

# Zadanie 8.1

①

①

$$H = \{P, O, E, B, K\}$$

$$F = \{\{P, O\} \rightarrow E, \{P, E\} \rightarrow O, \{P, O\} \rightarrow B, B \rightarrow K\}$$

$$P^+ = \{P\}$$

$$PO^+ = \{P, O, E, B, K\}$$

$$PE^+ = \{P, E, O, B, K\}$$

$$PB = \{P, B, K\}$$

L	M	R
P	O E B	K

$$KLUCZE: \{P, O\} \{P, E\}$$

②

$$F^+ = \{\{P, O\} \rightarrow K, \{P, E\} \rightarrow B, \{P, E\} \rightarrow K, \{P, O, E\} \rightarrow B, \{P, O, E\} \rightarrow K\}$$

③ Jest minimalny

# Zadanie 8.3

①

$$F = \{C \rightarrow \{A, B\}, E \rightarrow \{A, D\}, C \rightarrow D, E \rightarrow B\}$$

$$F = \{C \rightarrow A, C \rightarrow B, E \rightarrow A, E \rightarrow D, C \rightarrow D, E \rightarrow B\}$$

$$A^+ = \{A\} \quad AB^+ = \{A, B, D\} \quad \begin{matrix} C \rightarrow A & E \rightarrow A \\ C \rightarrow B & E \rightarrow B \\ C \rightarrow D & E \rightarrow D \end{matrix}$$

②

$$F = \{A \rightarrow B, A \rightarrow C, \{A, B\} \rightarrow D, \{A, C\} \rightarrow \{B, D\}\}$$

$$F = A \rightarrow B, A \rightarrow C, \underbrace{\{A, B\} \rightarrow D}_{A \rightarrow D}, \underbrace{\{A, C\} \rightarrow B}_{A \rightarrow B}, \underbrace{\{A, C\} \rightarrow D}_{A \rightarrow D}$$

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

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

$$F = \{A \rightarrow B, A \rightarrow C, A \rightarrow D\}$$

$$\textcircled{3} F = \{A \rightarrow B, B \rightarrow C, \cancel{A \rightarrow C}, \cancel{C \rightarrow A}, C \rightarrow B, B \rightarrow A\} \quad \textcircled{2}$$

$$F = \{A \rightarrow B, B \rightarrow C, C \rightarrow B, B \rightarrow A\}$$

Zadanie 8.4

$$\textcircled{1} F = \{\{S, T\} \rightarrow R, \{R, T\} \rightarrow C, \{R, T\} \rightarrow S, \{A, T\} \rightarrow G, \{A, T\} \rightarrow N, \{N, R, T\} \rightarrow A\}$$

$$\textcircled{1} H_1 = \{A, G, N, R, T\} \quad H_2 = \{C, R, S, T\}$$

$$\cancel{H_1 \cap H_2} = \{R, T\}$$

$$\{R, T\} \rightarrow \{A, G, N, R, T\} \in F^+?$$

$$\{R, T\}^+ = \{R, T, C, S\}$$

$$\{R, T\} \rightarrow \{C, R, S, T\} \in F^+ \quad \text{bezstratna}$$

$$\textcircled{2} H_1 = \{A, G, N, T\} \quad H_2 = \{C, R, S, T\}$$

$$H_1 \cap H_2 = \{T\}$$

$$\pi^+ \{T\}^+ = T \quad \text{stratna}$$

$$\textcircled{3} H_1 = \{A, G, N, S, T\} \quad H_2 = \{C, R, S, T\}$$

$$H_1 \cap H_2 = \{S, T\}$$

$$\{S, T\}^+ = \{S, T, R, C\}$$

bezstratna

(3)

