Databases IK-AI, 2007
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1 Question 1

Consider for example a list of student numbers and their telephone numbers:

Student nr.	Telephone nr.
43555	035432433
23432	062343444
32434	020345435
etc.	etc.

1.1 The three levels of data abstraction

1.1.1 Physical level

On the physical level it is decided how these integers will be represented in memory. Storing them as "long" integers is the best. But one could also store them as binary coded decimals (BCD), which might be useful for searching substrings of digits.

In lower level programming languages (eg. C) this is up to the programmer. In higher level programming languages it is handled by the interpreter/compiler, eg. in Python:

```
telnrs = [[4355, 035432433], etc]
```

1.1.2 Logical level

The logical level describes what kind of data are stored. You could allow multiple telephone numbers per student, or vice versa.

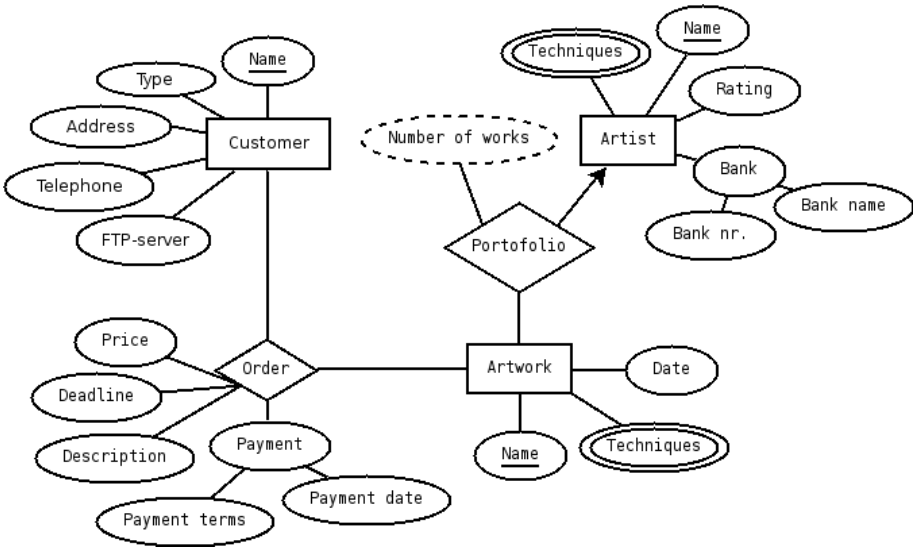
1.1.3 View level

The view level defines how the data can be accessed. In case of phonenumbers it is often not allowed to search by phonenumber, but only to search for the phonenumber belonging to a person. It is also not useful to match a part of a studentnumber or phonenumber, only exact matches count.

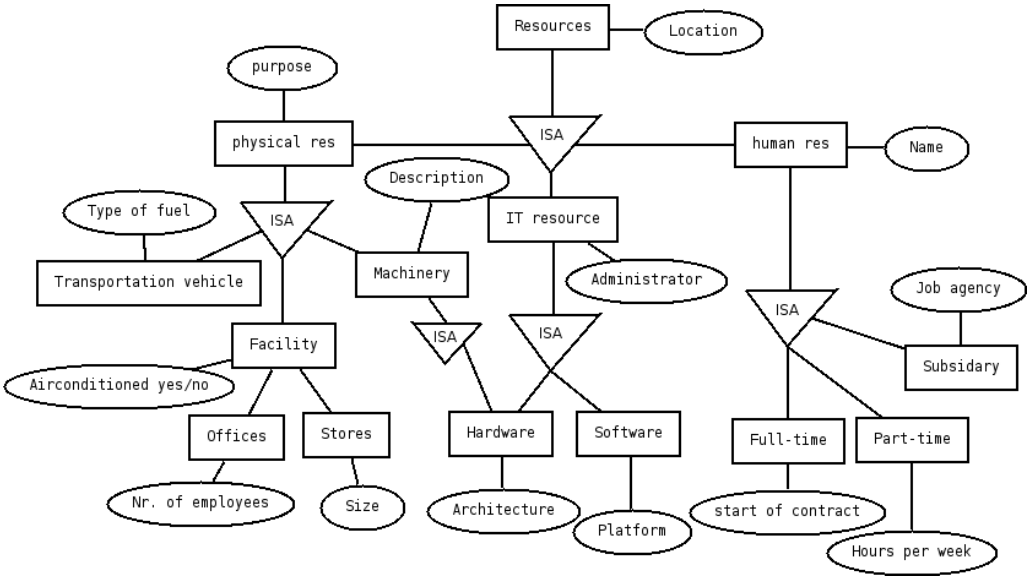
1.2 The schema and its instances

In this case the schema is simply a tuple with a 5 digit number (student ID) and a 9 digit (phone) number. The instances are the records of students and their phonenumbers.

2 Question 2



3 Question 3



4 Question 4

4.2

$$notrented\_apartments \leftarrow \Pi_{a\#}(Apartment) - \Pi_{a\#}(Agreement)$$
$$single\_apartments \leftarrow \sigma_{a-capacity=1}(Apartment)$$
$$\Pi_{a-address,a-monthly-rent}(single\_apartments)$$

4.4

$$appcount \leftarrow am\#\mathcal{G}count(a-date)asapp-count(\sigma_{a-date=2006}(Appointment))$$
$$maxapp \leftarrow \mathcal{G}max(app-count)asapp-count(appcount)$$
$$maxam \leftarrow \sigma_{app-count=maxapp.app-count}(appcount)$$
$$\Pi am-name(\sigma_{am\#=maxam.am\#}(Apt-manager))$$

4.6

$$avg-rent \leftarrow \mathcal{G}avg(a-monthly-rent)(Apartment)$$
$$\Pi_{a-address,a-capacity}(\sigma_{a-monthly-rent>avg-rent.a-monthly-rent}(Apartment))$$

4.8

$$amj \leftarrow \sigma_{am-name="Johnson"}(Apt-manager)$$
$$tj \leftarrow \Pi_{t\#}(\sigma_{am\#=amj.am\#}(Appointment))$$
$$aj \leftarrow \Pi_{a\#}(tj \bowtie Agreement)$$
$$\Pi_{a-address}(aj \bowtie Apartment)$$