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Practical task: Jan Binder (Back end)

Beginning

First of all the basics, like the technology we are using and the design are set. The database, in which all the tables and data sets are, is also appointed.

Fundamentals

You need some foreknowledgement to build a database and a database connectivity. Knowlegde about SQL, JPA and Java is required. You need these languages to create queriesor to understand how the program communicates with the database.

SQL

SQL is short for "Structured Query Language". It is used to insert, change and delete data sets or create or delete tables.

Beispielcode von SQL

```
①
CREATE TABLE mitarbeiter (
    id integer,
    nachname text,
    vorname text,
    gehalt integer
);

②
INSERT INTO mitarbeiter (id, nachname, vorname, gehalt)
VALUES (1, Mustermann, Max, 2000);


③
SELECT * FROM mitarbeiter;

④
ALTER TABLE mitarbeiter ADD CONSTRAINT "MITARBEITER_pkey" PRIMARY KEY ("id");
```

① All this code does is it creates a new table called "mitarbeiter" which contains the columns "id", "nachname", "vorname" and "gehalt". Every column has its datatype next to it. Optionally there are constraints to the columns, such as "NOT NULL". which tells the database that this column cannot be empty or "UNIQUE", which means that a data set must be unique in this column.

② The next command is INSERT INTO. This code tells the database to write data into the table. First you need to set the table with all its columns and then the values like shown.

③ The "SELECT * FROM mitarbeiter;" command picks out every data set from the table "mitarbeiter". This is done by the '*' parameter. Further there is a possibility to only select a few

specific data sets.

④ This command lets you change an already existing table. In this example I updated the tables constraints, in detail I set the primary key of the table.

JPA

Applications are made up of business logic, interaction with other systems, user interfaces and data. Most of the data that our applications manipulate have to be stored in databases, retrieved, and analyzed. Databases are important: they store business data, act as a central point between applications, and process data through triggers or stored procedures. Persistent data are everywhere, and most of the time they use relational databases as the underlying persistence engine (as opposed to schemaless databases). Relational databases store data in tables made of rows and columns. Data are identified by primary keys, which are special columns with uniqueness constraints and, sometimes, indexes. The relationships between tables use foreign keys and join tables with integrity constraints.

