# DASC 5333 Database Systems for Data Science
# CSCI 4333 Design of Database Systems
# Spring 2025
# Suggested Solution for Homework #7

[1] See h7q1_sol.pdf.

[2] F = {C->AD, AC->E, BE->F, F->A} |- prove BC -> F

Proof.

[1] C->AD (given)
[2] C->A (decomposition of [1])
[3] AC->E (given)
[4] CC->E (pseudo-transitivity rule on [2] and [3])
[5] C->E (simplification of [4])
[6] BE-> F (given)
[7] CB->F (pseudo-transitivity rule on [5] and [6])

[3]

[a] R(A,B,C,D) {B->AD, AD->C}

CK:[1] B
Canonical Cover (optional): {B->AD, AD->C}; as is.
Highest NF: 2NF
Reason: AD-> C violates 3NF since AD is not a superkey and D is non-prime.

[b] R(A,B,C,D) {AB->D, BD->C}

CK:[1] AB
Canonical Cover (optional): {AB->D, BD->C}; as is.
Highest NF: 2NF
Reason: The FD BD -> C violate 3NF. BD is not a superkey and C is a non-prime attributes.

[c] R(A,B,C,D) R(A,B,C,D) {C->ABD, AD->BC}

CK: [1] C, [2] AD
Canonical Cover (optional): {C->ABD, AD->C}.
Highest NF: BCNF
Reason: The LHS of all non-trivial FD are superkeys.

[d] R(A,B,C,D) {A->B, B->A, AC->D, AD->C}

CK:[1] AC, [2] BC, [3] AD, [4] BD
Canonical Cover (optional):

Highest NF: 3NF
Reason: In 3NF as all attributes are prime. However, A -> B and B -> A violate BCNF.

[4] Consider F = {A->C, BD->E, D->BC, E->B, BE->C}

(a) A+=AC, B+=B, C+= C, D+=BCDE, E+=BCE

(b) The candidate key is AD

(c) Prime: A, D, non-prime: B, C, E

(d) {A->C, D->E, E->BC}

(e) 1NF since A->C violates 2NF: C is non-prime and A is a proper subset of a CK.

(f) Yes, the decomposition:

1. R1(A,C) {A->C}
2. R2(D,E) {D->E}
3. R3(B,C,E) {E->BC}
4. R4(A,D) {}

[5] (a) FD:

FD1: stuId -> stulname

FD2: studId, semester -> dormName, dormRoom, mealPlan

FD3: dormName, dormRoom, semester -> dormFee

FD4: mealPlan, semester -> mealFee

(b) CK: {stuId, semester}

(c) 1NF. FD1 violates 2NF. FD3 and FD4 violate 3NF.

(d) Decomposition into BCNF component relations:

Student(stuId, stulname, ..) { stuId -> stulname }

DormFee(dormName, dormRoom, semester, dormFee) {dormName, dormRoom, semester -> dormFee }

MeanFee(mealPlan, semester, mealFee) { mealPlan, semester -> mealFee }

StudentSemester(studId, semester, dormName, dormRoom, mealPlan) { studId, semester -> dormName, dormRoom, mealPlan}

[6] Minimum: 9, e.g., when ACDE is the second candidate key.

Maximum: 20, e.g., when C is the second candidate key.