Free University of Bozen-Bolzano – Faculty of Computer Science
Data and Process Modelling – A.Y. 2014/2015
Midterm – 22/04/2015 ***Time: 120 minutes***

This is a closed book exam: the only resources allowed are blank paper, pens, and your head. Explain your reasoning. Write clearly, in the sense of logic, language and legibility. The clarity of your explanations affects your grade. Write your name and ID on every solution sheet. Good luck!

1 Data Modelling

1.1 Design

Austronaut Cooper (from the *Interstellar* movie) wants to build an information system for keeping track of expeditions to space objects.

A space object is identified using a code, and located in the space using the *horizontal coordinate system*. According to Wikipedia, in this system there are two independent horizontal angular coordinates:

- Altitude (Alt), sometimes referred to as elevation, is the angle between the object and the observer's local horizon. [...] it is an angle between 0 degrees to 90 degrees.
  - Alternatively, zenith distance, the distance from directly overhead (i.e. the zenith) may be used instead of altitude. The zenith distance is the complement of altitude (i.e. 90 degrees minus altitude).
- Azimuth (Az), that is the angle of the object around the horizon, usually measured from the north increasing towards the east.

Clearly, no two space objects can share the same location.

Space objects of interest are tracked in Cooper's information system either because they host people, or because they show the potential of hosting life. In the first case, Cooper also tracks all the persons that are known to live in that space object. Each person is identified using a code that is local to the space object in which that person lives. For each person, we keep track of the date of birth, name, and occupation. Codes are used to identify the different kinds of occupations (assuming that code "A" stands for "astronaut"). In general, a person may have many occupations.

Space objects of interest are of three kinds: space stations, planets, and satellites. Space stations always have a commander, who is elected among those persons who live in the space station. For the other celestial objects (planets and satellites), atmospheric parameters are of interest, such as minum, maximum and average temperature, and up to three most diffused chemical elements in the atmosphere. In addition, for satellites it it tracked what is the planet around which they orbit, together with the period of revolution (in days).

The most important aspect for Cooper is to track planned, current, and completed expeditions. In particular Cooper knows that a team of expeditioners planned (or plans) to visit a space object at a starting planned datetime. Each team is identified by a team name, and may be composed by astronauts, but possibly also robots. For simplicity, we assume that teams are defined once and forall, and that every austronaut/robot belongs to no more than one team. Robots have a name, an operating system, and are primarily identified by a hardware code. Each expeditioner assigned to a team has an expeditioner code used to identify him/her/it in the context of the team, which has in turn a global identification number.

For each expedition, Cooper wants to record in the information system all infos that are present in the expedition report. In the following, three sample reports are included.

Problem 1.1 [7 points] Design an ORM conceptual schema that represents the fact types, object types, constraints and derivation rules related to the domain described above. Consider not only the text, but also the information hidden in the tables. Remember to specify all required constraints, documenting the assumptions made when the text is not explicit.

