = db.Find(&users)     // Get all users - SELECT * FROM users;

if result.Error != nil {          // if returns error

            log.Fatal(result.Error)
}

fmt.Printf("Number of users: %d\n", result.RowsAffected) // returns found records count, equals `len(users)`

utils.PrintUsers(users)
```

gorm.io/gorm: Preloading (Prefetching) Associations

```
result = db.Preload(clause.Associations).Find(&companies) // SELECT * FROM companies fetching projects
if result.Error != nil {
        log.Fatal(result.Error) // returns error
}
fmt.Printf("Number of companies: %d\n", result.RowsAffected)// returns found records count, equals `len(users)`
utils.PrintCcompanies(companies)
```

```
result = db.Preload(clause.Associations).Find(&projects)      // SELECT * FROM users with associations
if result.Error != nil { log.Fatal(result.Error) } // returns error
err = db.Model(&(projects[0])).Association("Users").Find(&users) // Association mode
if err != nil { log.Fatal(result.Error) } // returns error
fmt.Printf("Users in Project '%s': %v\n", projects[0].Name, users)
```

```
db.Session(&gorm.Session{FullSaveAssociations: true}).Updates(&user) // Saving all associations
```

Common Pitfalls when Using RDBs with Go - I

- Deferring rows.Close() inside a loop → memory and connections
- Opening many dbobjects (sql.Db) → many TCP connections in TIME_WAIT
- Not doing rows.Close()when done → Run rows.Close() as soon as possible, you can run it later again (no problem). Chain db.QueryRow() & .Scan()
- Unnecessaey use of prepared statements → if concurrency is high, consider whether prepared statements are necessary → re-prepared on busy connections → should be used only if executed many times
- Too much strconv or casts → let conversions to .Scan()
- Custom error-handling and retry → database/sql should handle connection pooling, reconnecting, and retrys

Source: Common Pitfalls When Using database/sql in Go:
https://orangematter.solarwinds.com/2017/03/23/common-pitfalls-when-using-database-sql-in-go/

Common Pitfalls when Using RDBs with Go - II

- Don't forgetting to check errors after **rows.Next()** → rows.Next() can exit with error
- Using **db.Query()** for **non-SELECT** queries → iterating over a result set when there is no one, leaking connections.
- Don't assuming subsequent statements are executed on same connection → Two statements can run on different connections → to solve the problem execute all statements on a single transaction (**sql.Tx**).
- Don't mix **db** access while using a **tx** → **sql.Tx** is bound to transaction, **db** not
- Unexpected **NULL** → to scan for NULL use one of the **NullXXX** types provided by the database/sql package – e.g. NullString

Source: Common Pitfalls When Using database/sql in Go:
https://orangematter.solarwinds.com/2017/03/23/common-pitfalls-when-using-database-sql-in-go/

Homework 4

Persistence Layer for Users and Recipies

Homework 4: Persistence Layer for Users and Recipies

Using ***database/sql*** or ***Go ORM framework (gorm, xorm)*** and ***MySQL*** implement application for **users** sharing **cooking recipes**. The application should implement *Create-Read-Update-Delete (CRUD)* functionality for **users** and **cooking recipes**.

1. Implement **User** entity with following properties:

- ID (uint, auto increment by DB);
- unique user name;
- login name (u*sername* - up to 15 word characters);
- password at least 8 characters;
- gender;
- user role (*user* or *admin*);
- picture URL - optional, if missing should be substituted with a default picture of male/female avater;
- short description of the user (up to 512 characters);
- account validity status - (*active* or *deactivated*);
- date and time or registration (should be genrated automatically);
- date and time of last modification (should be updated automatically);

Homework 4: Persistence Layer for Users and Recipies

2. Implement **Recipe** entity with following properties:

- ID (uint);
- author ID (the ID of the user that has shared the Recipe - should be a valid user ID);
- recipe title (up to 80 characters);
- short description of the recipe (до 256 символа);
- time to cook (in minutes);
- used products (list of products);
- recipe picture URL - optional, if missing should be substituted with a default picture;
- detailed description (up to 2048 characters);
- keywords - tags (list of tags);
