

The cuboid of privilege

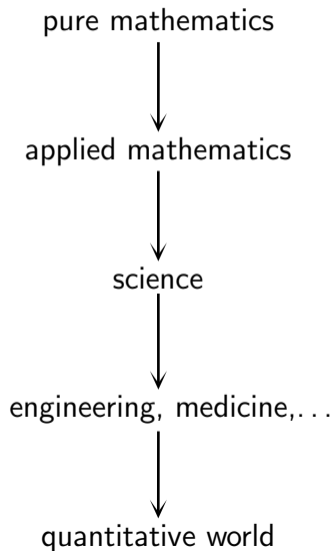
Eugenia Cheng

School of the Art Institute of Chicago

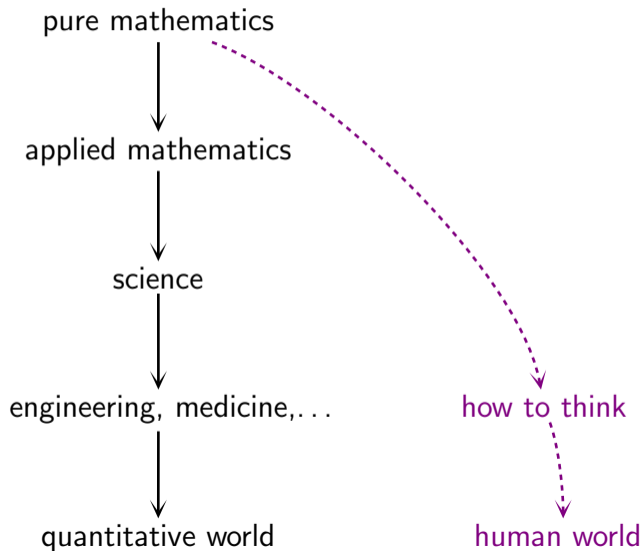
bluesky.com/DrEugeniaCheng

Pure mathematics is a framework for agreeing on things.

Mathematics, applied



Mathematics, applied



Analogies

Pure mathematics is a theory of analogies

Analogies

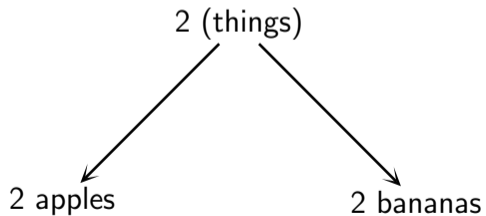
Pure mathematics is a theory of analogies

2 apples

2 bananas

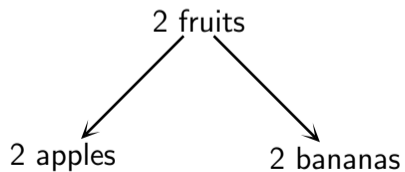
Analogies

Pure mathematics is a theory of analogies



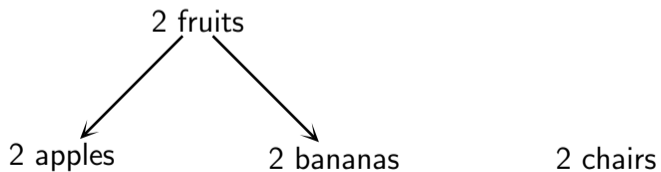
Analogies

Pure mathematics is a theory of analogies



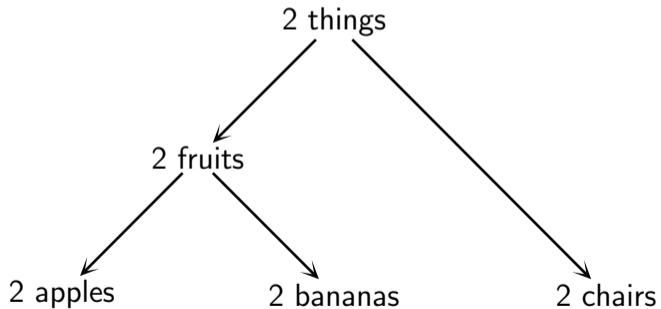
Analogies

Pure mathematics is a theory of analogies



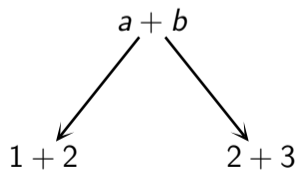
Analogies

Pure mathematics is a theory of analogies



Analogies

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Analogies

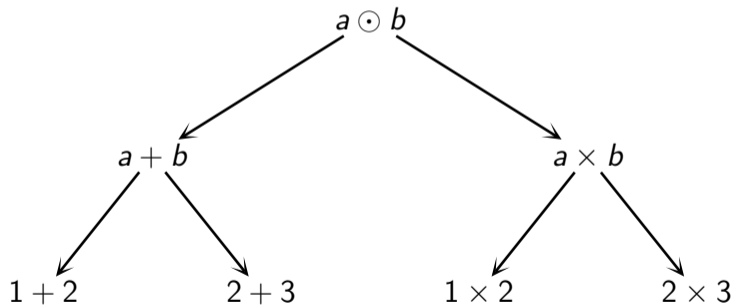
Pure mathematics is a theory of analogies

$$\begin{array}{ccc} & a + b & \\ & \swarrow \quad \searrow & \\ 1 + 2 & & 2 + 3 \end{array}$$

$$\begin{array}{ccc} & a \times b & \\ & \swarrow \quad \searrow & \\ 1 \times 2 & & 2 \times 3 \end{array}$$

Analogies

Pure mathematics is a theory of analogies



Factors of 30

Factors of 30

1,

Factors of 30

1, 2,

Factors of 30

1, 2, 3,

Factors of 30

1, 2, 3, 5,

Factors of 30

1, 2, 3, 5, 6,

Factors of 30

1, 2, 3, 5, 6, 10,

Factors of 30

1, 2, 3, 5, 6, 10, 15,

Factors of 30

1, 2, 3, 5, 6, 10, 15, 30

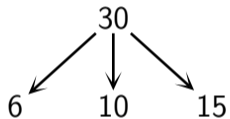
Factors of 30

1, 2, 3, 5, 6, 10, 15, 30

30

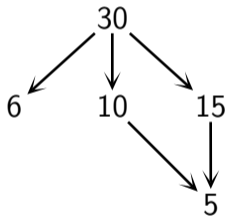
Factors of 30

1, 2, 3, 5, 6, 10, 15, 30



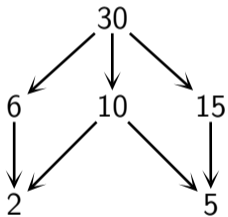
Factors of 30

1, 2, 3, 5, 6, 10, 15, 30



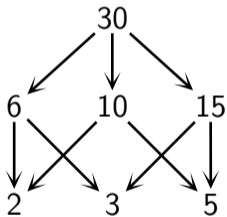
Factors of 30

1, 2, 3, 5, 6, 10, 15, 30



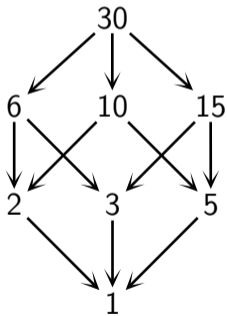
Factors of 30

1, 2, 3, 5, 6, 10, 15, 30

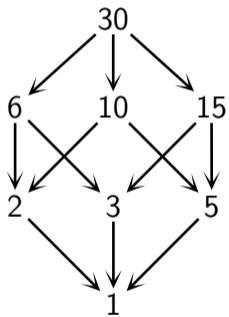


Factors of 30

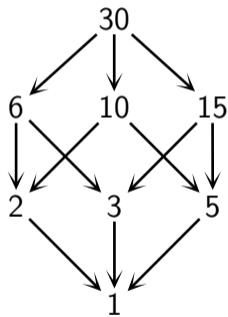
1, 2, 3, 5, 6, 10, 15, 30



Try some yourself



Try some yourself



a) 6

d) 70

g) 24, 36, ...

b) 10

e) 42

h) hard: 60, 210

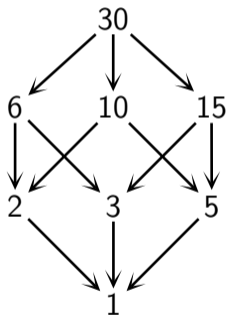
c) 8

f) 12

i) any number you like

Try some yourself

- | | | |
|-------|-------|------------------------|
| a) 6 | d) 70 | g) 24, 36, ... |
| b) 10 | e) 42 | h) hard: 60, 210 |
| c) 8 | f) 12 | i) any number you like |

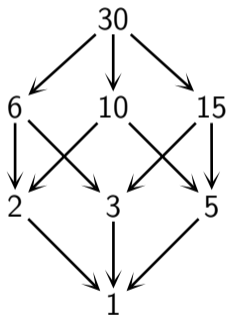


Some things to remember

- Each factor is drawn only once.
- We don't draw arrows that are redundant.

Try some yourself

- | | | |
|-------|-------|------------------------|
| a) 6 | d) 70 | g) 24, 36, ... |
| b) 10 | e) 42 | h) hard: 60, 210 |
| c) 8 | f) 12 | i) any number you like |



Some things to remember

- Each factor is drawn only once.
- We don't draw arrows that are redundant.

Questions

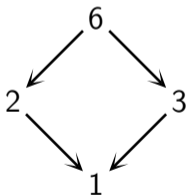
What shapes are produced?

Why do some numbers produce the same shapes?

What is going on and why?

Examples

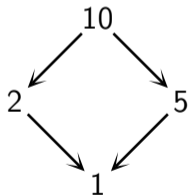
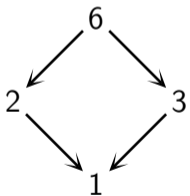
6 : 1, 2, 3, 6



Examples

6 : 1, 2, 3, 6

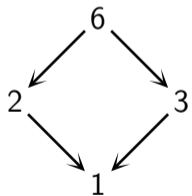
10 : 1, 2, 5, 10



Examples

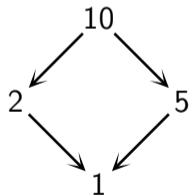
6 : 1, 2, 3, 6

$$6 = 2 \times 3$$



10 : 1, 2, 5, 10

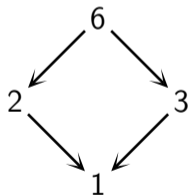
$$10 = 2 \times 5$$



Examples

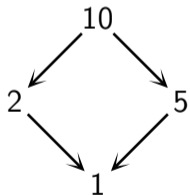
6 : 1, 2, 3, 6

$$6 = 2 \times 3$$

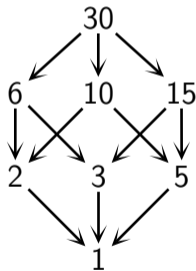


10 : 1, 2, 5, 10

$$10 = 2 \times 5$$



$$30 = 2 \times 3 \times 5$$

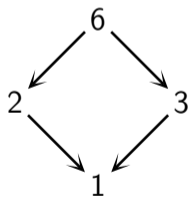


← primes

Examples

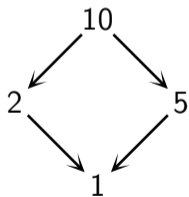
6 : 1, 2, 3, 6

$$6 = 2 \times 3$$

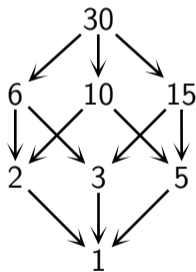


10 : 1, 2, 5, 10

$$10 = 2 \times 5$$



$$30 = 2 \times 3 \times 5$$



← product of 3 primes

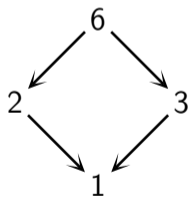
← products of 2 primes

← primes

Examples

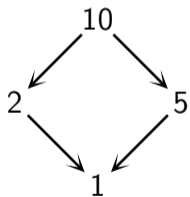
6 : 1, 2, 3, 6

$$6 = 2 \times 3$$

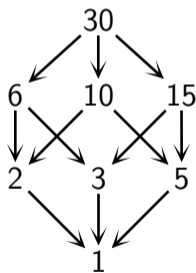


10 : 1, 2, 5, 10

$$10 = 2 \times 5$$



$$30 = 2 \times 3 \times 5$$



← product of 3 primes

← products of 2 primes

← primes

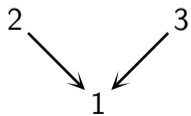
← product of 0 primes

Examples

$$12 = 2 \times 2 \times 3$$

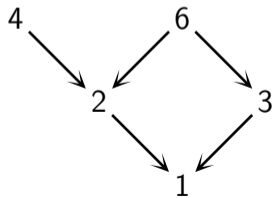
Examples

$$12 = 2 \times 2 \times 3$$



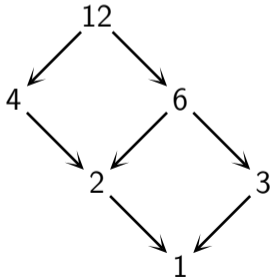
Examples

$$12 = 2 \times 2 \times 3$$



Examples

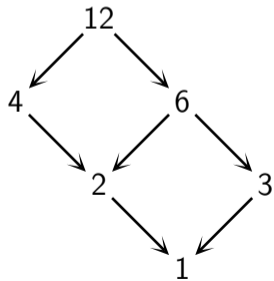
$$12 = 2 \times 2 \times 3$$



Examples

$$12 = 2 \times 2 \times 3$$

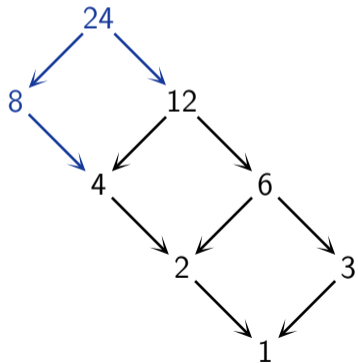
$$24 = 2 \times 2 \times 2 \times 3$$



Examples

$$12 = 2 \times 2 \times 3$$

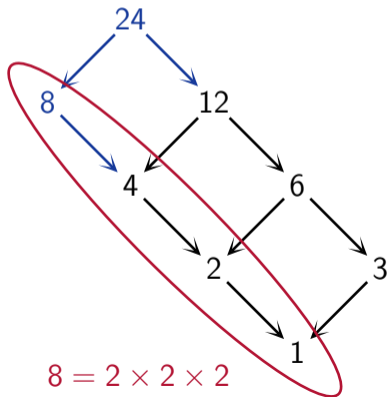
$$24 = 2 \times 2 \times 2 \times 3$$



Examples

$$12 = 2 \times 2 \times 3$$

$$24 = 2 \times 2 \times 2 \times 3$$

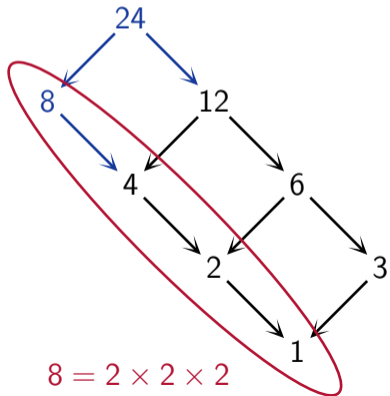


Examples

$$12 = 2 \times 2 \times 3$$

$$36 = 2 \times 2 \times 3 \times 3$$

$$24 = 2 \times 2 \times 2 \times 3$$

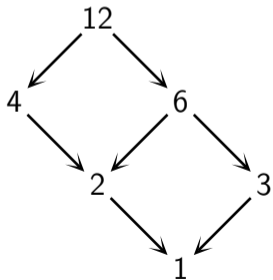
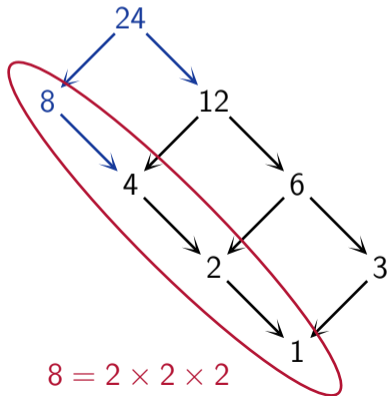


Examples

$$12 = 2 \times 2 \times 3$$

$$24 = 2 \times 2 \times 2 \times 3$$

$$36 = 2 \times 2 \times 3 \times 3$$

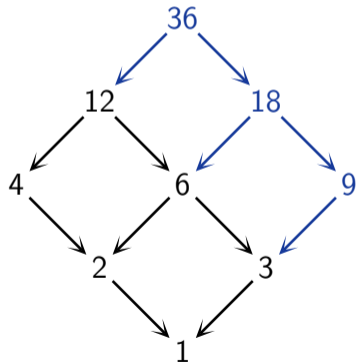
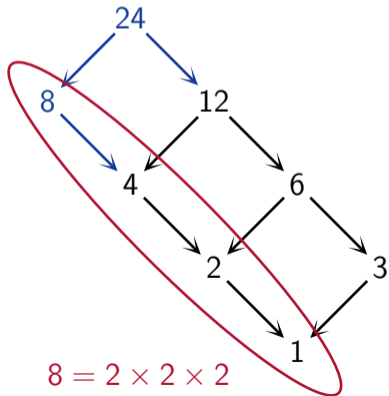


Examples

$$12 = 2 \times 2 \times 3$$

$$24 = 2 \times 2 \times 2 \times 3$$

$$36 = 2 \times 2 \times 3 \times 3$$

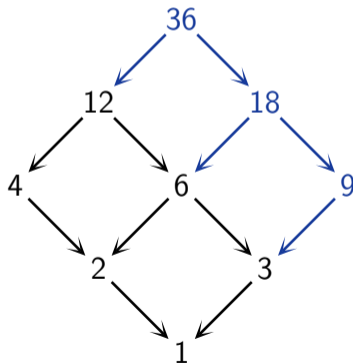
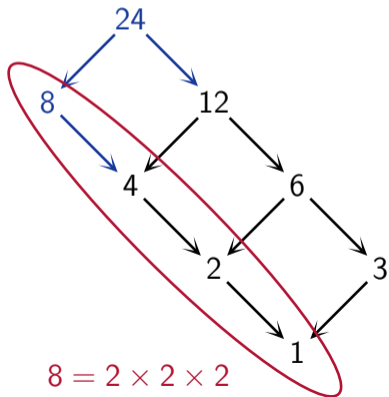


Examples

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$$24 = 2 \times 2 \times 2 \times 3$$

$$36 = 2 \times 2 \times 3 \times 3$$



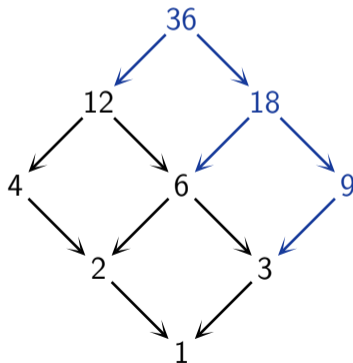
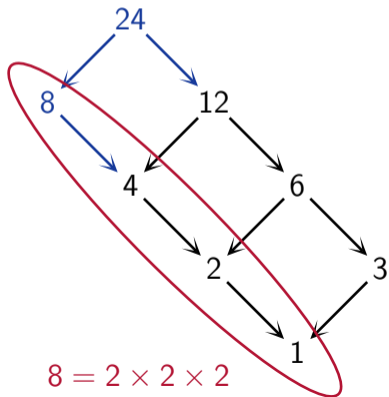
- Number of dimensions
= number of distinct prime factors

Examples

$$12 = 2 \times 2 \times 3$$

$$24 = 2 \times 2 \times 2 \times 3$$

$$36 = 2 \times 2 \times 3 \times 3$$



- Number of dimensions
= number of distinct prime factors
- Lengths of paths
= number of repetitions of prime factors

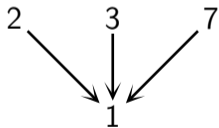
Factors of 42

Factors of 42

1, 2, 3, 6, 7, 14, 21, 42

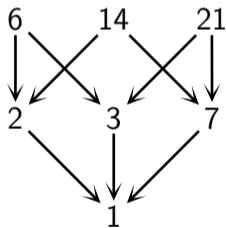
Factors of 42

1, 2, 3, 6, 7, 14, 21, 42



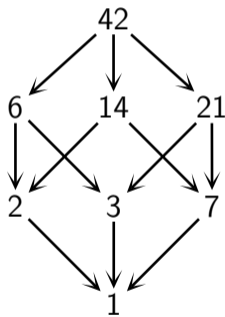
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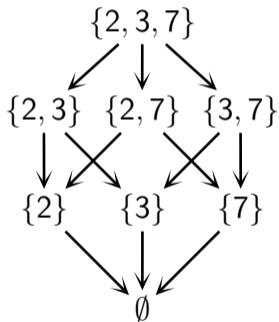
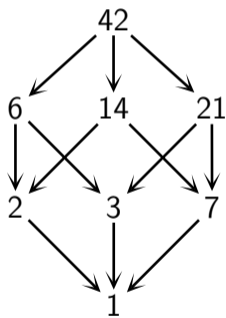
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1, 2, 3, 6, 7, 14, 21, 42



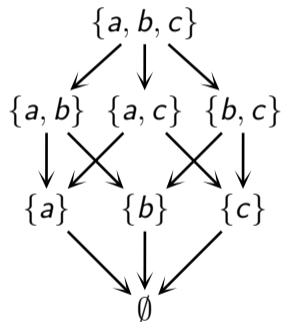
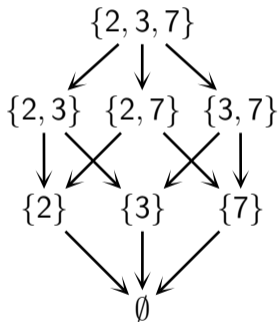
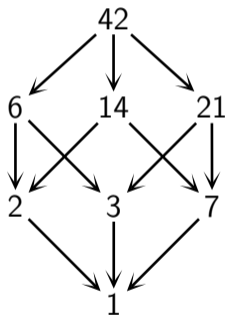
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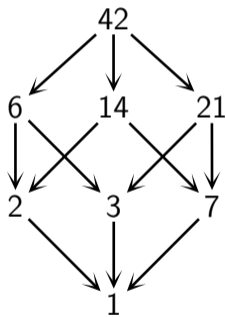
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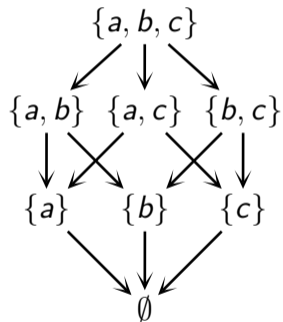
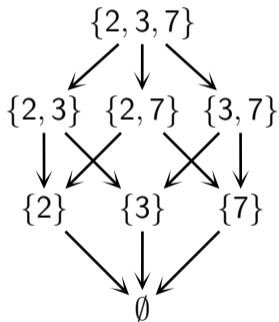