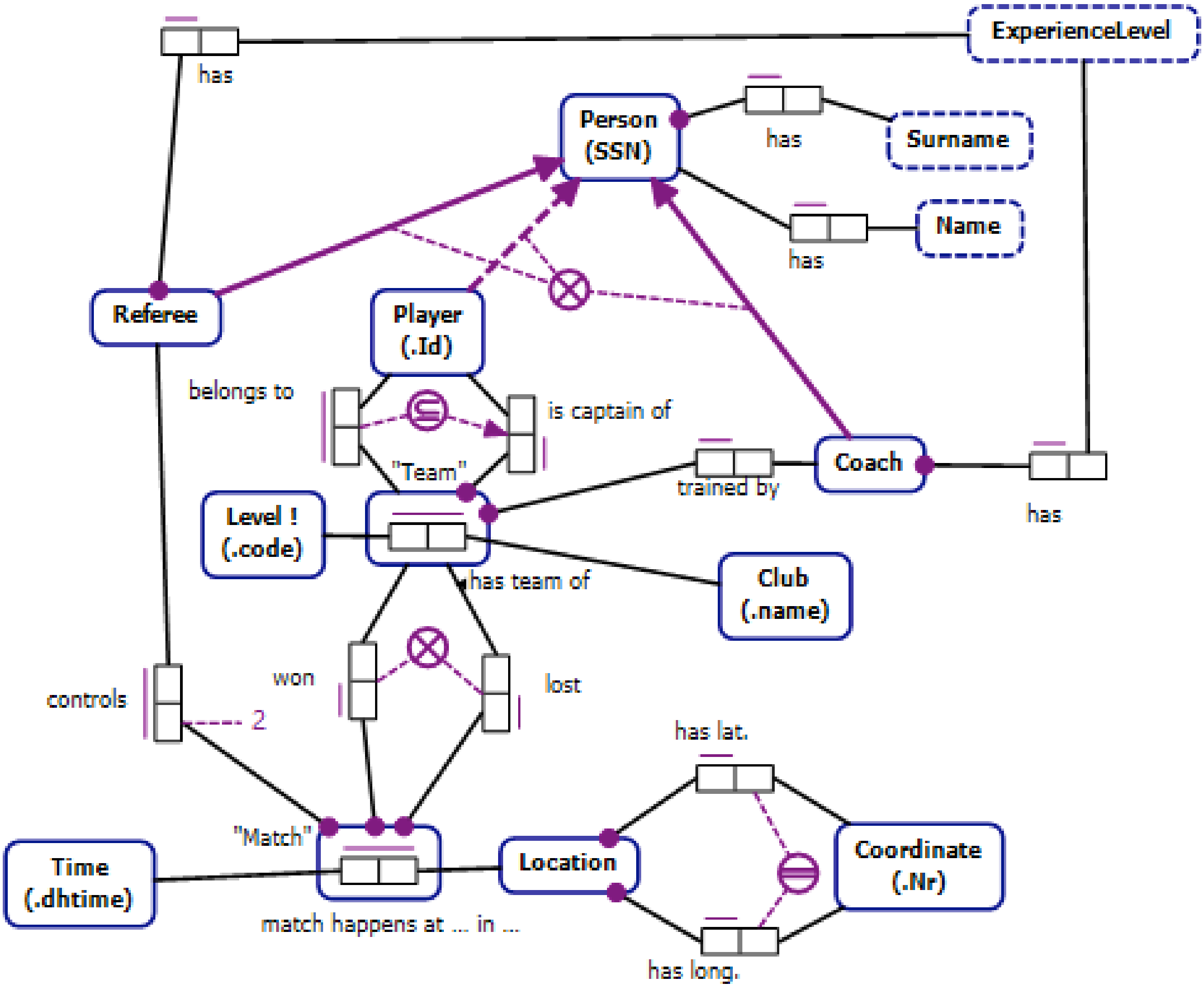
Expedition report	
Destination:	satellite XC-214-H
Planned start date: Actual start date: End date:	21/03/2051 – –
Team:	T21: • Cooper, exp. code= COO5 (*team head*) • Amelia, exp. code= AME2 • John, exp. code= JOH1 • CASE, exp. code=CASE8 (robot)
Observations:	1. 10/01/2050: needed to set up precise route.

Expedition report	
Destination:	planet P-5121-O
Planned start date: Actual start date: End date:	20/01/2050 22/01/2050 –
Team:	T21: • Cooper, exp. code= COO5 (*team head*) • Amelia, exp. code= AME2 • John, exp. code= JOH1 • CASE, exp. code=CASE8 (robot)
Observations:	1. 20/01/2050: start posticipated of two days. 2. 22/01/2050: perfect take-off. 3. 23/01/2050: going to hibernation.

Expedition report	
Destination:	space station S-32-C2
Planned start date: Actual start date: End date:	30/03/2050 30/03/2050 22/04/2050
Team:	T35: • Gordon, exp. code=GOR2 (*team head*) • Jane, exp. code=JAN2 • TARS, exp. code=TARS1 (robot)
Observations:	1. 30/03/2050: take-off ok 2. 10/04/2050: space station reached. 3. 11/04/2050: documents delivered to station commander. 4. 12/04/2050: going back home.

1.2 Relational Mapping

Consider the following ORM schema, modelling a fragment of an information system used to keep track of Volleyball teams and matches



Problem 1.2 [5 points] Build a relational schema corresponding to the ORM schema, following the `Rmap` procedure and operating as follows:

- `Referee` is absorbed into `Person`;
- `Player` and `Coach` are kept separate.

For each relation schema that you produce, highlight the primary key, alternative keys, mandatory and optional attributes. Depict relevant constraints, including foreign keys.

Problem 1.3 [1 points] Describe how the `controls` fact type (binding referees to matches) could be reformulated so as to improve relational mapping, and discuss the impact of your reformulation on the obtained logical database schema.