Introduction to Predicate Logic

PHIL 500

$\forall x(Fx \rightarrow Gx), Fa \therefore Ga$

Outline

The Need for Predicate Logic

The Need for PL

Everyone who has a dog is happy

Obama has a dog

∴ Obama is happy

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- This argument is valid.

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- This argument is valid.
- But it isn't an entailment—so SL isn't able to tell us that it is valid.

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$$\begin{array}{rl} & E \\ & \text{Obama has a dog} \\ \therefore & \text{Obama is happy} \end{array}$$

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E

O

$\therefore$ Obama is happy

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The Need for PL

E

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$\therefore\ H$

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E [T]

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$$\begin{array}{ll} & E\ [\text{T}] \\ & O\ [\text{T}] \\ \therefore & H\ [\text{F}] \end{array}$$

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$$D\_\_\_\_\_ \;:\; \_\_\_\_\_ \text{ has a dog}$$
$$H\_\_\_\_\_ \;:\; \_\_\_\_\_ \text{ is happy}$$

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$$o : \text{Obama}$$

- We'll have *predicates*, like

$$D\_\_\_\_\_ : \_\_\_\_\_ \text{ has a dog}$$
$$H\_\_\_\_\_ : \_\_\_\_\_ \text{ is happy}$$

▹ Putting them together will give *statements* like

$$Do : \text{Obama has a dog}$$
$$Ho : \text{Obama is happy}$$

The Need for PL

- Finally, we'll have two additional symbols, known as *quantifiers*:

$$\forall x \;\_\_\_\_\_ \quad : \quad \text{Everything is } \_\_\_\_\_$$
$$\exists x \;\_\_\_\_\_ \quad : \quad \text{Something is } \_\_\_\_\_$$

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- ‘$\forall$’ is an upside-down ‘A’—it stands for ‘*all*’.
- $\exists$’ is a backwards ‘E’—it stands for ‘*exists*’.
- ‘x’ is a *variable*—we'll come back to this.

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The Need for PL

$$\forall x(Dx \rightarrow Hx)$$

$$Do$$

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Translation into PL

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Symbolization Keys

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  - For instance:

$$A : \text{Abelard loves Heloise}$$
$$H : \text{Heloise loves Abelard}$$
$$B : \text{Abelard is bald}$$

  - We will also translate into PL with a *symbolization key*, except that these symbolization keys will tell us what each relevant *name* and *predicate* of PL means.

Predicate Logic: Names

- In PL, we use the lowercase letters 'a' through 'v' as *names*. (We can add subscripts if we need to.)

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- The names in PL are just like *proper names* in English. Each name in PL refers to some particular person, place or thing.

Predicate Logic: Names

- A (partial) symbolization key:

$$\begin{aligned} a &: \text{Abelard} \\ h &: \text{Heloise} \\ b &: \text{Barcelona} \\ j &: \text{Jupiter} \end{aligned}$$

Predicate Logic: Predicates

- In PL, we use *uppercase* letters, 'A' through 'Z', for *predicates*. (We can add subscripts if we need to.)

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▹ Think of a *predicate* as a *gappy statement*—it's a statement with a name (or names) missing.

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Predicate Logic: Predicates

- A (partial) symbolization key:

$$\begin{aligned} L\_\_\_\_ &: \_\_\_\_ \text{ is large} \\ B\_\_\_\_ &: \_\_\_\_ \text{ is bald} \\ P\_\_\_\_ &: \_\_\_\_ \text{ loves Philosophy} \\ X\_\_\_\_ &: \_\_\_\_ \text{ is excited} \end{aligned}$$

Predicate Logic: Names and Predicates

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- If will fill in those gaps with names, then we get back a statement.