Factors of 42

1, 2, 3, 6, 7, 14, 21, 42



$6 < 7$



Privilege

rich white male

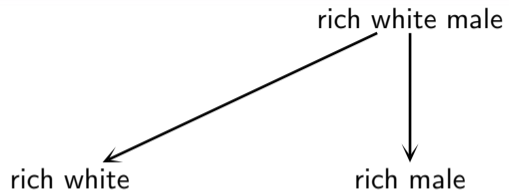
Privilege

rich white male

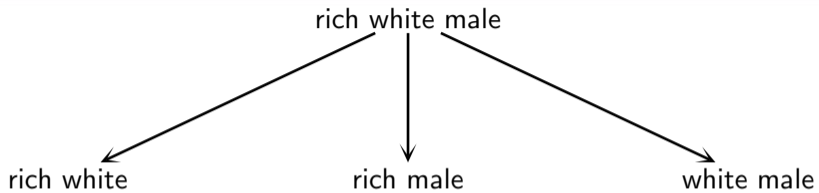
rich white



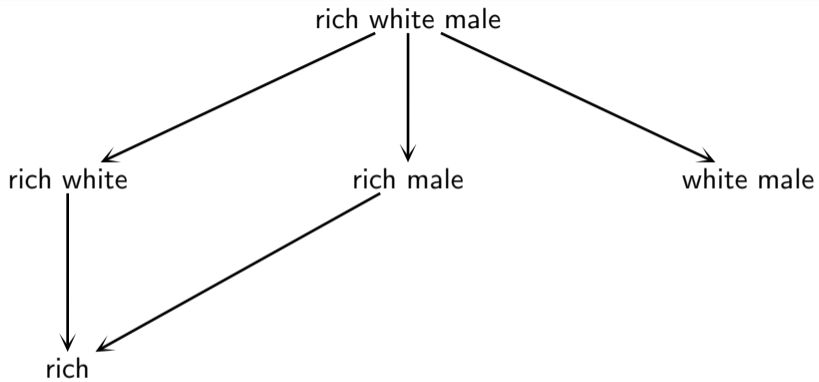
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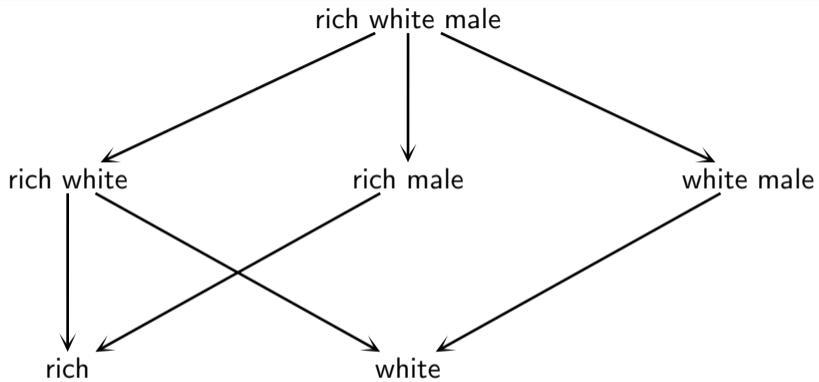
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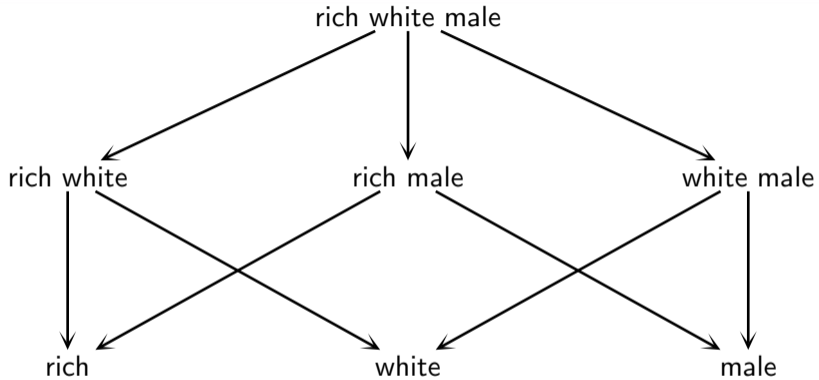
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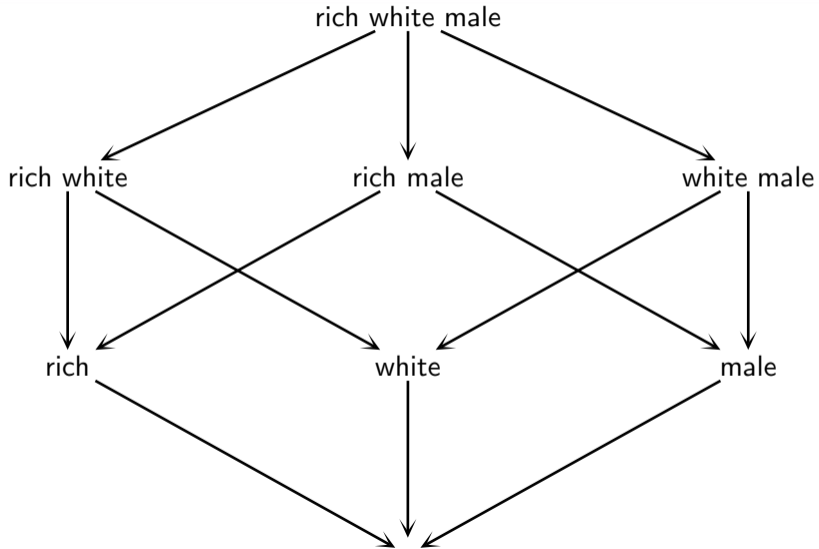