(4)

$$H_1 = \{A, G, S, T\} \quad H_2 = \{A, N, R, T\} \quad H_3 = \{C, S, R, T\}$$

	A	C	G	N	S	R	T
H <sub>1</sub>	✓	✓	✓	✓	✓	✓	✓
H <sub>2</sub>	✓		✓	✓	✓	✓	✓
H <sub>3</sub>		✓			✓	✓	✓

berstratna

$$(5) \quad H_1 = \{A, G, T\} \quad H_2 = \{A, N, T\} \quad H_3 = \{C, S, R, T\}$$

	A	C	G	N	S	R	T
H <sub>1</sub>	✓		✓	✓			✓
H <sub>2</sub>	✓		✓	✓			✓
H <sub>3</sub>		✓			✓	✓	✓

Stratna

$$(6) \quad H_1 = \{A, G, S, T\} \quad H_2 = \{A, N, T\} \quad H_3 = \{C, S, R, T\}$$

	A	C	G	N	S	R	T
H <sub>1</sub>	✓	✓	✓	✓	✓	✓	✓
H <sub>2</sub>	✓			✓			✓
H <sub>3</sub>		✓			✓	✓	✓

berstratna

# Zadanie 8.5

(4)

$$M = \{M, P, S, T\}$$

$$F = \{S, T\} \rightarrow M, M \rightarrow P, P \rightarrow S\}$$

$$\textcircled{1} H_1 = \{M, S, T\} \quad H_2 = \{M, P, S\}$$

$$\{M\}^+ = \{M, P, S\} \quad \{S, T\}^+ = \{S, T, M, P, S\} \quad \{M, T\}^+ = \{M, T, P, S\} \quad \{P, S\}^+ = \{P, S\}$$

$$\{P\}^+ = \{P, S\} \quad \{M, S\}^+ = \{M, S, P\} \quad \{M, P\}^+ = \{M, P, S\}$$

$$\{S\}^+ = \{S\}$$

$$\{T\}^+ = \{T\}$$

$$\pi_{H_1}(F) = \{M \rightarrow S, M \rightarrow P, P \rightarrow S\}$$

$$\pi_{H_1}(F) = \{M \rightarrow S, \cancel{M \rightarrow T}, \cancel{M \rightarrow P}, \cancel{P \rightarrow S}\}$$

wymazanie

ze względu na  $M \rightarrow S$

$$\pi_{H_2}(F) = \{M \rightarrow S, M \rightarrow P, M \rightarrow S\}$$

$$\{M \rightarrow S, M \rightarrow P, P \rightarrow S\} \leftarrow \text{po minimalizacji}$$

↑  
wyznaczone z przechodności

$$\pi_{H_2}(F) = \{M \rightarrow P, P \rightarrow S\}$$

$\{S, T\}^+ = \{S, T\}$  zależności funkcyjne są utracane  
bo ~~nie~~  $\{S, T\}^+$  są różne

(5)

$$\textcircled{2} H_1 = \{M, S, T\} \quad H_2 = \{P, S\}$$

$$\{M\}^+ = \{M, P, S\}$$

$$\{P\}^+ = \{P, S\}$$

$$\{S\}^+ = \{S\}$$

$$\{P, S\}^+ = \{P, S\}$$

$$\{T\}^+ = \{T\}$$

$$\Pi_{H_1}(F) = \{M \rightarrow S, \cancel{M \rightarrow P}, \cancel{M, T \rightarrow S}\}$$

$$\{MT\}^+ = \{M, P, S, T\}$$

$$\Pi_{H_1}(F) = \{M \rightarrow S, \{M, T\} \rightarrow S\}$$

$$\{ST\}^+ = \{S, T, M, P\}$$

$$\Pi_{H_1}(F) = \{M \rightarrow S, T \rightarrow S\}$$

$$\{MS\}^+ = \{M, S, P\}$$

$$\Pi_{H_1}(F) = \{M \rightarrow S, \cancel{MT \rightarrow S}\} \quad \text{uproszczenie}$$

