C(x): has a **cat** · F(x): has a **ferret** · D(x) has a **dog** B(x): **bikes** to campus · H(x): wears a **helmet**

R(x): ate breakfast today \cdot L(x): lives on campus

name	С	F	D	В	Н	R	L
Alex	1			✓	1	1	
Bea	✓	✓		✓	1	1	1
Chen			1			1	
Devo				✓	1		1
Emi	1		1			1	
Farah		1				1	1
Gus			1				
Hana	✓						1

For each of the following questions: 1) write an equivalent English statement, 2) determine its truth value, 3) write its negation.

1.
$$\exists x, C(x) \land F(x) \land \neg D(x)$$

2.
$$\forall x, B(x) \rightarrow H(x)$$

3.
$$\forall x, C(x) \land \neg D(x)$$

4.
$$\forall x, R(x) \lor L(x)$$

5.
$$\exists x, \neg (C(x) \lor F(x))$$

C(x): has a **cat** \cdot F(x): has a **ferret** \cdot D(x) has a **dog** B(x): **bikes** to campus \cdot H(x): wears a **helmet**

R(x): ate **breakfast** today \cdot L(x): **lives on campus**

name	С	F	D	В	Н	R	L
Alex	✓			1	1	1	
Bea	✓	1		1	1	1	1
Chen			1			1	
Devo				1	1		1
Emi	1		1			1	
Farah		1				1	1
Gus			1				
Hana	✓						1

Your turn: write one true and one false statement containing at least two predicates, and the negation of each.

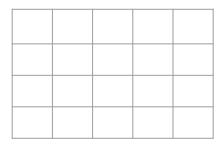
1. True statement:

Negation:

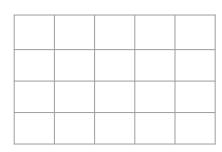
2. False statement:

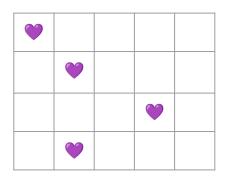
Negation:

- In the grids below, each row represents a Hero (H) and each column represents a Villain (V). A heart in cell (x,y) means Hero x likes Villain y.
 - 1. Using as few as possible, place hearts in the grid to represent $\forall x, \exists y, x \text{ likes } y$



2. Using as few as possible, place hearts in the grid to represent $\exists y, \forall x, x \text{ likes } y$

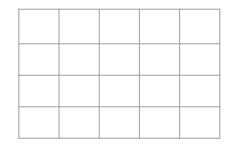




Determine whether each of the following statements are true or false for the grid above.

- 1. $\exists y, \forall x, x \text{ likes } y$
- 2. $\forall x, \exists y, x \text{ likes } y$
- 3. $\exists x, \forall y, x \text{ likes } y$
- 4. $\forall y, \exists x, x \text{ likes } y$

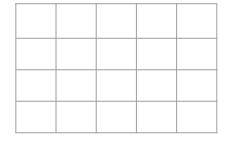
- 4 Suppose we create a new quantifier, $\exists^{=2}$ which means "there exists exactly 2." In each of the Hero/Villain puzzles below, determine the minimum and the maximum number of hearts you should place in order to make each quantified statement true.
 - 1. $\forall x, \exists^{=2}y, x \text{ likes y}$



Min: _____

Max:

2. $\exists^{=2}y, \forall x, x \text{ likes y}$



Min: _____

Max: