SURPRISED?

At the beginning of the class, the professor told her students "I will do something that you don't expect today and you will be surprised." The students waited until the end of class and nothing surprising seemed to happen. At the end of class, Bob said, "Hey, you said you would do something we didn't expect. But I wasn't surprised at all." The professor said "You expected that you would be surprised in class today right?" Bob: "Yes" Prof: "But you weren't. Therefore something happened that you didn't expect. So I surprised you after all."



HERE'S COMPARENT STOCK

Friday, 14 March

LIMITS OF TRUTH-FUNCTIONS

All men are mortal Socrates is a man

Socrates is mortal

All men are tall Not every man is bald Some tall people aren't bald

No apples are rotten Some fruits are rotten

Some fruits aren't apples

For any number, there is a larger prime number

There is no largest prime number

None are truth-functionally valid - We need a stronger logical system



A CARDING AND A CONTRACTOR

1.4.

Wednesday, March 19, 2014



AND REAL CANTES AND A

Two quantifier symbols:



Two quantifier symbols:

♦ means "everything" or "for all".



Two quantifier symbols:

- ♦ means "everything" or "for all".
- I means "something" or "there exists at least one".



Two quantifier symbols:

- ♦ means "everything" or "for all".
- I means "something" or "there exists at least one".
- Just these two quantifiers can be used to capture many of the quantifications we want to talk about.
 For example, all, every, any, none, not all of, some, some are not, at least one, at least two, exactly two, etc.

State Block and a Ch

Cube(a)

True in a world if *a* is a cube in that world

Cube(a)

∀xCube(x)

True in a world if *a* is a cube in that world

True in a world if every object in that world is a cube

Wednesday, March 19, 2014

Cube(a)

∀xCube(x)

True in a world if *a* is a cube in that world

True in a world if every object in that world is a cube

For every object x, x is a cube

State Block and a Ch

Cube(a)

True in a world if *a* is a cube in that world

Cube(a)

∃xCube(x)

True in a world if *a* is a cube in that world

True in a world if at least one object in that world is a cube

Cube(a)

∃xCube(x)

True in a world if *a* is a cube in that world

True in a world if at least one object in that world is a cube

For some object x, x is a cube

Wednesday, March 19, 2014

Cube(a)

∃xCube(x)

True in a world if *a* is a cube in that world

True in a world if at least one object in that world is a cube

For some object x, x is a cube

Cube(x) - Not true or false - not even a sentence

The Lord And Block - words of Cheve to

Wednesday, March 19, 2014

Something is a cube

(There is at least one cube)

Something is a cube
 ∃x Cube(x)

- Something is a cube
 ∃x Cube(x)
- Something is a small cube

• Something is a cube

- ∃x Cube(x)
- Something is a small cube
 - ∃x(Cube(x) ∧ Small(x))

Something is a cube

- A Cube(x)
- Something is a small cube
 - ∃x(Cube(x) ∧ Small(x))
- Some cubes are small

Something is a cube
 ∃x Cube(x)

- Something is a small cube
 - ∃x(Cube(x) ∧ Small(x))
- Some cubes are small
 - ∃x(Cube(x) ∧ Small(x))

Something is a cube
 ∃x Cube(x)

- Something is a small cube
 ∃x(Cube(x) ∧ Small(x))
- Some cubes are small
 - $\exists x(Cube(x) \land Small(x))$
- Some small things are cubes

Something is a cube
 ∃x Cube(x)

- Something is a small cube
 - ∃x(Cube(x) ∧ Small(x))
- Some cubes are small
 - $\exists x(Cube(x) \land Small(x))$
- Some small things are cubes
 - Ix(Small(x) ^ Cube(x)) (Obviously equivalent)

The Lord And Block - words of Cheve to

Wednesday, March 19, 2014

Something is a cube

(There is at least one cube)

Something is a cube
 ∃x Cube(x)

- Something is a cube
 ∃x Cube(x)
- Nothing is a cube

(There is at least one cube)

- Something is a cube
 ∃x Cube(x)
 Nothing is a cube
 - ¬∃x Cube(x)

(There is at least one cube)

- Something is a cube
 ∃x Cube(x)
- Nothing is a cube
 - ¬∃x Cube(x)
- Some cubes are not small

(There is at least one cube)

(There is at least one cube)

- Something is a cube
 ∃x Cube(x)
- Nothing is a cube
 - ¬∃x Cube(x)
- Some cubes are not small
 - $\exists x(Cube(x) \land \neg Small(x))$

Something is a cube
 ∃x Cube(x)