Predicate Logic: Names and Predicates

a	:	Abelard	L____	:	____ is large
h	:	Heloise	B____	:	____ is bald
b	:	Barcelona	P____	:	____ loves Philosophy
j	:	Jupiter	X____	:	____ is excited

- Abelard is bald :

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- Abelard is bald : Ba
- Heloise is excited :

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- Abelard is bald : Ba
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a : Abelard	L____	:	____ is large
h : Heloise	B____	:	____ is bald
b : Barcelona	P____	:	____ loves Philosophy
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- Abelard is bald : Ba
- Heloise is excited : Xh
- Heloise isn't bald :

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h	:	Heloise	$B\_\_\_\_$	: $\_\_\_\_$ is bald
b	:	Barcelona	$P\_\_\_\_$	: $\_\_\_\_$ loves Philosophy
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- Abelard is bald : Ba
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- Abelard is bald : Ba
- Heloise is excited : Xh
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- Heloise is excited only if Abelard loves Philosophy :

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- Heloise is excited only if Abelard loves Philosophy : $Xh \rightarrow Pa$

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- Barcelona is large unless Jupiter isn't. :

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- Neither Barcelona nor Jupiter is large :

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- Neither Barcelona nor Jupiter is large : $\neg(Lb \vee Lj)$

SL Translation

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- Recall from SL:
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  - $\mathscr{A}$ only if $\mathscr{B}$: $\mathscr{A} \rightarrow \mathscr{B}$
  - Neither $\mathscr{A}$ nor $\mathscr{B}$: $\neg(\mathscr{A} \vee \mathscr{B})$

Predicate Logic: Variables

- Predicates are statements with gaps for names. Putting a name in the gap gives us a statement. However, we will also allow ourselves to fill the gap in a predicate with a *variable*.

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- In PL, the lowercase letters w, x, y, and z are *variables*. (We can add subscripts if we need to.)

$$w, x, y, z, w_1, x_1, y_1, z_1, w_2, \ldots$$

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  ▹ Think of a variable as a name without a fixed meaning—it can refer to *anything* (in the domain).

Predicate Logic: Variables and quantifiers

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- Everyone should be circumspect when meeting in-laws

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- We must say which things our variables could refer to—which things we are potentially talking about.
- A *Domain* specifies which things we might be talking about. It says which things a variable in our language could refer to.
  - Note: if one of our *names* refers to something, then that thing must be included in the domain.

Predicate Logic: Domains

$$\begin{aligned} \text{Domain} &: \quad \text{all students at Pitt} \\ H\_\_\_\_ &: \quad \_\_\_\_ \text{ is happy} \\ D\_\_\_\_ &: \quad \_\_\_\_ \text{ has a dog} \end{aligned}$$

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Domain	:	all people
D_____	:	_____ has a dog
P_____	:	_____ is a student at Pitt

Predicate Logic: Domains

$$\begin{aligned} \text{Domain} &: \quad \text{all people} \\ D\_\_\_\_ &: \quad \_\_\_\_ \text{ has a dog} \\ P\_\_\_\_ &: \quad \_\_\_\_ \text{ is a student at Pitt} \end{aligned}$$

- Every student at Pitt has a dog.

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- Some student at Pitt has a dog.

Predicate Logic: Domains

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- Every student at Pitt has a dog.

$$\forall x \; (Px \rightarrow Dx)$$

- Some student at Pitt has a dog.

$$\exists x \; (Px \wedge Dx)$$

Predicate Logic: Domains

Domain	:	all people
B_____	:	_____ is bald

Predicate Logic: Domains

Domain	:	all people
B_____	:	_____ is bald

- Everyone is bald.

Predicate Logic: Domains

$$\begin{aligned} \text{Domain} &: \quad \text{all people} \\ B\_\_\_\_\_ &: \quad \_\_\_\_\_ \text{ is bald} \end{aligned}$$

- Everyone is bald.

$$\forall x \; Bx$$

Predicate Logic: Domains

$$\begin{aligned} \text{Domain} &: \quad \text{all things on planet Earth} \\ B\_\_\_\_\_ &: \quad \_\_\_\_\_ \text{ is bald} \end{aligned}$$

- Everyone is bald.

$$\forall x \; Bx$$

Predicate Logic: Domains

$$\begin{aligned} \text{Domain} &: \text{ all things on planet Earth} \\ B\_\_\_\_ &: \text{ \_\_\_\_ is bald} \\ P\_\_\_\_ &: \text{ \_\_\_\_ is a person} \end{aligned}$$

- Everyone is bald.

$$\forall x \; Bx$$

Predicate Logic: Domains

$$\begin{aligned} \text{Domain} &: \quad \text{all things on planet Earth} \\ B\_\_\_\_\_ &: \quad \_\_\_\_\_ \text{ is bald} \\ P\_\_\_\_\_ &: \quad \_\_\_\_\_ \text{ is a person} \end{aligned}$$

- Everyone is bald.

$$\forall x\ (Px \rightarrow Bx)$$

Predicate Logic: Symbolization Keys

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  - Each name has to refer to one and only one thing
  - Multiple names can refer to the same thing (*e.g.* 'Sam Clemens' and 'Mark Twain')
- For each relevant predicate of PL, it tells us which gappy statement that predicate represents.

Translation into PL

Important Statement Forms

Four Important Statement Forms

All $\mathscr{F}$s are $\mathscr{G}$s

Four Important Statement Forms

All $\mathscr{F}$s are $\mathscr{G}$s

No $\mathscr{F}$s are $\mathscr{G}$s

Four Important Statement Forms

All $\mathscr{F}$s are $\mathscr{G}$s

No $\mathscr{F}$s are $\mathscr{G}$s

Some $\mathscr{F}$s are $\mathscr{G}$s

Four Important Statement Forms

All $\mathscr{F}$s are $\mathscr{G}$s

No $\mathscr{F}$s are $\mathscr{G}$s

Some $\mathscr{F}$s are $\mathscr{G}$s

Some $\mathscr{F}$s are not $\mathscr{G}$s

Four Important Statement Forms

All $\mathscr{F}$s are $\mathscr{G}$s

- All mammals are warm-blooded

No $\mathscr{F}$s are $\mathscr{G}$s

Some $\mathscr{F}$s are $\mathscr{G}$s

Some $\mathscr{F}$s are not $\mathscr{G}$s

Four Important Statement Forms

All $\mathscr{F}$s are $\mathscr{G}$s

- All mammals are warm-blooded

No $\mathscr{F}$s are $\mathscr{G}$s

- No reptiles are warm-blooded

Some $\mathscr{F}$s are $\mathscr{G}$s

Some $\mathscr{F}$s are not $\mathscr{G}$s

Four Important Statement Forms

All $\mathcal{F}$s are $\mathcal{G}$s

- All mammals are warm-blooded

No $\mathcal{F}$s are $\mathcal{G}$s

- No reptiles are warm-blooded

Some $\mathcal{F}$s are $\mathcal{G}$s

- Some mammals are carnivorous

Some $\mathcal{F}$s are not $\mathcal{G}$s

Four Important Statement Forms

All $\mathcal{F}$s are $\mathcal{G}$s

- All mammals are warm-blooded

No $\mathcal{F}$s are $\mathcal{G}$s

- No reptiles are warm-blooded

Some $\mathcal{F}$s are $\mathcal{G}$s

- Some mammals are carnivorous

Some $\mathcal{F}$s are not $\mathcal{G}$s

- Some mammals are not carnivorous

All $\mathscr{F}$s are $\mathscr{G}$s

- All of the following mean the same thing, and so can be translated into PL in the same way:

All $\mathscr{F}$s are $\mathscr{G}$s

- All of the following mean the same thing, and so can be translated into PL in the same way:
  - All $\mathscr{F}$s are $\mathscr{G}$s — All mammals are warm-blooded

All $\mathscr{F}$s are $\mathscr{G}$s

- All of the following mean the same thing, and so can be translated into PL in the same way:
  - All $\mathscr{F}$s are $\mathscr{G}$s — All mammals are warm-blooded
  - Every $\mathscr{F}$ is $\mathscr{G}$ — Every mammal is warm-blooded

All $\mathscr{F}$s are $\mathscr{G}$s

- All of the following mean the same thing, and so can be translated into PL in the same way:
  - All $\mathscr{F}$s are $\mathscr{G}$s — All mammals are warm-blooded
  - Every $\mathscr{F}$ is $\mathscr{G}$ — Every mammal is warm-blooded
  - Each $\mathscr{F}$ is $\mathscr{G}$ — Each mammal is warm-blooded

All $\mathscr{F}$s are $\mathscr{G}$s

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  - Every $\mathscr{F}$ is $\mathscr{G}$ — Every mammal is warm-blooded
  - Each $\mathscr{F}$ is $\mathscr{G}$ — Each mammal is warm-blooded
  - Any $\mathscr{F}$ is $\mathscr{G}$ — Any mammal is warm-blooded

All $\mathcal{F}$s are $\mathcal{G}$s

- Given a domain,

$$\forall x(\mathcal{F}x \rightarrow \mathcal{G}x)$$

  says:

  All $\mathcal{F}$s in the domain are $\mathcal{G}$

All $\mathcal{F}$s are $\mathcal{G}$s

- Given a domain,

$$\forall x(\mathcal{F}x \rightarrow \mathcal{G}x)$$

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  All $\mathcal{F}$s in the domain are $\mathcal{G}$

  Every $\mathcal{F}$ in the domain is $\mathcal{G}$

All $\mathscr{F}$s are $\mathscr{G}$s

- Given a domain,

  $$\forall x(\mathscr{F}x \rightarrow \mathscr{G}x)$$

  says:

  All $\mathscr{F}$s in the domain are $\mathscr{G}$

  Every $\mathscr{F}$ in the domain is $\mathscr{G}$

  Each $\mathscr{F}$ in the domain is $\mathscr{G}$

All $\mathscr{F}$s are $\mathscr{G}$s

- Given a domain,

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  says:

  All $\mathscr{F}$s in the domain are $\mathscr{G}$

  Every $\mathscr{F}$ in the domain is $\mathscr{G}$

  Each $\mathscr{F}$ in the domain is $\mathscr{G}$

  Any $\mathscr{F}$ in the domain is $\mathscr{G}$

All $\mathscr{F}$s are $\mathscr{G}$s

- Given a domain,

  $$\forall y(\mathscr{F}y \rightarrow \mathscr{G}y)$$

  says:

  All $\mathscr{F}$s in the domain are $\mathscr{G}$

  Every $\mathscr{F}$ in the domain is $\mathscr{G}$

  Each $\mathscr{F}$ in the domain is $\mathscr{G}$

  Any $\mathscr{F}$ in the domain is $\mathscr{G}$

All $\mathscr{F}$s are $\mathscr{G}$s

- Given a domain,

  $$\forall z(\mathscr{F}z \rightarrow \mathscr{G}z)$$

  says:

  All $\mathscr{F}$s in the domain are $\mathscr{G}$

  Every $\mathscr{F}$ in the domain is $\mathscr{G}$

  Each $\mathscr{F}$ in the domain is $\mathscr{G}$

  Any $\mathscr{F}$ in the domain is $\mathscr{G}$

All mammals are warm-blooded

$$\begin{aligned} \text{Domain} &: \quad \text{all mammals} \\ W\underline{} &: \quad \underline{} \text{ is warm-blooded} \end{aligned}$$

$$\forall y\ Wy$$

All mammals are warm-blooded

$$\begin{aligned} \text{Domain} &: \quad \text{all animals} \\ W\_\_\_\_\_ &: \quad \_\_\_\_\_ \text{ is warm-blooded} \end{aligned}$$

$$\forall y \; Wy$$

All mammals are warm-blooded

$$\begin{aligned} \text{Domain} &: \quad \text{all animals} \\ W\_\_\_\_\_ &: \quad \_\_\_\_\_ \text{ is warm-blooded} \\ M\_\_\_\_\_ &: \quad \_\_\_\_\_ \text{ is a mammal} \end{aligned}$$

$$\forall y \; Wy$$

All mammals are warm-blooded

$$\begin{aligned} \text{Domain} &: \quad \text{all animals} \\ W\_\_\_\_\_ &: \quad \_\_\_\_\_ \text{ is warm-blooded} \\ M\_\_\_\_\_ &: \quad \_\_\_\_\_ \text{ is a mammal} \end{aligned}$$

$$\forall x(Mx \rightarrow Wx)$$

No $\mathscr{F}$s are $\mathscr{G}$s

- All of the following mean the same thing, and so can be translated into PL in the same way:

No $\mathscr{F}$s are $\mathscr{G}$s

- All of the following mean the same thing, and so can be translated into PL in the same way:
  - No $\mathscr{F}$s are $\mathscr{G}$s   No reptiles are warm-blooded

No $\mathcal{F}$s are $\mathcal{G}$s

- All of the following mean the same thing, and so can be translated into PL in the same way:
  - No $\mathcal{F}$s are $\mathcal{G}$s — No reptiles are warm-blooded
  - No $\mathcal{F}$ is $\mathcal{G}$ — No reptile is warm-blooded

No $\mathscr{F}$s are $\mathscr{G}$s

- All of the following mean the same thing, and so can be translated into PL in the same way:
  - No $\mathscr{F}$s are $\mathscr{G}$s — No reptiles are warm-blooded
  - No $\mathscr{F}$ is $\mathscr{G}$ — No reptile is warm-blooded
  - Every $\mathscr{F}$ is not $\mathscr{G}$s — Every reptile is not warm-blooded

No $\mathscr{F}$s are $\mathscr{G}$s

- Given a domain,

$$\forall x(\mathscr{F}x \to \neg\mathscr{G}x)$$

says:

No $\mathscr{F}$s in the domain are $\mathscr{G}$

No $\mathscr{F}$s are $\mathscr{G}$s

- Given a domain,

$$\forall x(\mathscr{F}x \rightarrow \neg \mathscr{G}x)$$

says:

No $\mathscr{F}$s in the domain are $\mathscr{G}$

No $\mathscr{F}$ in the domain is $\mathscr{G}$

No $\mathscr{F}$s are $\mathscr{G}$s

- Given a domain,

$$\forall x(\mathscr{F}x \rightarrow \neg \mathscr{G}x)$$

says:

No $\mathscr{F}$s in the domain are $\mathscr{G}$

No $\mathscr{F}$ in the domain is $\mathscr{G}$

Every $\mathscr{F}$ in the domain is not $\mathscr{G}$

No $\mathscr{F}$s are $\mathscr{G}$s

- Given a domain,

$$\neg\exists x(\mathscr{F}x \wedge \mathscr{G}x)$$

  says:

  No $\mathscr{F}$s in the domain are $\mathscr{G}$

  No $\mathscr{F}$ in the domain is $\mathscr{G}$

  Every $\mathscr{F}$ in the domain is not $\mathscr{G}$

No reptiles are warm-blooded

$$\begin{aligned} \text{Domain} &: \quad \text{all reptiles} \\ W\_\_\_\_\_ &: \quad \_\_\_\_\_ \text{ is warm-blooded} \end{aligned}$$

$$\forall y \, \neg W y$$

No reptiles are warm-blooded

Domain : all animals

W_____ : _____ is warm-blooded

$$\forall y \neg Wy$$

No reptiles are warm-blooded

Domain	:	all animals
W_____	:	_____ is warm-blooded
R_____	:	_____ is a reptile

$$\forall y\ \neg Wy$$

No reptiles are warm-blooded

Domain : all animals

W_____ : _____ is warm-blooded

R_____ : _____ is a reptile

$$\forall y(Ry \rightarrow \neg Wy)$$

Some $\mathscr{F}$s are $\mathscr{G}$s

- All of the following mean the same thing, and so can be translated into PL in the same way:

Some $\mathscr{F}$s are $\mathscr{G}$s

- All of the following mean the same thing, and so can be translated into PL in the same way:
  - Some $\mathscr{F}$s are $\mathscr{G}$s   Some mammals are carnivorous

Some $\mathscr{F}$s are $\mathscr{G}$s

- All of the following mean the same thing, and so can be translated into PL in the same way:
  - Some $\mathscr{F}$s are $\mathscr{G}$s — Some mammals are carnivorous
  - Some $\mathscr{F}$ is $\mathscr{G}$ — Some mammal is carnivorous

Some $\mathscr{F}$s are $\mathscr{G}$s

- All of the following mean the same thing, and so can be translated into PL in the same way:

▹ Some $\mathscr{F}$s are $\mathscr{G}$s	Some mammals are carnivorous
▹ Some $\mathscr{F}$ is $\mathscr{G}$	Some mammal is carnivorous
▹ There are $\mathscr{G}$ $\mathscr{F}$s	There are carnivorous mammals

Some $\mathscr{F}$s are $\mathscr{G}$s

- Given a domain,

$$\exists x(\mathscr{F}x \land \mathscr{G}x)$$

says:

Some $\mathscr{F}$s in the domain are $\mathscr{G}$

Some $\mathscr{F}$s are $\mathscr{G}$s

- Given a domain,

$$\exists x(\mathscr{F}x \wedge \mathscr{G}x)$$

says:

Some $\mathscr{F}$s in the domain are $\mathscr{G}$

Some $\mathscr{F}$ in the domain is $\mathscr{G}$

Some $\mathscr{F}$s are $\mathscr{G}$s

- Given a domain,

$$\exists x(\mathscr{F}x \land \mathscr{G}x)$$

says:

Some $\mathscr{F}$s in the domain are $\mathscr{G}$

Some $\mathscr{F}$ in the domain is $\mathscr{G}$

There are $\mathscr{G}$ $\mathscr{F}$s in the domain

Some $\mathscr{F}$s are $\mathscr{G}$s

- Given a domain,

  $$\exists y(\mathscr{F}y \land \mathscr{G}y)$$

  says:

  Some $\mathscr{F}$s in the domain are $\mathscr{G}$

  Some $\mathscr{F}$ in the domain is $\mathscr{G}$

  There are $\mathscr{G}$ $\mathscr{F}$s in the domain

Some $\mathscr{F}$s are $\mathscr{G}$s

- Given a domain,

  $$\exists z(\mathscr{F}z \wedge \mathscr{G}z)$$

  says:

  Some $\mathscr{F}$s in the domain are $\mathscr{G}$

  Some $\mathscr{F}$ in the domain is $\mathscr{G}$

  There are $\mathscr{G}$ $\mathscr{F}$s in the domain

Some mammals are carnivorous

$$\begin{aligned} \text{Domain} &: \quad \text{all mammals} \\ C\_\_\_\_\_ &: \quad \_\_\_\_\_ \text{ is carnivorous} \end{aligned}$$

$$\exists z\ Cz$$

Some mammals are carnivorous

Domain : all animals

C_____ : _____ is carnivorous

$$\exists z\, Cz$$

Some mammals are carnivorous

Domain	:	all animals
C_____	:	_____ is carnivorous
M_____	:	_____ is a mammal

$$\exists z\ Cz$$

Some mammals are carnivorous

$$\begin{aligned} \text{Domain} &: \quad \text{all animals} \\ C\_\_\_\_\_ &: \quad \_\_\_\_\_ \text{ is carnivorous} \\ M\_\_\_\_\_ &: \quad \_\_\_\_\_ \text{ is a mammal} \end{aligned}$$

$$\exists x(Mx \wedge Cx)$$

Some $\mathscr{F}$s are not $\mathscr{G}$s

- All of the following mean the same thing, and so can be translated into PL in the same way:

Some $\mathscr{F}$s are not $\mathscr{G}$s

- All of the following mean the same thing, and so can be translated into PL in the same way:
  - Some $\mathscr{F}$s are not $\mathscr{G}$s   Some mammals are not carnivorous

Some $\mathscr{F}$s are not $\mathscr{G}$s

- All of the following mean the same thing, and so can be translated into PL in the same way:
  - Some $\mathscr{F}$s are not $\mathscr{G}$s — Some mammals are not carnivorous
  - Some $\mathscr{F}$ is not $\mathscr{G}$ — Some mammal is not carnivorous

Some $\mathscr{F}$s are not $\mathscr{G}$s

- All of the following mean the same thing, and so can be translated into PL in the same way:

▹ Some $\mathscr{F}$s are not $\mathscr{G}$s   Some mammals are not carnivorous

▹ Some $\mathscr{F}$ is not $\mathscr{G}$ Some mammal is not carnivorous

▹ There are non-$\mathscr{G}$ $\mathscr{F}$s   There are non-carnivorous mammals

Some $\mathscr{F}$s are not $\mathscr{G}$s

- Given a domain,

$$\exists x(\mathscr{F}x \wedge \neg \mathscr{G}x)$$

says:

Some $\mathscr{F}$s in the domain are not $\mathscr{G}$

Some $\mathscr{F}$s are not $\mathscr{G}$s

- Given a domain,

$$\exists x(\mathscr{F}x \wedge \neg \mathscr{G}x)$$

says:

Some $\mathscr{F}$s in the domain are not $\mathscr{G}$

Some $\mathscr{F}$ in the domain is not $\mathscr{G}$

Some $\mathscr{F}$s are not $\mathscr{G}$s

- Given a domain,

$$\exists x(\mathscr{F}x \wedge \neg \mathscr{G}x)$$

says:

Some $\mathscr{F}$s in the domain are not $\mathscr{G}$

Some $\mathscr{F}$ in the domain is not $\mathscr{G}$

There are non-$\mathscr{G}$ $\mathscr{F}$s in the domain

Some $\mathcal{F}$s are not $\mathcal{G}$s

- Given a domain,

$$\exists w(\mathcal{F}w \wedge \neg \mathcal{G}w)$$

says:

Some $\mathcal{F}$s in the domain are not $\mathcal{G}$

Some $\mathcal{F}$ in the domain is not $\mathcal{G}$

There are non-$\mathcal{G}$ $\mathcal{F}$s in the domain

Some $\mathscr{F}$s are not $\mathscr{G}$s

- Given a domain,

$$\exists z(\mathscr{F}z \wedge \neg\mathscr{G}z)$$

says:

Some $\mathscr{F}$s in the domain are not $\mathscr{G}$

Some $\mathscr{F}$ in the domain is not $\mathscr{G}$

There are non-$\mathscr{G}$ $\mathscr{F}$s in the domain

Some mammals are not carnivorous

Domain	:	all mammals
C_____	:	_____ is carnivorous

$$\exists z\, \neg Cz$$

Some mammals are not carnivorous

Domain	:	all animals
C_____	:	_____ is carnivorous

$$\exists z\ \neg Cz$$

Some mammals are not carnivorous

Domain : all animals

C_____ : _____ is carnivorous

M_____ : _____ is a mammal

$$\exists z \neg Cz$$

Some mammals are not carnivorous

$$
\begin{aligned}
\text{Domain} &: \quad \text{all animals} \\
C\_\_\_\_\_ &: \quad \_\_\_\_\_ \text{ is carnivorous} \\
M\_\_\_\_\_ &: \quad \_\_\_\_\_ \text{ is a mammal}
\end{aligned}
$$

$$\exists x(Mx \wedge \neg Cx)$$

Four Important Statement Forms

- All $\mathscr{F}$s are $\mathscr{G}$s $\qquad \forall x(\mathscr{F}x \rightarrow \mathscr{G}x)$

Four Important Statement Forms

- All $\mathcal{F}$s are $\mathcal{G}$s $\quad \forall x(\mathcal{F}x \rightarrow \mathcal{G}x)$
- No $\mathcal{F}$s are $\mathcal{G}$s $\quad \forall x(\mathcal{F}x \rightarrow \neg\mathcal{G}x)$

Four Important Statement Forms

- All $\mathscr{F}$s are $\mathscr{G}$s — $\forall x(\mathscr{F}x \rightarrow \mathscr{G}x)$
- No $\mathscr{F}$s are $\mathscr{G}$s — $\forall x(\mathscr{F}x \rightarrow \neg\mathscr{G}x)$
- Some $\mathscr{F}$s are $\mathscr{G}$s — $\exists x(\mathscr{F}x \wedge \mathscr{G}x)$

Four Important Statement Forms

- All $\mathscr{F}$s are $\mathscr{G}$s $\qquad \forall x(\mathscr{F}x \longrightarrow \mathscr{G}x)$
- No $\mathscr{F}$s are $\mathscr{G}$s $\qquad \forall x(\mathscr{F}x \longrightarrow \neg\mathscr{G}x)$
- Some $\mathscr{F}$s are $\mathscr{G}$s $\qquad \exists x(\mathscr{F}x \wedge \mathscr{G}x)$
- Some $\mathscr{F}$s are not $\mathscr{G}$s $\qquad \exists x(\mathscr{F}x \wedge \neg\mathscr{G}x)$