

### Homework 3

CS 435  
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1] Let  $r$  be a relation over  $R(\mathcal{U})$ , and  $X \subseteq \mathcal{U}$ . Prove that if  $X$  is a superkey for  $r$ , then for every  $Y \subseteq \mathcal{U}$ ,  $r$  satisfies  $X \rightarrow Y$ .

2] Let  $R(\mathcal{U})$  be a relation scheme in Boyce-Codd Normal Form with a set  $F$  of designated functional dependencies. Prove that in all relation instances  $r$  over  $R(\mathcal{U})$ ,  $r$  satisfies all functional dependencies in  $F$ .

3] Let  $r_1, r_2$  be relations over  $R_1(X), R_2(X)$ , respectively. Prove that

$$r_1 \bowtie r_2 = r_1 \cap r_2.$$

4] Consider a database scheme referring to a catalogue of books with personal data on the authors:

BOOKS (ISBN, Author, Title, Publisher, Year)

COAUTHORS (ISBN, JointAuthor)

PERSONS (Name, Birth, Residence)

PUBLISHERS (Publisher, City)

where Author indicates the senior author of each book, the others (if any) being stored in the COAUTHORS relation, and Residence is the city of residence of a person (assumed invariant). Formulate the following queries in relational algebra, i.e., write expressions using selection, projection, natural join, union, intersection, difference, and renaming that retrieve the following:

- Find the books whose senior author lives in the city of the publisher.
- Find the joint authors who are younger than their senior authors, indicating also the title of the book and the year of publication.
- Find the pairs of people who published together more than one book, exchanging the roles of senior author and joint author.
- Find the authors who published a book before a coauthor of a subsequent book of theirs was born.