Tutorial 9

CSC 343
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Functional Dependencies (FDs)

- Need a special type of constraint to help us with normalization.

  X $\longrightarrow$ **Y** is an assertion about relation R that whenever two tuples of R agree on all the attributes in set X, they must also agree on all attributes in set Y.

  e.g. Let's say that X = {AB} and Y = {C}

R

A	B	C
x1	y1	c2
x1	y1	c2
x2	y2	c3

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Armstrong's Axioms

X, Y, Z are sets of attributes

1. **Reflexivity**: If **Y** $\supseteq$ **X**, then **Y** $\rightarrow$ **X**.
2. **Augmentation**: If **X** $\rightarrow$ **Y**, then **XZ** $\rightarrow$ **YZ** for any **Z**.
3. **Transitivity**: If **X** $\rightarrow$ **Y** and **Y** $\rightarrow$ **Z**, then **X** $\rightarrow$ **Z**.
4. **Union**: If **X** $\rightarrow$ **Y** and **X** $\rightarrow$ **Z**, then **X** $\rightarrow$ **YZ**.
5. **Decomposition**: If **X** $\rightarrow$ **YZ**, then **X** $\rightarrow$ **Y** and **X** $\rightarrow$ **Z**.

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Example: Closure

Given F (i.e. the Functional Dependencies):

AB ⟶ C
A ⟶ D
D ⟶ EF
AC ⟶ B

Calculate the following closures:

- A^+
- AB^+
- AC^+
- B^+
- D^+

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Who wants to share their solution?

- A^+
- AB^+
- AC^+
- B^+
- D^+

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Example: Closure

- A^+ = ADEF
- AB^+= ABCDEF
- AC^+= ACBDEF
- B^+= B
- D^+= DEF

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Example: Minimal Basis/Cover

Given a relation R(A, B, C, D) and a defined set of FDs F = {A→BC, B→CE, A→E, AC→H, D→B}, find the minimal basis ***M*** of F.

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Example: Minimal Basis/Cover

Given a relation R(A, B, C, D) and a defined set of FDs F = {A→BC, B→CE, A→E, AC→H, D→B}, find the minimal basis ***M*** of F.

1st Step

- H = {A→B, A→C, B→C, B→E, A→E, AC→H, D→B}

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1st Step

- H = {A→B, A→C, B→C, B→E, A→E, AC→H, D→B}

2nd Step

- A→B: cannot be removed, A^+ = ACEH
- A→C: can be removed, A^+ = AB**C**
- B→C, B->E: cannot be removed, B^+ =BE, B^+ = BC, respectively
- A→E: can be removed, A^+ = ABC**E**
- AC→H: cannot be removed, AC^+ = AC
- D→B: cannot be removed, D^+ = D

Step outcome: H = {A→B, B→CE, AC→H, D→B}

Example: Minimal Basis/Cover

Given a relation R(A, B, C, D) and a defined set of FDs F = {A→BC, B→CE, A→E, AC→H, D→B}, find the minimal basis ***M*** of F.

1st Step

- H = {A→B, ~~A→C~~, B→C, B→E, ~~AC→E~~, AC→H, D→B}

2nd Step

- A→B: cannot be removed, A^+ = ACEH
- A→C: can be removed, A^+ = ABC
- B→C, B->E: cannot be removed, B^+ =BE, B^+ = BC, respectively
- A→E: can be removed, A^+ = ABCE
- AC→H: cannot be removed, AC^+ = AC
- D→B: cannot be removed, D^+ = D

Step outcome: H = {A→B, B→CE, AC→H, D→B}

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Example:

3rd Step

H = {A->B, B->C, B->E, AC->H, D->B}

Example:

3rd Step

A->H

H = {A->B, B->C, B->E, AC->H, D->B}

A^+ = {A,B,C}

Since C can be derived, it is redundant.

Example:

3rd Step

C->H

H = {A->B, B->C, B->E, AC->H, D->B}

$A^+ = \{A,B,C\}$

Since C can be derived, it is redundant.

$C^+ = \{C\}$

Since A cannot be derived, it is not redundant.

Example:

3rd Step

C->H

H = {A->B, B->C, B->E, AC->H, D->B}

$A^+ = \{A,B,C\}$

Since C can be derived, it is redundant.

$C^+ = \{C\}$

Since A cannot be derived, it is not redundant.

4th Step

- H doesn't change

Minimal Basis: ***M*** = H = {A⟶BH, B⟶CE, D⟶B}

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Checkpoint

Given the ERD posted in association to A2 (Ministry of Health), find **two** design flaws in that diagram.

1. Justify your reasoning as to why you think it is a flaw.

2. Explain how you would re-work the ERD/Schema to account for a better overall design.

Write these on a sheet of paper (include your name and student number) and submit them to me for tutorial credit.

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Any Questions?

- Do you have any questions?
  1. Check piazza
  2. Post the question on piazza
     (unless it's a personal question then email one of the TAs)
- If you have any content that you would like to be added in a Tutorial, please let me know by Friday!
- Email requests to:
  - abdulqader.saafan@mail.utoronto.ca OR
  - a.seraliyeva@mail.utoronto.ca