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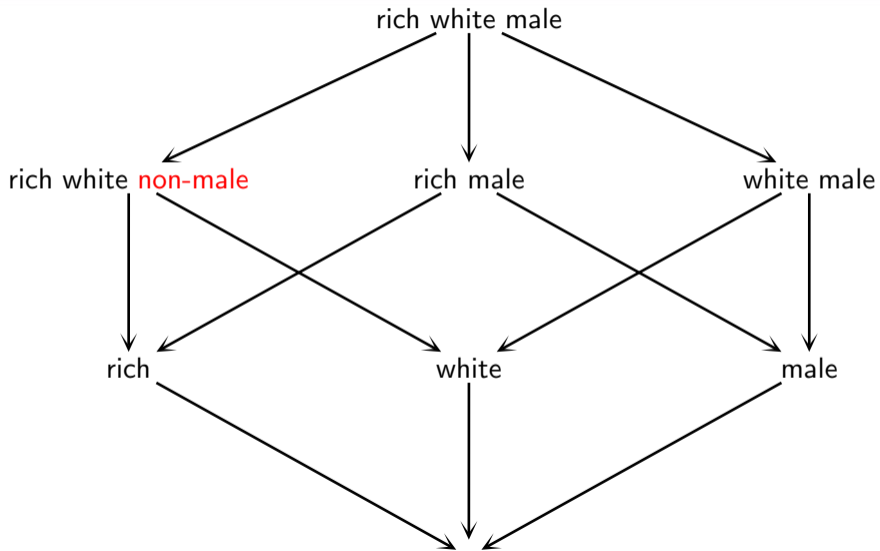
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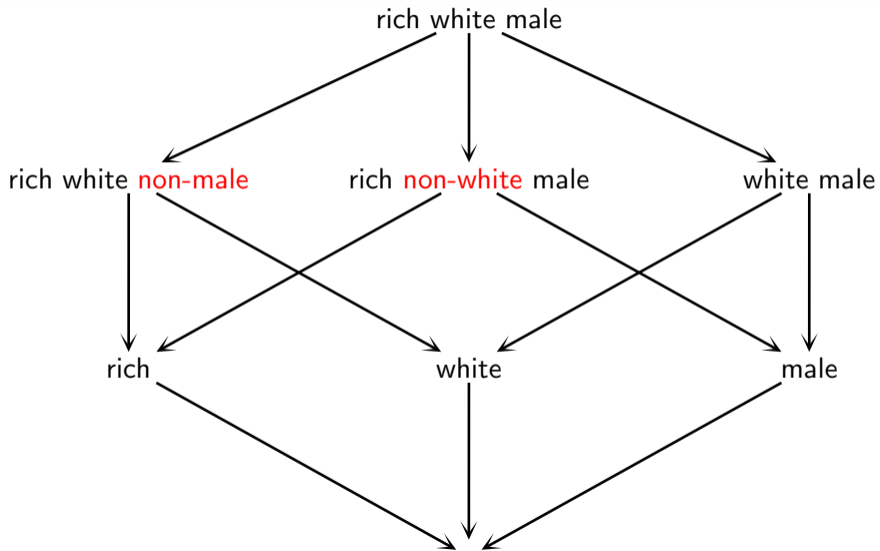
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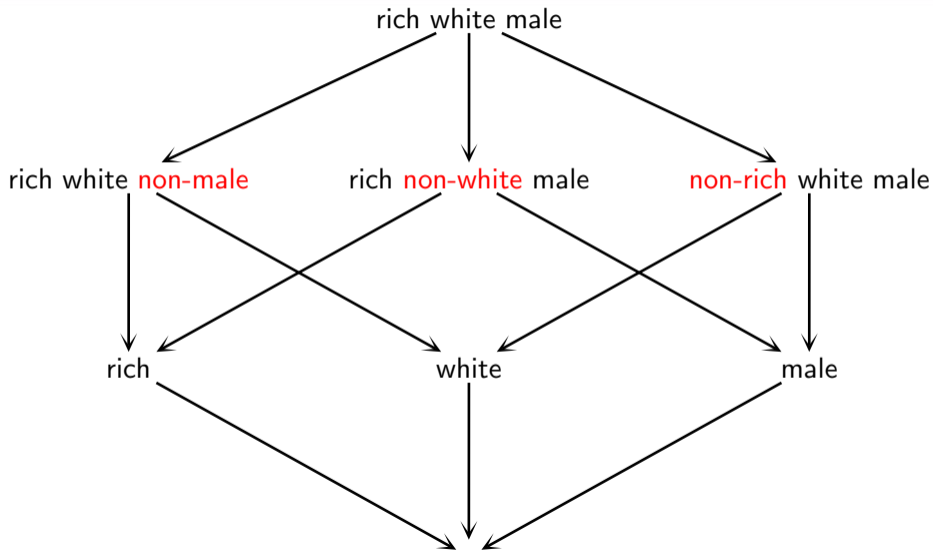
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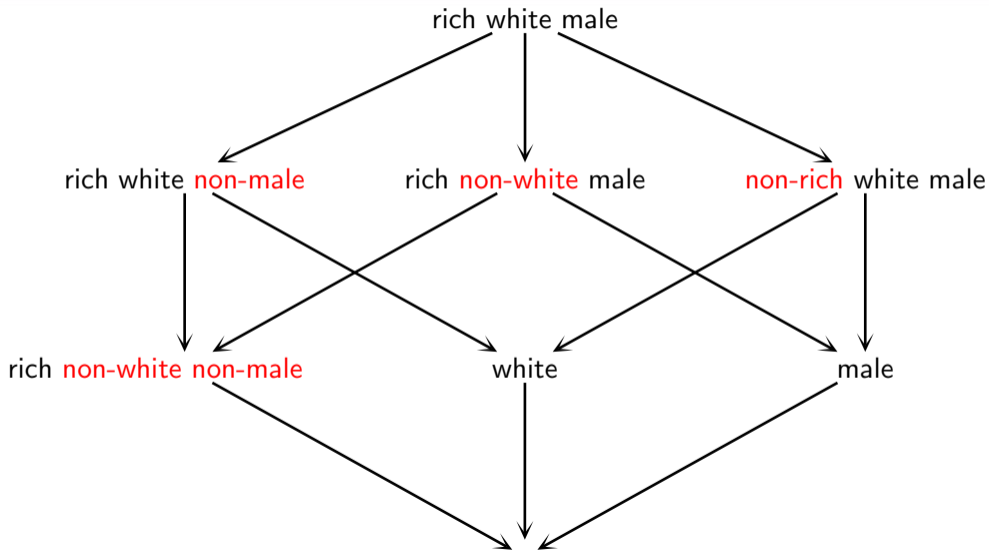
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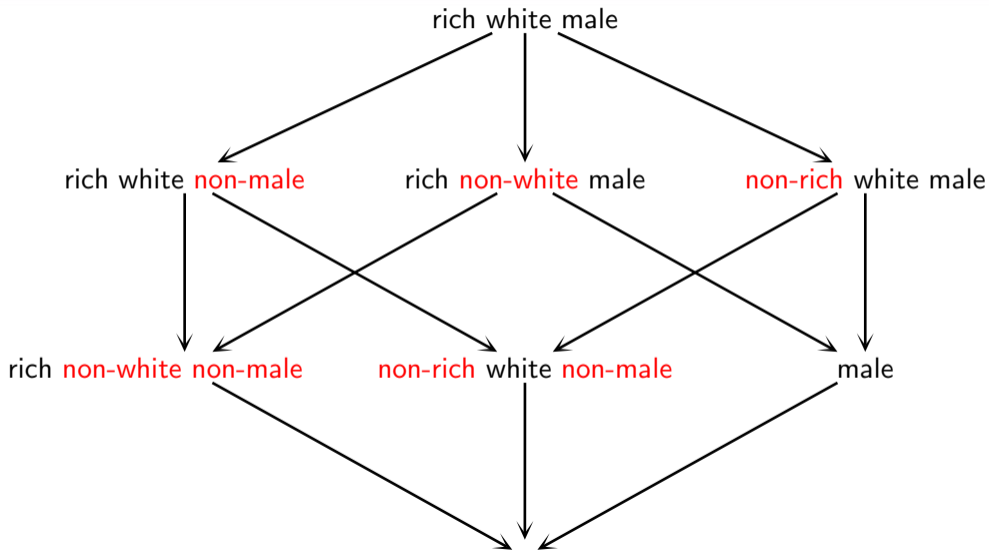