$$\Pi_{H_2}(F) = \emptyset$$

nie zachowuje

$$\textcircled{3} H_1 = \{M, P, S\} \quad H_2 = \{S, T\}$$

$$\{M\}^+ = \{M, P, S\}$$

$$\{T\}^+ = \{T\}$$

$$\{P\}^+ = \{P, S\}$$

$$\{S, T\}^+ = \{M, S, T\}$$

$$\{S\}^+ = \{S\}$$

$$\Pi_{H_1}(F) = \{M \rightarrow S, \cancel{MP \rightarrow S}\} \quad \text{uproszczone}$$

$$\{MP\}^+ = \{M, P, S\}$$

$$\{MS\}^+ = \{M, P, S\}$$

$$\Pi_{H_2}(F) = \emptyset$$

nie zachowuje

$$\{PS\}^+ = \{P, S\}$$

⑥

$$R = \{A, B, C, D, E\}$$

$$F = \{AB \rightarrow C, C \rightarrow E, B \rightarrow D, E \rightarrow A\}$$

$$H_1 = \{B, C, D\} \quad H_2 = \{A, C, E\}$$

$$B^+ = \{B, D\}$$

$$C^+ = \{C, E\}$$

$$D^+ = \{D\}$$

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

$$\{C, D\}^+ = \{C, D, E, A\}$$

$$\{B, D\}^+ = \{B, D\}$$

$$\{A\}^+ = \{A\}$$

$$\{E\}^+ = \{E, A\}$$

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

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

$$\{A, E\}^+ = \{A, E\}$$

$$\pi_{H_1}(F) = \{B, C \rightarrow D\}$$

$$\pi_{H_2}(F) = \{A, C \rightarrow E\}$$

Share part M to S to MT as measure

wrong

$$F = \{s, t\} \rightarrow M, M \rightarrow P, P \rightarrow s$$

$$M = \{M, s, t\} \quad H_2 = \{M, P, s\}$$

$$M^+ = \{M, P, s\}$$

$$P^+ = \{P, s\}$$

$$M, s^+ = \{M, s, P\}$$

$$M, t^+ = \{M, t, P, s\}$$

$$s, t^+ = \{s, t, M, P\}$$

$$P, s^+ = \{P, s\}$$

$$\pi_{H_1}(F) = \{M \rightarrow s, M \rightarrow t, s \rightarrow M\}$$

$t^+ = \{t\}$

$s^+ = \{s\}$

$M^+ = \{M\}$

$P^+ = \{P\}$

$M, s^+ = \{M, s, P\}$

$M, t^+ = \{M, t, P, s\}$

$s, t^+ = \{s, t, M, P\}$

$P, s^+ = \{P, s\}$

$\pi_{H_2}(F) = \{M, s \rightarrow t, M, t \rightarrow s\}$

$x \rightarrow A \quad A \in R^+$

# Zadanie 8.6.

7

$$H = \{M, P, S, T\}$$

$$F = \{S \rightarrow T, T \rightarrow M, M \rightarrow P, P \rightarrow S\}$$

L	M	R
T	MPS	

$$\{ST\}^+ = \{STMP\} = H$$

Klucz

$$\{PT\}^+ = \{PT, S\}$$

Kluczowe  
ST

Niekluczowe  
MP

$$\{MS\}^+ = \{M, S, P\}$$



$$\{S\}^+ = \{S\} \quad \text{Jest w 2NF}$$

$$\{T\}^+ = \{T\}$$

Nie jest w 3NF bo każdy element F nie posiada po lewej stronie nadklucza.

Zadanie 8.7.