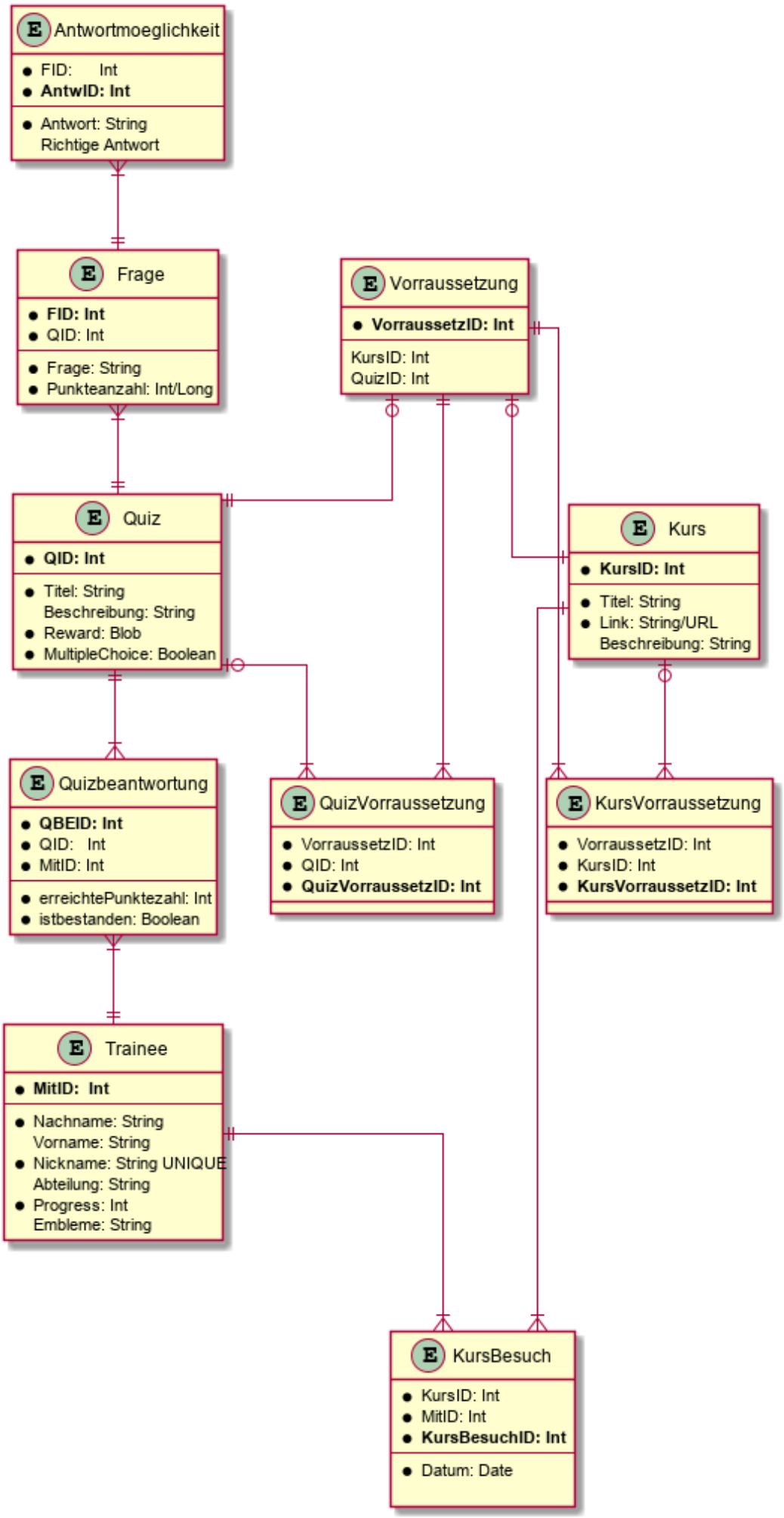
All this vocabulary is completely unknown in an object-oriented language such as Java. In Java, we manipulate objects that are instances of classes. Objects inherit from others, have references to collections of other objects, and sometimes point to themselves in a recursive manner. We have concrete classes, abstract classes, interfaces, enumerations, annotations, methods, attributes, and so on. Objects encapsulate state and behavior in a nice way, but this state is only accessible when the Java Virtual Machine (JVM) is running: if the JVM stops or the garbage collector cleans its memory content, objects disappear, as well as their state. Some objects need to be persistent. By persistent data, I mean data that are deliberately stored in a permanent form on magnetic media, flash memory, and so forth. An object that can store its state to get reused later is said to be persistent. The principle of object-relational mapping (ORM) is to bring the world of database and objects together. It involves delegating access to relational databases to external tools or frameworks, which in turn give an objectoriented view of relational data, and vice versa. Mapping tools have a bidirectional correspondence between the database and objects. Java Persistence API (JPA) is the preferred technology and is part of Java EE 7.

(vgl. Beginning Java EE-Java Persistence API, Antonio Goncalves, 2013)

Getting Started

The first task was to visually showcase how all the tables needed, connect with each other, so we can understand what we need to do, and how everything should look and interact. Here we used the diagram called ER-Modell which does exactly that for us.

ER-Modell


Antwortmoeglichkeit
FID: Int
AntwID: Int
Antwort: String
Richtige Antwort
Frage
FID: Int
QID: Int
Frage: String
Punkteanzahl: Int/Long
Vorraussetzung
VorraussetzID: Int
KursID: Int
QuizID: Int
Quiz
QID: Int
Titel: String
Beschreibung: String
Reward: Blob
MultipleChoice: Boolean
Kurs
KursID: Int
Titel: String
Link: String/URL
Beschreibung: String
Quizbeantwortung
QBEID: Int
QID: Int
MitID: Int
erreichtePunktezahl: Int
istbestanden: Boolean
QuizVorraussetzung
VorraussetzID: Int
QID: Int
QuizVorraussetzID: Int
KursVorraussetzung
VorraussetzID: Int
KursID: Int
KursVorraussetzID: Int
Trainee
MitID: Int
Nachname: String
Vorname: String
Nickname: String UNIQUE
Abteilung: String
Progress: Int
Embleme: String
KursBesuch
KursID: Int
MitID: Int
KursBesuchID: Int
Datum: Date

The ER-Model in general is a diagram, which shows the relationships between the entities of a database.