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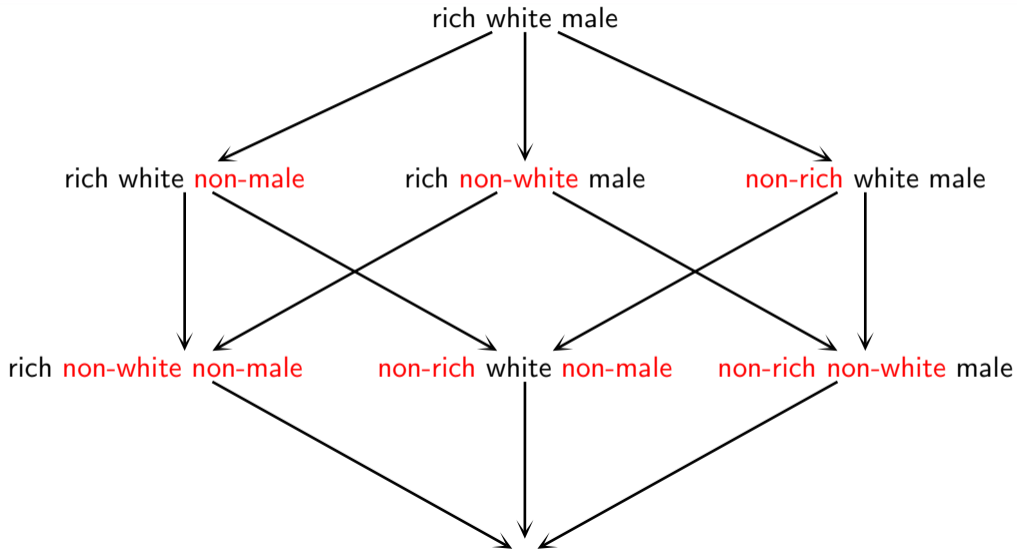
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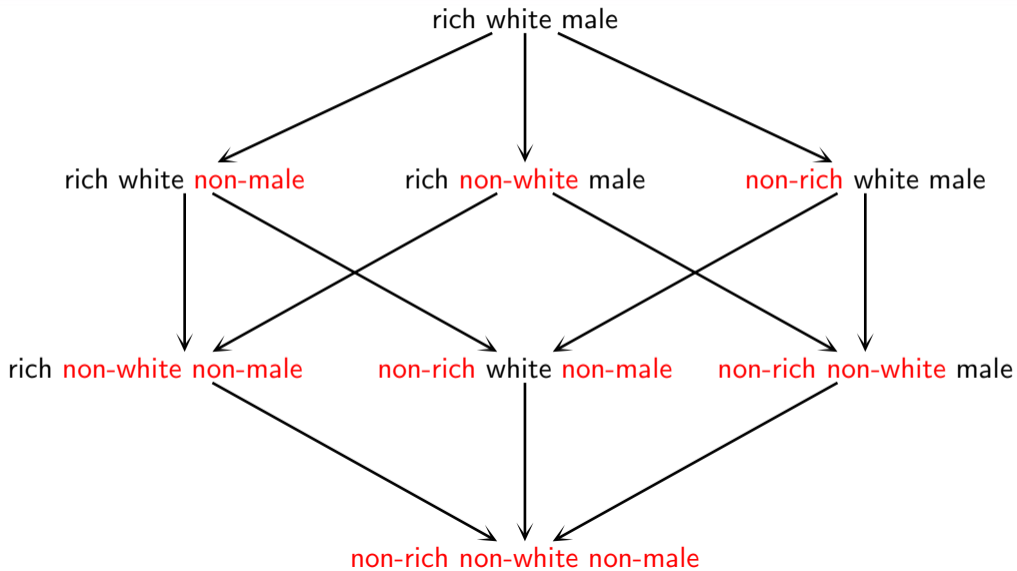
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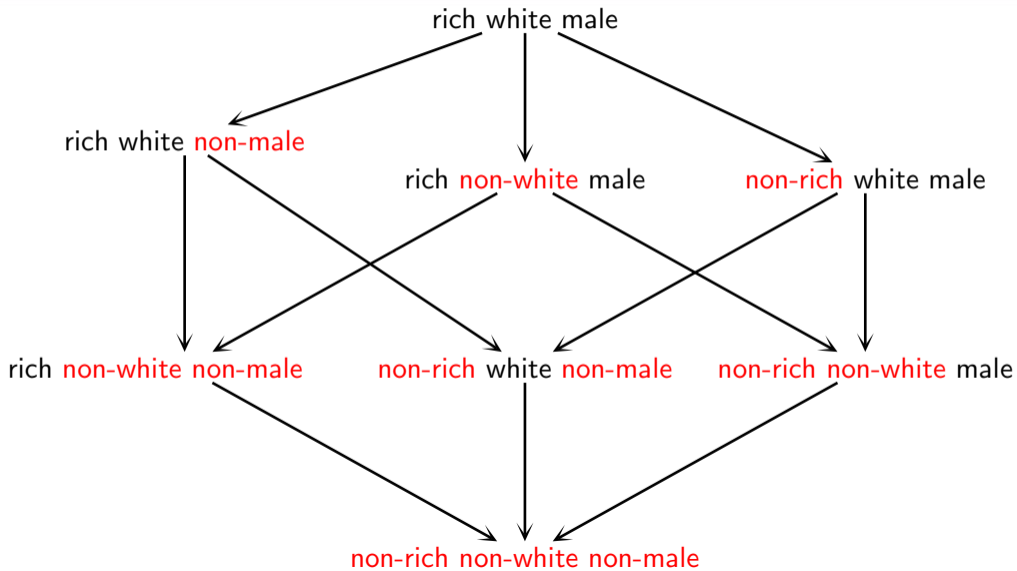
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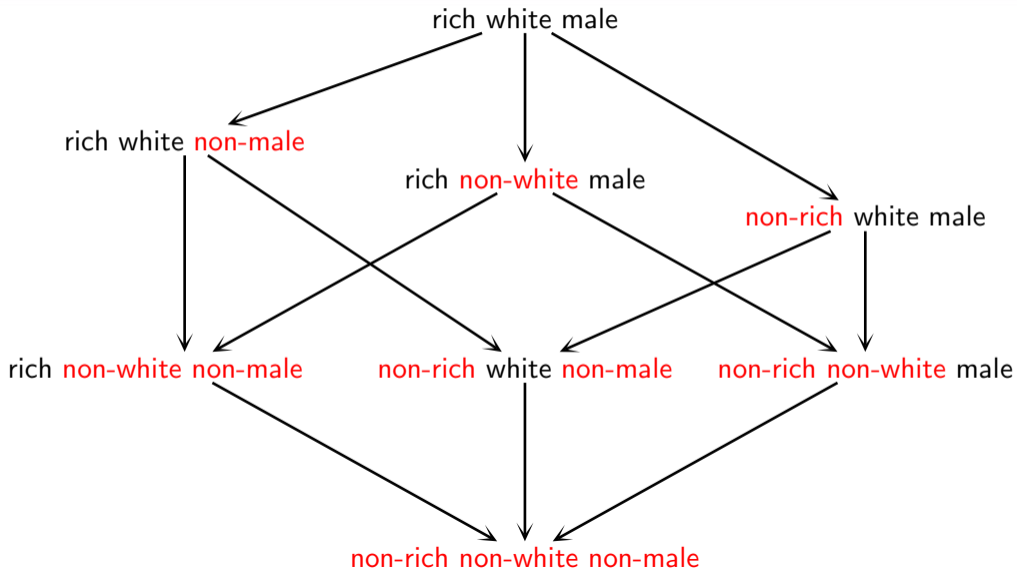
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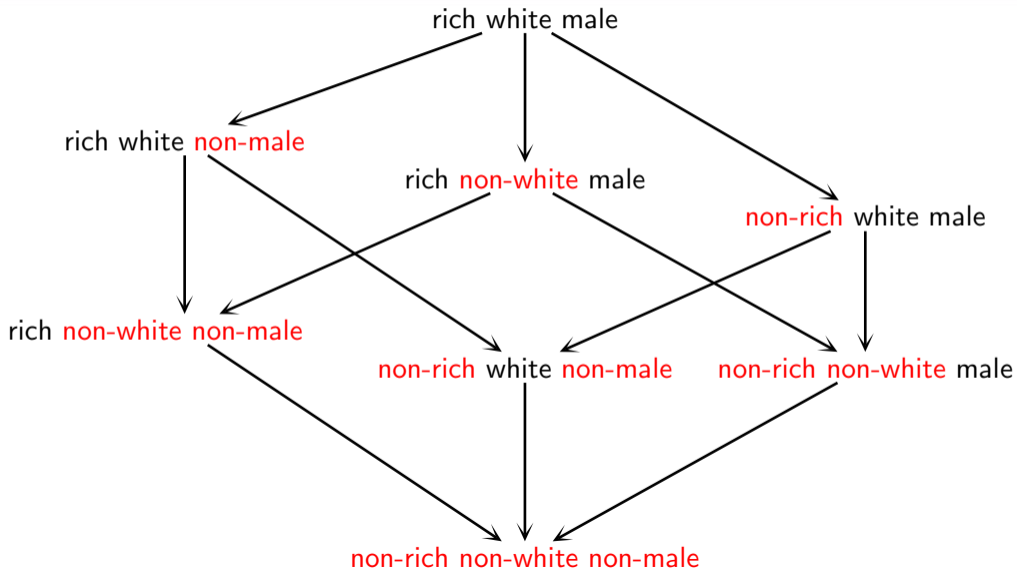
Privilege



