

## Practice Using Quantifiers

Here are the interpretations for several predicates (“open sentences”).

$M(x)$	$x$ is male
$F(x)$	$x$ is female
$P(x, y)$	$x$ is a parent of $y$
$S(x, y)$	$x$ is a sibling of $y$
$R(x)$	$x$ has red hair.
$L(x, y)$	$x$ loves $y$

Let the universe be all human beings (living or dead).

1. We can use these to define new predicates in terms of the old ones. For example, we could define

$$B(x, y) \text{ as } M(x) \wedge S(x, y) \quad (“x \text{ is a brother of } y”)$$

Write a definition for  $G(x, y)$  to mean “ $x$  is a grandfather of  $y$ ”

$$G(x, y)$$

2. Interpret in English:

- a)  $(\exists x)(\exists y)(B(x, y) \wedge R(x))$
- b)  $(\forall y)(\exists x)P(x, y)$
- c)  $(\forall x)(\exists y)P(x, y)$
- d)  $(\exists x)(\forall y)P(x, y)$
- e)  $(\exists y)(\forall x)P(x, y)$

3. Write using quantifiers and the predicates above:

- a) Not everybody has a cousin.
- b) Everybody loves somebody
- c) “All the world loves a lover”