- Nothing is a cube (There are no cubes)
 - ¬∃x Cube(x)
- Some cubes are not small
 - $\exists x(Cube(x) \land \neg Small(x))$
- Some small things are not cubes

Something is a cube
 ∃x Cube(x)

- Nothing is a cube (There are no cubes)
 - ¬∃x Cube(x)
- Some cubes are not small
 - $\exists x(Cube(x) \land \neg Small(x))$
- Some small things are not cubes
 - Ix(Small(x) ^ ¬Cube(x)) (not equivalent)

THE UNIVERSAL QUANTIFIER

Landersteine with a Stratt

Wednesday, March 19, 2014

THE UNIVERSAL QUANTIFIER

Control Store - ANTRE ST.

• Everything is a cube

THE UNIVERSAL QUANTIFIER

Control State of Article of Car

Everything is a cube
 ∀x Cube(x)

- Everything is a cube
 ∀x Cube(x)
- Everything is a small cube

- Everything is a cube
 ∀x Cube(x)
 Everything is a small cube
 - $\forall x(Cube(x) \land Small(x))$

- Everything is a cube
 - Vx Cube(x)
- Everything is a small cube
 - $\forall x(Cube(x) \land Small(x))$
- Everything is either small or is cube

- Everything is a cube
 ∀x Cube(x)
- Everything is a small cube
 - $\forall x(Cube(x) \land Small(x))$
- Everything is either small or is cube
 - $\forall x(Cube(x) \lor Small(x))$

- Everything is a cube
 - Vx Cube(x)
- Everything is a small cube
 - $\forall x(Cube(x) \land Small(x))$
- Everything is either small or is cube
 - $\forall x(Cube(x) \lor Small(x))$
- Every small thing is a cube

• Everything is a cube Vx Cube(x) Everything is a small cube • $\forall x(Cube(x) \land Small(x))$ Everything is either small or is cube • $\forall x(Cube(x) \lor Small(x))$ Every small thing is a cube • $\forall x(Small(x) \rightarrow Cube(x))$

Landersteine with a Stratt

Wednesday, March 19, 2014

• Every cube is small

(All the cubes are small)

Wednesday, March 19, 2014

Every cube is small (All the cubes are small)
 ∀x(Cube(x) → Small(x))

Every cube is small (All the cubes are small)
 ∀x(Cube(x) → Small(x))
 Not every cube is small (Not all the cubes are small)

Every cube is small (All the cubes are small)
 ∀x(Cube(x) → Small(x))
 Not every cube is small (Not all the cubes are small)
 ¬∀x(Cube(x) → Small(x))

Every cube is small (All the cubes are small)
∀x(Cube(x) → Small(x))
Not every cube is small (Not all the cubes are small)
¬∀x(Cube(x) → Small(x))
Every cube is not small (None of the cubes are small)

Every cube is small (All the cubes are small)
∀x(Cube(x) → Small(x))
Not every cube is small (Not all the cubes are small)
¬∀x(Cube(x) → Small(x))
Every cube is not small (None of the cubes are small)
∀x(Cube(x) → ¬Small(x))

Every cube is small (All the cubes are small)
∀x(Cube(x) → Small(x))
Not every cube is small (Not all the cubes are small)
¬∀x(Cube(x) → Small(x))
Every cube is not small (None of the cubes are small)
∀x(Cube(x) → ¬Small(x))
∀x(¬Cube(x) → Small(x)) ??

Every cube is small (All the cubes are small) • $\forall x(Cube(x) \rightarrow Small(x))$ Not every cube is small (Not all the cubes are small) • $\neg \forall x(Cube(x) \rightarrow Small(x))$ Every cube is not small (None of the cubes are small) • $\forall x(Cube(x) \rightarrow \neg Small(x))$ • $\forall x(\neg Cube(x) \rightarrow Small(x)) ??$ All of the non-cubes are small

10 million and the second of the state



Examples:

della traine to an and the most of the the

Forms:

• All Ps are Qs.

Examples:

All mammals are animals.

Wednesday, March 19, 2014

ALL MAN LINE BURGER

Forms:

- All Ps are Qs.
- Some Ps are Qs.

Examples:

All mammals are animals.

Some mammals live in water.

Forms:

- All Ps are Qs.
- Some Ps are Qs.
- No Ps are Qs.

Examples:

All mammals are animals.

Some mammals live in water.

No humans have wings.

Forms:

- All Ps are Qs.
- Some Ps are Qs.
- No Ps are Qs.
- Some Ps are not Qs.

Examples:

All mammals are animals.

Some mammals live in water.

No humans have wings.

Some birds cannot fly.

the Louis and Share and a Con-

All Ps are Qs

All mammals are animals

And Black MARS

All Ps are Qs

All mammals are animals

For any x, if x is a P, then x is a Q

All Ps are Qs

All mammals are animals

For any x, if x is a P, then x is a Q

For any x, $P(x) \rightarrow Q(x)$

All Ps are Qs

All mammals are animals

For any x, if x is a P, then x is a Q

For any x, $P(x) \rightarrow Q(x)$

 $\forall x(P(x) \rightarrow Q(x))$

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All Ps are Qs

All mammals are animals

For any x, if x is a P, then x is a Q

For any x, $P(x) \rightarrow Q(x)$

 $\forall x(P(x) \rightarrow Q(x))$

 $\forall x(Mammal(x) \rightarrow Animal(x))$

A State Block - MARS

Some Ps are Qs

Some mammals live in water

Some Ps are Qs

Some mammals live in water

There is at least one P that is also a Q

Some Ps are Qs

Some mammals live in water

There is at least one P that is also a Q

There is at least one thing x such that x is both P and Q

Some Ps are Qs

Some mammals live in water

There is at least one P that is also a Q

There is at least one thing x such that x is both P and Q

There is at least one thing x such that $P(x) \wedge Q(x)$

Some Ps are Qs

Some mammals live in water

There is at least one P that is also a Q

There is at least one thing x such that x is both P and Q

There is at least one thing x such that $P(x) \wedge Q(x)$

 $\exists x(P(x) \land Q(x))$

Some Ps are Qs

Some mammals live in water

There is at least one P that is also a Q

There is at least one thing x such that x is both P and Q

There is at least one thing x such that $P(x) \wedge Q(x)$

 $\exists x(P(x) \land Q(x)) \qquad \qquad \exists x(Mammal(x) \land LiWa(x))$

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The man and the second of the

No Ps are Qs

No humans have wings

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No Ps are Qs

No humans have wings

For any x, if x is a P, then x is not a Q

No Ps are Qs

No humans have wings

For any x, if x is a P, then x is not a Q

For any x, $P(x) \rightarrow \neg Q(x)$

No Ps are Qs

No humans have wings

For any x, if x is a P, then x is not a Q

For any x, $P(x) \rightarrow \neg Q(x)$

 $\forall x(P(x) \rightarrow \neg Q(x))$

No Ps are Qs

No humans have wings

For any x, if x is a P, then x is not a Q

For any x, $P(x) \rightarrow \neg Q(x)$

 $\forall x(P(x) \rightarrow \neg Q(x)) \quad \forall x(Human(x) \rightarrow \neg Wings(x))$

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No Ps are Qs

No humans have wings

For any x, if x is a P, then x is not a Q

For any x, $P(x) \rightarrow \neg Q(x)$

 $\begin{aligned} \forall x (P(x) \rightarrow \neg Q(x)) & \forall x (Human(x) \rightarrow \neg Wings(x)) \\ \neg \exists x (P(x) \land Q(x)) & \neg \exists x (Human(x) \land Wings(x)) \end{aligned}$

And Black Martin P.

Some Ps are not Qs

Some birds can't fly

Some Ps are not Qs

Some birds can't fly

There is at least one P that is not a Q

Some Ps are not Qs

Some birds can't fly

There is at least one P that is not a Q

There is at least one thing x such that x is P but not Q

Some Ps are not Qs Some birds can't fly

There is at least one P that is not a Q

There is at least one thing x such that x is P but not Q

There is at least one thing x such that $P(x) \wedge \neg Q(x)$

Some Ps are not Qs Some birds can't fly

There is at least one P that is not a Q

There is at least one thing x such that x is P but not Q

There is at least one thing x such that $P(x) \wedge \neg Q(x)$

 $\exists x(P(x) \land \neg Q(x))$

Some Ps are not QsSome birds can't flyThere is at least one P that is not a QThere is at least one thing x such that x is P but not QThere is at least one thing x such that $P(x) \land \neg Q(x)$

 $\exists x(P(x) \land \neg Q(x)) \qquad \exists x(Bird(x) \land \neg Fly(x))$

Some birds can't fly Some Ps are not Os There is at least one P that is not a Q There is at least one thing x such that x is P but not Q There is at least one thing x such that $P(x) \wedge \neg Q(x)$ $\exists x(P(x) \land \neg Q(x))$ $\exists x(Bird(x) \land \neg Fly(x))$ $\neg \forall x (P(x) \rightarrow Q(x))$ $\neg \forall x(Bird(x) \rightarrow Fly(x))$

Winter Constanting and Marita



QL sentence:

A Charles and the second of the state

Forms:

QL sentence:

• All Ps are Qs.

 $\forall x(P(x) \rightarrow Q(x))$

Wednesday, March 19, 2014

A Contraction of the second state of the secon

Forms:

- All Ps are Qs.
- Some Ps are Qs.

QL sentence:

 $\forall x(P(x) \rightarrow Q(x))$

 $\exists x(P(x) \land Q(x))$

and a second state of the second state of the second state

Forms:

- All Ps are Qs.
- Some Ps are Qs.
- No Ps are Qs.

QL sentence:

 $\forall x(P(x) \rightarrow Q(x))$

 $\exists x(P(x) \land Q(x))$

 $\forall x(P(x) \rightarrow \neg Q(x))$

A STATE AND A STATE OF A STATE

Forms:

- All Ps are Qs.
- Some Ps are Qs.
- No Ps are Qs.
- Some Ps are not Qs.

QL sentence: $\forall x(P(x) \rightarrow Q(x))$ $\exists x(P(x) \land Q(x))$ $\forall x(P(x) \rightarrow \neg Q(x))$

C. Lord And Hard Martin

Some Ps are Qs

$\exists x(P(x) \land Q(x))$

Wednesday, March 19, 2014

Some Ps are Qs

 $\exists x(P(x) \land Q(x))$ $\exists x([P(x) \land R(x)] \land Q(x))$

Some Ps that are also Rs are Qs

Some Ps are Qs

Some Ps that are also Rs are Qs

Some cubes are to the right of a

 $\exists x(P(x) \land Q(x))$ $\exists x([P(x) \land R(x)] \land Q(x))$

∃x(Cubes(x) ∧ RightOf(x,a))

Some Ps are Qs

Some Ps that are also Rs are Qs

Some cubes are to the right of a

Some small cubes are to the right of a

 $\exists x(P(x) \land Q(x))$ $\exists x([P(x) \land R(x)] \land Q(x))$

∃x(Cubes(x) ∧ RightOf(x,a))

∃x([Small(x) \ Cubes(x)] \
RightOf(x,a))

Wednesday, March 19, 2014

There is a large cube to the left of b

There is a large cube to the left of b

 $\exists x(L(x) \land C(x) \land LO(x,b))$

There is a large cube to the left of b

 $\exists x(L(x) \land C(x) \land LO(x,b))$

There is a cube to the left of *b* which is in the same row as c

There is a large cube to the left of b

 $\exists x(L(x) \land C(x) \land LO(x,b))$

There is a cube to the left of *b* which is in the same row as *c*

 $\exists x(C(x) \land LO(x,b) \land SR(x,c))$

There is a large cube to the left of b

 $\exists x(L(x) \land C(x) \land LO(x,b))$

There is a cube to the left of *b* which is in the same row as c

b is in the same row as a large cube $\exists x(C(x) \land LO(x,b) \land SR(x,c))$

There is a large cube to the left of b

 $\exists x(L(x) \land C(x) \land LO(x,b))$

There is a cube to the left of *b* which is in the same row as c

 $\exists x(C(x) \land LO(x,b) \land SR(x,c))$

b is in the same row as a large cube

 $\exists x(L(x) \land C(x) \land SR(b,x))$

The second descent of the second second

All Ps are Qs

$\forall x(P(x) \rightarrow Q(x))$

Wednesday, March 19, 2014

All Ps are Qs

 $\forall x(P(x) \rightarrow Q(x))$ $\forall x([P(x) \land R(x)] \rightarrow Q(x))$

All Ps that are also Rs are Qs

Wednesday, March 19, 2014

All Ps are Qs

All Ps that are also Rs are Qs

All cubes are to the right of a $\forall x (P(x) \rightarrow Q(x))$

 $\forall x([P(x) \land R(x)] \rightarrow Q(x))$

 $\forall x(Cubes(x) \rightarrow RightOf(x,a))$

All Ps are Qs

All Ps that are also Rs are Qs

All cubes are to the right of a

All small cubes are to the right of a $\forall x(P(x) \rightarrow Q(x))$ $\forall x([P(x) \land R(x)] \rightarrow Q(x))$

 $\forall x(Cubes(x) \rightarrow RightOf(x,a))$

 $\forall x ([Small(x) \land Cubes(x)] \rightarrow RightOf(x,a))$