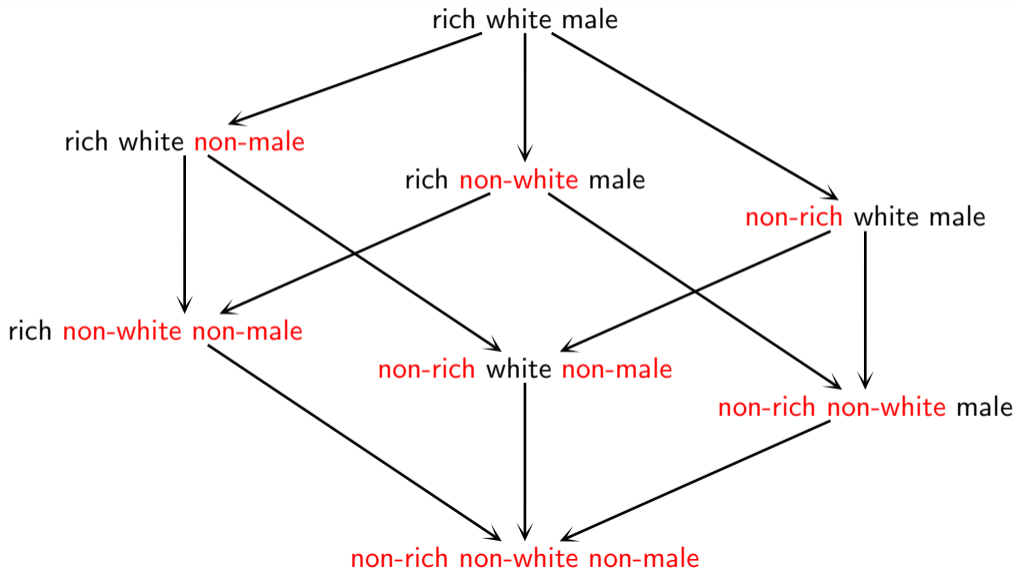
Privilege



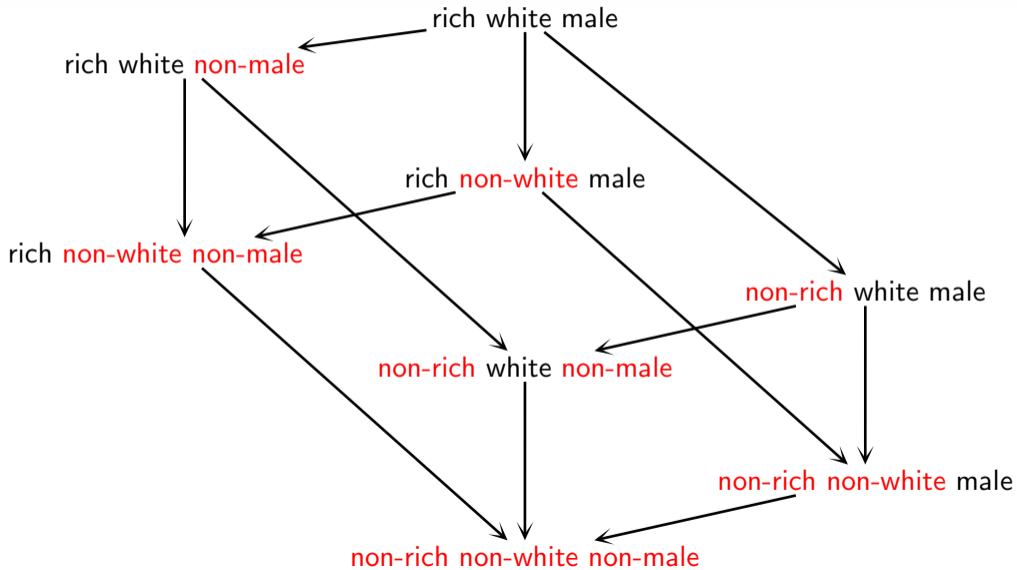
Privilege



Privilege



Privilege



Conclusion

Abstraction has a point

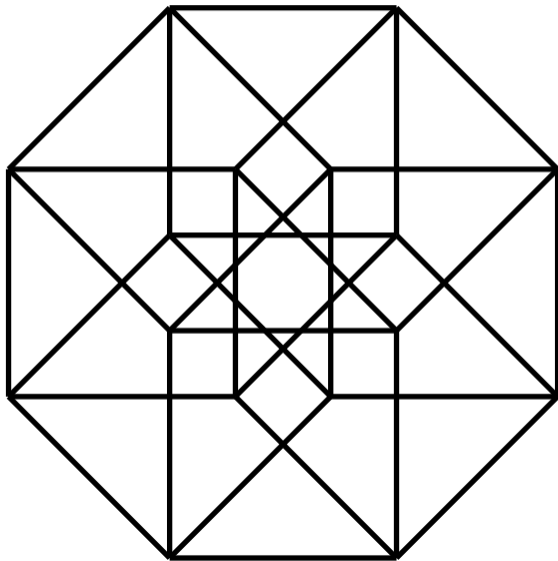
Conclusion

Abstraction has a point

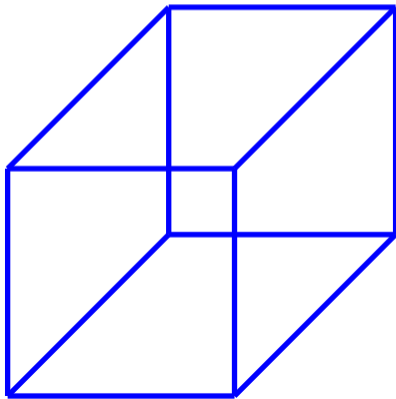
We gain:

- broader perspective,
- deeper understanding,
- wider applicability, and
- more connections between things.

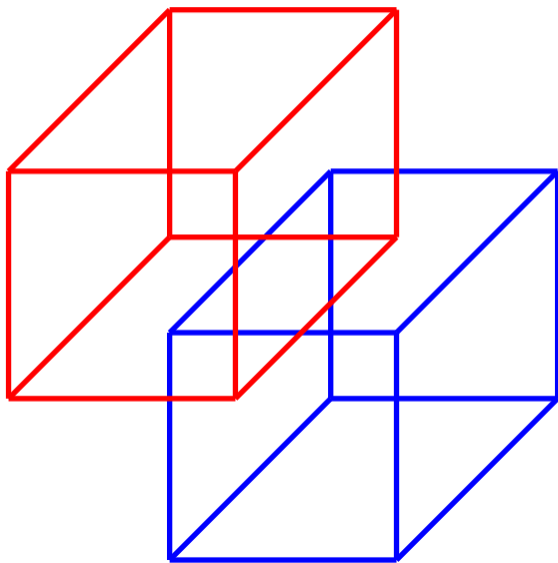
4-D cube



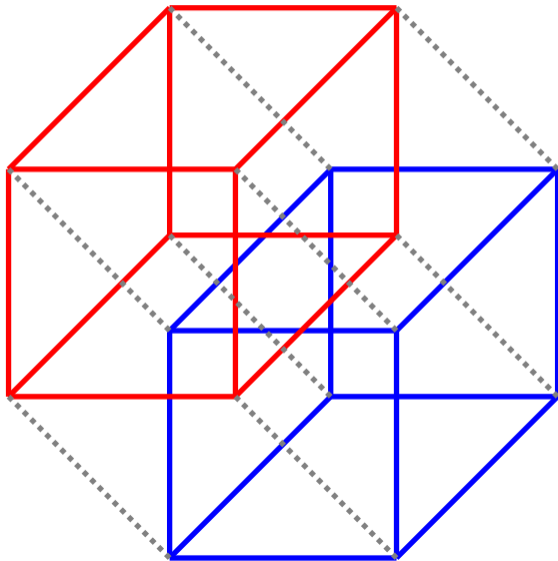
4-D cube



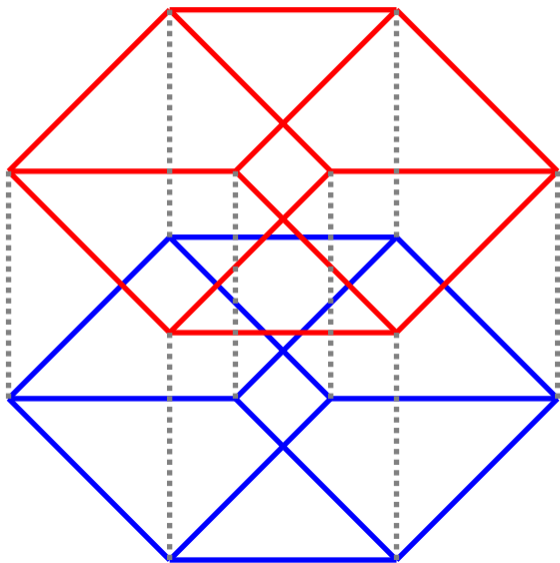
4-D cube



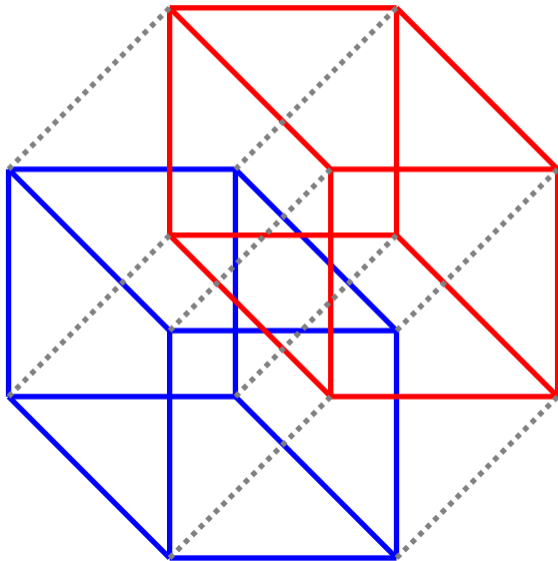
4-D cube



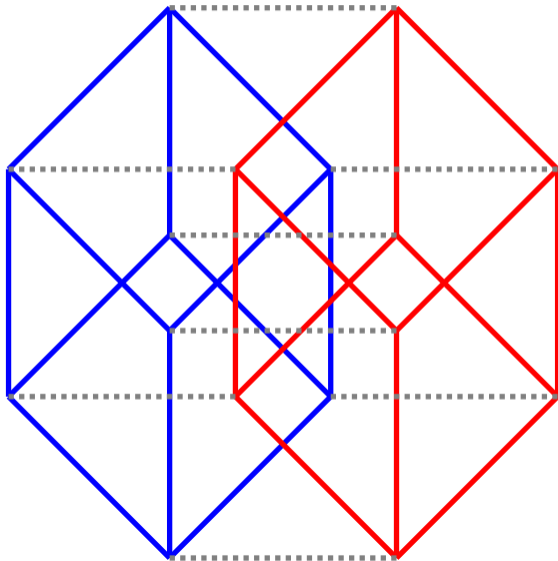
4-D cube



4-D cube



4-D cube



4-D cube

