Problem Set 2 Solutions

1.(a)

(b) VCFunds(name, number, size, closingdate)
    Startups(name, addr, industry)
    StealthCompanies(name, industry, buzz)
    PrivateCompanies(name, industry, buzz, CEO)
    Industries(name, size)
    Sectors(name, industry, growth)
    Invests1(VCname, VCnumber, name, industry)
    Invests2(VCname, VCnumber, name, industry, sector)
    Belongs(name, industry, sector)
    Targets(stealthName, stealthIndustry, privateName, privateIndustry)

The E/R diagram has two possible sources of inconsistencies, the first of which is eliminated in the relational schema:
i. Private companies are connected to their industry directly via Partof relationship and indirectly via the Belongs relationship to Sectors. So, the E/R diagram allows a company to be a part of one industry, but belong to a sector in another industry. In the relational schema, we can fix this bug by listing industry only once in Belongs, even though it is part of the key for Sectors and the key for PrivateCompanies.

ii. Similarly, Invest2 and Belongs may connect one private company to two different sectors.

2.(a) First, from EA->D and BD->CE, we can get two superkeys: \{A, B, E\} and \{A, B, D\}. Since we know that there are two keys of size 3, A, D and E cannot appear in the right side of B->?; otherwise, we would have a key of size less than 3 by eliminating the attribute that is hidden by ? from the superkeys. So, the only possible value for the hidden attribute is C and the two keys of size 3 are \{A, B, E\} and \{A, B, D\}.

(b) No. BD->C and B->C violate 3NF.

(c) No. All of the three dependencies violate BCNF. One possible decomposition of R into BCNF is:

   R1(B, C) with FDs: B -> C.
   R2(A, D, E) with FDs: EA-> D.
   R3(A, B, E) with no FDs.

3.(a) A  B  C
    a1  b1 c1
    a1  b2 c1
    a2  b1 c1
    a2  b2 c2

(b) The minimum number is 4. To violate A->C, we need at least two tuples t and u such that t and u agree on A and disagree on C. To violate C->A, we need at least one more tuple v which agrees with t on C but disagrees on A. To violate CA->B we need two tuples that agree on A and C but disagree on B. Since no two tuples among t, u, and v agree on both C and A we need at least one more tuple w. So, we need at least 4 tuples and the example in (a) shows that 4 is enough.

4.(a) Yes.

   A  B  C
   a1  b1  c1
   a1  b1  c2
   a1  b1  c3

(b) Yes.

   A  B  C
   a1  b1  c1
   a1  b2  c1

5.(a) \{A, B, D\}.
(b) Yes. Because it satisfies FD: A->C, proved below.

(c) Yes. Suppose tuples t and u agree on A but disagree on C. Since B->C, then t and u must also disagree on B. But A->->B, so there is a tuple v that agrees with t on A and B and agrees with u on C and D. Then, t and v agree on B but disagree on C, since t and u disagree on C. Contradiction. Thus, there are no tuples that agree on A and disagree on C, and therefore A->C.

(d) All of the dependencies violate 4NF.
   The new schema in 4NF is: {A, B}, {A, C}, {A, D}; or, {A, B}, {B, C}, {A, D}.