In this chapter I will showcase all the tables with their attributes and their respective meanings. Starting from the bottom to the top.

Trainee

The first table is the table "Trainee". This table contains all trainees. It contains their first name, last name, the nickname they use on the website, their department in the company and their progress they have by doing quizzes. Also every Trainee can get emblemes by completing quizzes. It has a One-To-Many relationship to the table "Quizbeantwortung" and to the table "KursBesuch".

KursBesuch

The entity "KursBesuch" is a table, which splits the many-to-many relationship between "trainee" and "kurs" into two seperate One-To-Many relationships therefor its relationships are Many-To-One to "Trainee" and to "Kurs". That means it has the PK (primary key) of both tables as a foreign key. It also provides a column named "datum" which indicates the date the user has visited the course. The function of this entity is to show which trainee has done which course and when.

KursVoraussetzung

The function of "KursVoraussetzung" is that a course can have a course or a quiz as a requirement to take this course. This table contains courses and their required quizzes or courses. Therefor it contains the "KursVoraussetzID", the "KursID" and the "VoraussetzID" as columns.

QuizVoraussetzung

This table has the same function as "KursVoraussetzung", but instead of courses with quizzes. So this table contains quizzes and the requirements to take this quiz, which can be courses or previous quizzes.

Quizbeantwortung

This entity is essential for the implementation of the "Voraussetzungs-Logik". We need this table to check if a trainee has already done a quiz. This is done with the column "istbestanden". Also it stores the points a trainee has achieved in the quiz. It also splits up a Many-To-Many relationship between "Quiz" and "Trainee" into two One-To-Many relationships.

Kurs

Here is the Kurs-Entity, it has the primary key "KursID", which helps to find a specific course from the table. The table also has a column "titel" which is basically the title of this course. It also has the constraint NOT NULL so if there is a new course there must be a title as well. The next column is the "link" it contains the links of the courses so the visitors can be redirected to the page with the explanation of the topic. This cannot be empty too. The last column is "beschreibung", which is the description of the course. This column can be empty, but it is not recommended since it helps the user specify which course contains what information.

Quiz

This is the table for all quizzes. It contains the "QID", which is the primary key, a title, a description and a reward. The title has a constraint called NOT NULL because every quiz must have a specification which topic it has. There is also a option if the quiz is multiple choice. There are also so called queries to find data with specific parameters from the database. These queries are defined in the associated entity class.

Voraussetzung

This table defines the requirement a course or a quiz can have. Therefor it containes a "KursId" and a "qid". The primary key of this table is then given to "KursVoraussetzung" or "QuizVoraussetzung" respectively.

Frage

Every Quiz contains many questions this means that "Frage" and "Quiz" have a Many-To-One relationship. The questions are stored in the table "Frage". Each question has a "FID", a "QID", so it can be connected to a quiz. A question also has the questiontext itself and points you get for each question.

Antwortmoeglichkeiten

Every question has 4 answers this means that there is a Many-To-One relationship between "Antwortmoeglichkeiten" and "Frage". These answers are stored in this table. Each answer is connected to its question. Also the answertext itself is stored here, as well as a boolean value if the answer is correct or not.

EJBs

After knowing how to connect the tables with each other, the next step was to create so called EJBs for every table we needed one for.

EJBs are components that summarize the business logic and take care of transactions and security. It is basically a connection to the database.

They must contain an annotation called "Stateless", this means that after a methode is called it is terminated. This is the usual way to annotate a EJB.

Every EJB has a methode to find exactly one entity, persist/merge an entity or delete one entitiy from the database.

KursEJB.java

```
public List<Kurs> findAll() {
    return em.createNamedQuery(Kurs.QUERY_FINDALLKURSE, Kurs.class)
    .getResultList();
}
```

The main use of this EJB is to provide the courses page with all the courses within the database.

This is done with the "findAll" methode. It is used on the courses page where all courses available are shown.

FrageEJB.java

```
@Stateless
public class FrageEJB {
    @PersistenceContext(unitName = "Diplomarbeit")
    private EntityManager em;
    private Frage frage;

    public Frage find(String FID) {
        return em.find(Frage.class, FID);
    }

    public List<Frage> findAll() {
        return em.createNamedQuery(Frage.QUERY_FINDALLFRAGEN, Frage.class)
                .getResultList();
    }

    public void update(Frage f) {
        em.merge(f);
    }


    public void delete(int FID) {
        em.getTransaction().begin();
        Frage f = em.getReference(Frage.class, FID);
        em.remove(f);
        em.getTransaction().commit();
    }

    public List<Frage> findFrageByQID(String qid) {
        return em.createNamedQuery(Frage.QUERY_FINDFRAGENZUQID, Frage.class)
                .setParameter("QID", qid).getResultList();
    }

}
```

The use of the "FrageEJB" is for example to find all questions connected to a qid. This is used to show the questions when you take a quiz. Also it is available to only find one question or all questions in form of a list.

QuizEJB.java

```
@Stateless
public class QuizEJB {
    @PersistenceContext(unitName = "Diplomarbeit")
    private EntityManager em;

    public Quiz find(String QID) {
        return em.find(Quiz.class, QID);
    }

    public List<Quiz> findAll() {
        return em.createNamedQuery(Quiz.QUERY_FINDALL, Quiz.class).getResultList();
    }

    public void update(Quiz q) {
        em.merge(q);
    }

    public void delete(int QID) {
        em.getTransaction().begin();
        Quiz q = em.getReference(Quiz.class, QID);
        em.remove(q);
        em.getTransaction().commit();
    }
}
```

The function of this EJB is to find all quizzes from the database and return them in a list to the website. Also you can find single quizzes with the methode "find", you can delete and update quizzes.

TraineeEJB.java

```
@Stateless
public class TraineeEJB {
    @PersistenceContext(unitName = "Diplomarbeit")
    private EntityManager em;

    public Trainee find(String MitID) {
        return em.find(Trainee.class, MitID);
    }

    public List<Trainee> findAll() {
        return em.createNamedQuery(Trainee.QUERY_FINDALLTRAINEES, Trainee.class)
.getResultList();
    }

    public void update(Trainee t) {
        em.merge(t);
    }

    public void delete(int MitID) {
        em.getTransaction().begin();
        Trainee t = em.getReference(Trainee.class, MitID);
        em.remove(t);
        em.getTransaction().commit();
    }
}
```

The use of this class is to provide all the trainees deposited on the database to the associated web page. As in every other EJB there is an opportunity to find, update or delete a trainee.

AntwortmoeglichkeitenEJB.java

```
@Stateless
public class AntwortmoeglichkeitenEJB {
    @PersistenceContext(unitName = "Diplomarbeit")
    private EntityManager em;

    public Antwortmoeglichkeiten find(int AntwID) {
        return em.find(Antwortmoeglichkeiten.class, AntwID);
    }

    public void update(Antwortmoeglichkeiten antw) {
        em.merge(antw);
    }

    public void delete(int AntwID) {
        em.getTransaction().begin();
        Antwortmoeglichkeiten antw = em.getReference(Antwortmoeglichkeiten.class,
AntwID);
        em.remove(antw);
        em.getTransaction().commit();
    }

    public List<Antwortmoeglichkeiten> findAntwortenByFID(String fid) {
        return em.createNamedQuery(Antwortmoeglichkeiten.QUERY_FINDANTWORTEN_BYFID,
Antwortmoeglichkeiten.class)
                .setParameter("FID", fid).getResultList();
    }

}
```

This EJB provides the page where you take the quiz with all the corresponding answers to the questions. This is done by the methode "findAntwortenByFID" which starts a query when invoked. This query is defined in the "Antwortmoeglichkeiten" entity.

QuizVoraussetzungEJB.java

```
@Stateless
public class QuizVoraussetzungEJB {
    @PersistenceContext(unitName = "Diplomarbeit")
    private EntityManager em;

    public QuizVoraussetzung find(String QuizVoraussetzID) {
        return em.find(QuizVoraussetzung.class, QuizVoraussetzID);
    }



    public void update(QuizVoraussetzung QuizVoraussetzID) {
        em.merge(QuizVoraussetzID);
    }

    public void delete(String QuizVoraussetzID) {
        em.getTransaction().begin();
        QuizVoraussetzung quizvoraussetzung = em.getReference(QuizVoraussetzung.class,
QuizVoraussetzID);
        em.remove(quizvoraussetzung);
        em.getTransaction().commit();
    }

    public List<QuizVoraussetzung> findAllQuizVoraussetzzungen(String qid) {
        return em.createNamedQuery(QuizVoraussetzung.QUERY_FINDALLVORAUSSETZUNGEN,
QuizVoraussetzung.class)
                .setParameter("QID", qid).getResultList();
    }
}
```

The "QuizVoraussetzungsEJB" allocates all "QuizVoraussetzungen" with the "findAllQuizVoraussetzungen" methode. It is used in the "Voraussetzungs-Logic".

VoraussetzungEJB.java

```
@Stateless
public class VoraussetzungEJB {
    @PersistenceContext(unitName = "Diplomarbeit")
    private EntityManager em;

    public Voraussetzung find(String VoraussetzID) {
        return em.find(Voraussetzung.class, VoraussetzID);
    }

    public void update(Voraussetzung v) {
        em.merge(v);
    }

    public void delete(int VoraussetzID) {
        em.getTransaction().begin();
        Voraussetzung v = em.getReference(Voraussetzung.class, VoraussetzID);
        em.remove(v);
        em.getTransaction().commit();
    }
}
```

This EJB is used for the requirements logic. It contains a find methode where you can search for a requirement via a "VoraussetzID", which then returns a "Voraussetzung"-Entity.

QuizbeantwortungEJB.java

```
@Stateless
public class QuizbeantwortungEJB {
    @PersistenceContext(unitName = "Diplomarbeit")
    private EntityManager em;

    public Quizbeantwortung find(String qbeid) {
        return em.find(Quizbeantwortung.class, qbeid);
    }



    public void update(Quizbeantwortung quizbeantw) {
        em.merge(quizbeantw);
    }

    public void delete(String qbeid) {
        em.getTransaction().begin();
        Quizbeantwortung quizbeantw = em.getReference(Quizbeantwortung.class, qbeid);
        em.remove(quizbeantw);
        em.getTransaction().commit();
    }

    public List<Quizbeantwortung> findByQIDAndMITID(String qid, String mitid) {
        return em.createNamedQuery(Quizbeantwortung.QUERY_FINDBY_QIDANDMITID,
Quizbeantwortung.class)
                .setParameter("QID", qid).setParameter("MitID", mitid).getResultList(
);
    }
}
```

The use of this bean is to provide information to all the quizzes a specific trainee has taken and when. This is done by a query, which is defined in the entity of this bean. It is required in the requirement logic.

Persistence.xml

persistence.xml

The "persistence.xml" is used to configure many things, such as the source of the scipt used for dropping, if the database should always drop and then create all tables, and much more.

SQL-Files

In this chapter I will introduce all SQL-files used in this project in the order they are runned when the program is started.

Dropping all tables

This script has the function of dropping every table before creating so there are no errors.

Creating the tables

This file is used to create all the tables we are using. It produces every table with its associated columns. This file is also used to give all the tables its associated primary keys and foreign keys.

Insert of data

Last there is the "insertSQL" script, which is used to insert all the data we want into the belonging table. The order of the commands is very important because, if you insert "antwortmoeglichkeiten" at first there would be no matching "FNR" or with "frage " no fitting "QID".