- date and time or registration (should be genrated automatically);
- date and time of last modification (should be updated automatically);

You can add more attributes if necessary.

Homework 4: Persistence Layer for Users and Recipies

3. Implement type **UserRepository** for user persitence (CRUD) operations providing following methods:

- ***FindAll() ([]User, error)*** - find all users
- ***FindAllPagedAndSorted(pageNumber int, pageSize int, sortingAttribute string, ascending bool) ([]User, error)*** - should return the ***pageNumber***-th page with maximum size of ***pageSize,*** ordered by ***sortingAttribute,*** **ascending or descending**.
- ***FindByID(id uint) (User, error)*** - should return the user with specific ID or nil and error if such user does not exist
- ***FindByUsername(username string) (User, error)*** - should return the user with specific ***username,*** or nil and appropriate error if such user does not exist
- ***Create(user *User) error*** - the ID should be updated with that returned from DB, the pasword should be hased using *bcrypt*
- ***Update(user *User) error*** - updates the user data in DB, ID should be existing in DB, username can not be changed, password if changed should be hased
- ***DeleteByID(userID uint) (User, error)*** - should delete the user from DB and return the deleted user, or nil and error if user with such ID does not exist
- ***Count() int*** - should return the count of users in DB

Homework 4: Persistence Layer for Users and Recipies

4. Implement type **RecipeRepository** for recipe persitence (CRUD) operations providing following methods:

- ***FindAll() ([]Recipe, error)*** - find all recipes
- ***FindAllPagedAndSorted(pageNumber int, pageSize int, sortingAttribute string, ascending bool) ([]Recipe, error)*** - should return the ***pageNumber***-th page with maximum size of ***pageSize,*** ordered by ***sortingAttribute,*** **ascending or descending**.
- ***FindByID(id uint) (Recipe, error)*** - returns the recipe with specific ID or nil and error if it does not exist
- ***FindAllByTitle(partOfThitle string) ([]Recipe, error)*** - returns all recipes containing part of title as substring
- ***FindAllByProducts(products []string) ([]Recipe, error)*** - should return all recipes containing all products
- ***FindAllByTags(tags []string) ([]Recipe, error)*** - should return all recipes containing at least one of the tags
- ***Create(recipe *Recipe) error*** - the ID should be updated with that returned from DB
- ***CreateBatch(recipes *[]Recipe) error*** - the IDs should be updated with that returned from DB, **all recipes should be created atomically, in a sigle transaction**, in case of rollback DB should not be changed
- ***Update(user *Recipe) error*** - updates the user data in DB, ID should be existing in DB
- ***DeleteByID(recipeID uint) (Recipe, error)*** - should delete the recipe from DB and return the deleted recipe, or nil and error if recipe with such ID does not exist
- ***Count() int*** - should return the count of recipes in DB

Homework 4: Persistence Layer for Users and Recipies

5. Create utility functions that print ***[]User*** and ***[]Recipe*** as formated tables to the console.

6. Create *main application* that demonstrates the above functionality calling all implemented methods with appropriate data

7. Implement a simple **LoginController** interface with following methods:

- ***Login(username, password string) (User, error)*** - returning the logged user if password is the same as hashed version in DB, or nil and error if not;
- ***Logout()*** - logging out the current user
- ***GetLoggedUser() User*** - returning the currently logged user

8. Add additional demo code to *main application* to demonstrate ***login/logout*** functionality

9. All ***Find**** operations should be implemented with timeout 1 second.

Recommended Literature

- The Go Documentation - https://golang.org/doc/
- The Go Bible: Effective Go - https://golang.org/doc/effective_go.html
- David Chisnall, *The Go Programming Language Phrasebook*, Addison Wesley, 2012
- Alan A. A. Donovan, Brian W. Kernighan, *The Go Programming Language*, Addison Wesley, 2016
- Nathan Youngman, Roger Peppé, *Get Programming with Go*, Manning, 2018
- Naren Yellavula, *Building RESTful Web Services with Go*, Packt, 2017

Thank's for Your Attention!

Trayan Iliev

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