

# Exercise Session: 2

16 November 2017

## 1 Functional dependencies and normal forms (4 parts, 10p)

Here is a part of a planet fact box in Wikipedia:

- Name: Earth
- Star: Sun
- Position in star-system: 3
- Distance from star (in millions of km): 149.6
- Radius: 6371 km
- Surface Area:  $510 \times 10^6 \text{ km}^2$
- Percentage of area that is water: 71%
- Percentage of area that is land: 29%
- Mass:  $5.972 \times 10^{24} \text{ kg}$
- Surface gravity:  $9.807 \text{ m/s}^2$
- Atmosphere? Present
- O<sub>2</sub> (oxygen) percentage: 20.95%
- other gases: 79.05%

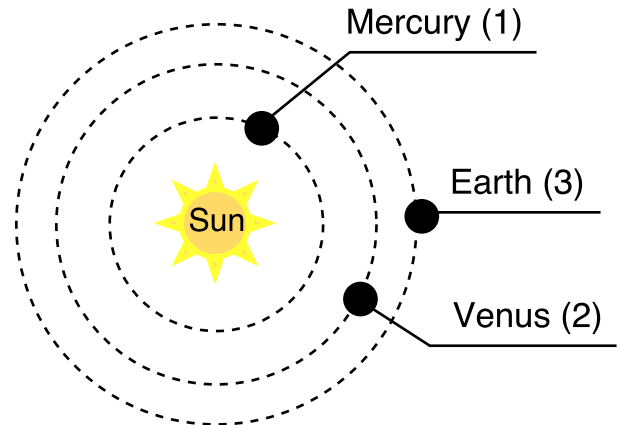


Figure 1: The planets Mercury, Venus and Earth orbit the Sun with circular orbits. The number in round brackets indicates the position in the star-system

We assume that all stars have different names, and that planet names are only unique within their star-system. A star-system has exactly one star, all planets have circular orbits around their star at different distances. A planet's position indicates which order it has in the star-system, e.g. Earth is the 3rd planet around the Sun, after Mercury and Venus. All planets are perfect spheres, and we can thus calculate their surface area from the radius using the well-known formula  $A = 4 \times \pi \times r^2$ . Likewise, the surface gravity  $g$  of a planet can be derived from its mass  $m$ , its radius  $r$  and the gravitational constant  $G$  as  $g = G \frac{m}{r^2}$ . If a planet has O<sub>2</sub> or other gases, it has an atmosphere. Without an atmosphere, a planet has no gases. The surface of a planet is either all water, all land, or a combination of water and land, but nothing else.

Now, consider the task of creating a database for this data. We start with a big table with the schema

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Planets(name, star, position, distance, radius, area, water, land, mass, gravity, atmosphere, oxygen, otherGas)
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- 2a. What functional dependencies can you find? (You don't need to list dependencies that follow from other ones you list.) (3p)
- 2b. What keys are suggested by the functional dependencies, and why? (2p)
- 2c. Which functional dependencies violate the Boyce Codd Normal Form (BCNF), and why? (2p)
- 2d. Decompose the table to bring it to BCNF. Show each step in the normalization process, and at each step indicate which functional dependency is being used. Indicate keys and references for the resulting relations. (3p)