(8)

$$H = \{G, P, T, W\}$$

$$F = \{\{P, T\} \rightarrow G, P \rightarrow W, \text{ oraz } \{G, T\} \rightarrow P\}$$

$$\{P\}^+ = \{P, W\}$$

L	M	R
T	G P	W

$$\{G, T\}^+ = \{G, T, P, W\}$$

$$\{T, P\}^+ = \{P, T, G, W\}$$

Kluczowe  
G P T

Niekluczowe  
W

$$\{G\}^+ = \{G\}$$

Jest w 2NF

$$\{P\}^+ = \{P, W\}$$

$$\{T\}^+ = \{T\}$$

Nie jest w 3NF bo po lewej stronie zależności  $\nexists$  nie występuje nadkluczowe ( $P \rightarrow W$  eliminuje)



Zadanie 8.8,

9

$$H = \{C, N, O, P\}$$

$$F = \{N \rightarrow P, \{NP\} \rightarrow C\}$$

①

L	M	R
NO		CP

$$\{N\}^+ = \{N, P\}$$

$$\{O\}^+ = \{O\}$$

$$\{NO\}^+ = \{N, O, P, C\}$$

kluczowe  
NO

Niekluczowe  
CP

Nie jest w 2NF bo  $N \rightarrow P$

- ②
1. Upewnić się, że F jest minimalny.
  2. Tworzymy  $H_1$  dla każdej funkcji z F.
  3. Zredukować schemat do 2.

$$H_1 = \{N, P\}$$

$$H_2 = \{N, O, C\}$$

	C	N	O	P
$H_1$		✓		✓
$H_2$	✓	✓	✓	✓

dekompozycja  
bestratna

③

$$H_1 = \{N, P\} \quad H_2 = \{N, O, C\}$$

klucz N                      klucz NO

$$\{N\}^+ = \{N, P\}$$

$$\{NO\}^+ = \{N, O, C, P\}$$

$$\{N, P\}^+ = \{N, P\}$$

$$\pi_{H_2}(F) = \{NO \rightarrow C\}$$

$$\pi_{H_1}(F) = \{N \rightarrow P\}$$

(Wydaje się), że  $SO_2$  w BCNF.

# Zadanie 8.9

(10)

$$M = \{M, P, S, T\}$$

$$F = \{S, T \rightarrow M, M \rightarrow P, P \rightarrow S\}$$

L	M	R
ST	MP	

kluczowe  
ST

niekuczowe  
MP

$$\{S, T\}^+ = \{S, T, M, P, S\} = K$$

$$\{M\}^+ = \{M, P, S\}$$

$$\{P\}^+ = \{P, S\}$$

$$\{S\}^+ = \{S\}$$

$$\{T\}^+ = \{T\}$$

Rozkład ze względu na  $M \rightarrow P$

$$H_1 = \{M, P\} F_1 = \pi_{H_1}(F) = \{M \rightarrow P\}$$

$$H_2 = \{M, S, T\} F_2 = \pi_{H_2}(F) = \{M \rightarrow S, \{S, T\} \rightarrow M\}$$

Rozkład  $H_2$  ze względu na  $M \rightarrow S$

$$H_{21} = \{M, S\} \pi_{H_{21}}(F_2) = \{M \rightarrow S\}$$

$$H_{22} = \{M, T\} \pi_{H_{22}}(F_2) = \emptyset$$

	M	P	S	T
$H_1$	✓	✓	✓	
$H_{21}$	✓	✓	✓	
$H_{22}$	✓	✓	✓	✓

Decompozycja jest bestratna  
ale nie zachowuje zależności  
funkcyjnych.

Zadanie 8. W.

(11)

$$H = \{A, B, C, D\}$$

$$F = \{\{A, B\} \rightarrow C, \{A, C\} \rightarrow D\}$$

$$H_1 = \{A, B, C\}$$

$$H_2 = \{A, C, D\}$$

	A	B	C	D
$H_1$	✓	✓	✓	✓
$H_2$	✓		✓	✓

Zadanie 8. U.

$$H = \{A, B, C, D, E\}$$

$$F = \{\{A, B\} \rightarrow C, \{A, D\} \rightarrow E, C \rightarrow D, E \rightarrow B\}$$

①

L	M	R
A	BCDE	

$$\{A\}^+ = \{A\}$$

$$\{A, B\}^+ = \{A, B, C, D, E\} = H$$

$$\{A, C\}^+ = \{A, C, D, E, B\} = H$$

$$\{A, D\}^+ = \{A, D, E, B, C\} = H$$

$$\{A, E\}^+ = \{A, E, B, C, D\} = H$$

② Można wybierać z dopełnień  $X^+$  kluczy.

