1.

i. AB->C, C->DE, D->F

Left: A, B Left and Right: C, D

$A^+ = \{A\}$ $B^+ = \{B\}$ $(AB)^+ = \{A, B, C, D, E, F\}$

Candidate key is AB

C->DE, D->F are BCNF violations.

Divide S{A, B, C, D, E, F} into S_1{C, D, E, F} and S_2{A, B, C}

S_2 is in BCNF

S_1: C->DE, D->F

Candidate key of S_1 is C

D->F is BCNF violation.

Divide R_1{C, D, E, F} into S_{11}{D, F} and S_{12}{C, D, E}

The collections of BCNF relation:

S_{11}{D, F}

S_{12}{C, D, E}

S_2{A, B, C}

ii. BC → D, C → AF, AB → CE

Left: B Left and Right: A, C

$B^+ = \{B\}$ $(AB)^+ = \{A, B, C, D, E, F\}$ $(BC)^+ = \{A, B, C, D, E, F\}$

Candidate key is AB and BC

C->AF is BCNF violation.

Divide S{A, B, C, D, E, F} into S_1{A, C, F} and S_2{A, B, C, D, E}

S_1 is in BCNF

S_2: BC->D, AB->CE

Candidate key of S_2 is AB

BC->D is BCNF violation

Divide S_2{A, B, C, D, E} into S_{21}{B, C, D} and S_{22}{A, B, C, E}

The collections of BCNF relation:

S_1{A, C, F}

S_{21}{B, C, D}

S_{22+}{A, B, C, E}

iii. ABC → D, CD → E, BD → A

Left: B, C Left and Right: A, D

$BC^+ = \{B, C\}$ $(ABC)^+ = \{A, B, C, D, E\}$ $(BCD)^+ = \{A, B, C, D, E\}$

Because there is no dependency about F, F is part of the candidate key.

Candidate key is ABCF and BCDF

ABC->D (if do not consider about F, it is not BCNF violation), CD->E, BD->A are BCNF violations.

Divide S{A, B, C, D, E, F} into S_1{A, B, C, D} and S_2{C, D, E, F}

S_1: ABC->D, BD->A

Candidate key of S_1 is ABC and BCD

Divide S_1 into S_{11}{A, B, D} and S_{12}{B, C, D}

S_2: CD->E

Candidate key of S_2 is CDF

Divide S_2 into S_{21}(C, D, E) and S_{22}(E, F)

The collections of BCNF relation:

S_{11}{A, B, D}

S_{12}{B, C, D}

S_{21}{C, D, E}

S_{22}(E, F)

iv. AB → DE, BCD → EF, B → C

Left: A, B, Left and Right: C, D

$(AB)^+$ = {A, B, C, D, E, F}

Candidate key is AB

BCD->EF, B->C are BCNF violations

Divide S{A, B, C, D, E, F} into S_1{B, C, D, E, F} and S_2{A, B, D}

S_2 is in BCNF

S_1: BCD->EF, B->C

Candidate key of S_1 is BD

Divide S_1 into S_{11}{B, C} and S_{12}{B, D, E, F}

The collections of BCNF relation:

S_{11}{B, C}

S_{12}{B, D, E, F}

S_2{A, B, D}

2.

i. Answer = Proj[person.name](
person join[person.personid = relationpersoninproceeding.personid]
relationpersoninproceeding
)

ii. temp1 = proj[person.personid, relationpersoninproceeding.inproceedingid](
person join[person.personid = relationpersoninproceeding.personid]
relationpersoninproceeding
)

temp 2 = proj[temp1.personid, inproceeding.proceedingid](
inproceeding join[temp1.inproceedingid = inproceeding.inproceedingid] temp1
)

temp3 = proj[temp2.personid](
proceeding join[temp2.proceedingid = proceeding.proceedingid and
temp2.personid = proceeding.editorid] temp2
)

answer = proj[person.name](

```
        person join[temp3.personid = person.personid] temp3
    )
```

iii.
```
    temp1 = proj[personid](
        sel[name ~ 'clark$'](person)
    )

    temp2 = proj[relationpersoninproceeding.inproceedingid](
        temp1 join[temp.personid = relationpersoninproceeding.personid]
    ) relationpersoninproceeding

    answer = proj[inproceeding.title](
        temp2 join[temp2.inproceedingid = inproceeding.inproceedingid] inproceeding
    )
```

iv.
```
    Re1 = relationpersoninproceeding
    Re2 = relationpersoninproceeding
    Inpro = inproceeding
    Per = person
    Pro = proceeding
    temp1 = Proj[personid](Re1) Minus Rename[editorid->personid](Proj[editorid](Pro))
    temp2 = Proj[Re1.personid](GroupSelect[size>1](
                GroupBy[Re1.personid,Re1.inproceedingid]
                (Re1 Join[Re1.inproceedingid = Re2.inproceedingid] Re2))
            )
    temp3 = temp1 Minus temp2
    Answer = Proj[name](temp3 Join[temp3.personid=Per.personid] Per)
```

3.

i. R INTERSECT (S UNION T).

Max(s, t) <= |S union T| <= s+t

0 <= |R intersect (S union T)| <= Min(r, s+t)

The minimum numbers of tuples is 0

The maximum numbers of tuples is Min(r, s+t)

ii. Sel[c](R) × S, for some condition c.

0 <= |Sel[c](R)| <= r

0 <= |Sel[c](R) × S | <= r × s

The minimum numbers of tuples is 0

The maximum numbers of tuples is r × s

iii. Proj[a](R) - S, for some list of attributes a.

|Proj[a](R)| = r

Max(r-s, 0) <= |Proj[a](R) – s| <= r

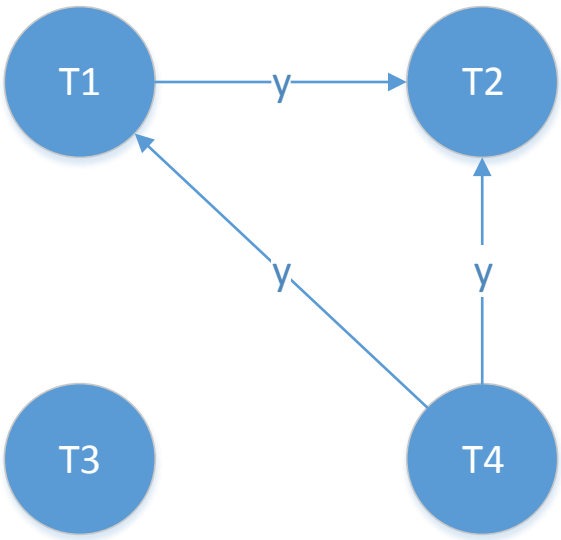
The minimum numbers of tuples is Max(r-s, 0)

The maximum numbers of tuples is r

4

```
T3:R(X) T4:W(Y) T4:W(Z) T1:W(Y) T2:R(Y) T3:R(D) T2:R(X) T1:W(A)
```

T1: W(Y) W(A)
T2: R(Y) R(X)
T3: R(X) R(D)
T4: W(Y) W(Z)



There is no circle in the graph, so it is schedule serialisable.