Zadanie 8.12

(12)

$$H = \{A, B, C, D, E, F\}$$

$$F = \{ \{A, B\} \rightarrow \{C, E\}, \{A, D\} \rightarrow E, E \rightarrow D, E \rightarrow \{B, C\}, A \rightarrow F \}$$

①

	A	B	C	D	E	F
H <sub>1</sub>	V	V	V	V		
H <sub>2</sub>				V	V	V

$$H_1 = \{A, B, C, D\}$$

$$H_2 = \{D, E, F\}$$

Stratna

②

	A	B	C	D	E	F
H <sub>1</sub>	V	V	V	V	V	
H <sub>2</sub>		V	V	V	V	V

$$H_1 = \{A, B, E\}$$

$$H_2 = \{C, D, E, F\}$$

Stratna

③

	A	B	C	D	E	F
H <sub>1</sub>	V	V	V	V	V	V
H <sub>2</sub>		V	V	V	V	

$$H_1 = \{A, B, E, F\}$$

$$H_2 = \{C, D, E\}$$

Stratna

④

	A	B	C	D	E	F
H <sub>1</sub>	V	V	V	V	V	
H <sub>2</sub>		V	V	V	V	V
H <sub>3</sub>		V	V	V	V	

$$H_1 = \{A, E\}$$

$$H_2 = \{B, E, F\}$$

$$H_3 = \{C, D, E\}$$

Stratna

⑤

	A	B	C	D	E	F
$H_1$	✓	✓			✓	✓
$H_2$		✓			✓	✓
$H_3$	✓		✓	✓		✓

$$H_1 = \{A, E\}$$

$$H_2 = \{B, E, F\}$$

$$H_3 = \{A, C, D, F\}$$

Stratna

⑥

	A	B	C	D	E	F
$H_1$	✓	✓	✓	✓	✓	✓
$H_2$	✓	✓	✓	✓	✓	✓
$H_3$	✓					✓

$$H_1 = \{A, B, C, E\}$$

$$H_2 = \{A, B, D\}$$

$$H_3 = \{A, F\}$$

bezstratna

### Zadanie 8.13.

$$H = \{A, B, C, D\}$$

$$F = \{ \{A, B\} \rightarrow C, A \rightarrow D, \{C, D\} \rightarrow B \}$$

L	M	R
A	BCD	

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

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

$$\{A, D\}^+ = \{A, D\}$$

$$\begin{array}{c} \text{kluczowe} \\ A \ B \ C \end{array}$$

$$\{A\}^+ = \{A, D\}$$

$$\begin{array}{c} \text{Niekluczowe} \\ D \end{array}$$

Nie jest w 2NF.

Zadanie 8.14

(14)

$$H = \{A, B, C, D\}$$

$$F = \{\{A, B\} \rightarrow C, \{A, D\} \rightarrow C\}$$

L	M	R
ABD	C	

kluczowe  
ABDnietuczowe  
C

$$\{ABD\}^+ = \{A, B, D, C\} = H$$

$$\{AB\}^+ = \{A, B, C\} \quad \text{Jest w 2NF.}$$

$$\{AD\}^+ = \{A, D, C\}$$

$$\{BD\}^+ = \{B, D\} \quad \text{Nie jest w 3NF.}$$

W 3NF dla każdej zależności funkcyjnej  
kiedy po prawej jest atrybut nietuczowy  
po lewej musi być klucz.

W BCNF każda lewa strona musi  
być kluczem.

Klucz również jest kluczem.