

It is clearly impossible for a human being to count to 10^20 in their lifetime, but what is wrong with the following argument?

1. It is possible for a human to count to 100. 2. If it is possible to count to x, then it is possible to count to x+1. Therefore 3. It is possible to count to 10^20. Note that $\forall x(CanCount(x) \rightarrow CanCount(x+1)) \Leftrightarrow$

¬∃x(CanCount(x) ∧ ¬CanCount(x+1))

More Quantifier Translations

Monday, 24 March

Winter Constanting and Marita



QL sentence:

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Forms:

QL sentence:

• All Ps are Qs.

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

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Forms:

• All Ps are Qs.

All cubes are large

QL sentence:

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

 $\forall x(Cube(x) \rightarrow Large(x))$

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Forms:

- All Ps are Qs.
- All cubes are large
- Some Ps are Qs.

QL sentence:

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

 $\forall x(Cube(x) \rightarrow Large(x))$

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

Forms:

- All Ps are Qs.
- All cubes are large
- Some Ps are Qs.
- Some dodecs are small

QL sentence: $\forall x(P(x) \rightarrow Q(x))$ $\forall x(Cube(x) \rightarrow Large(x))$ $\exists x(P(x) \land Q(x))$ $\exists x(Dodec(x) \land Small(x))$

Winter Constanting and Marita



QL sentence:

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Forms:

QL sentence:

• No Ps are Qs.

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

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Forms:

QL sentence:

No Ps are Qs.

No cubes are small

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

 $\forall x(Cube(x) \rightarrow \neg Small(x))$

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Forms:

- No Ps are Qs.
- No cubes are small
- Some Ps are not Qs.

QL sentence:

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

 $\forall x(Cube(x) \rightarrow \neg Small(x))$

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

Forms:

• No Ps are Qs.

QL sentence:

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

No cubes are small

 $\forall x(Cube(x) \rightarrow \neg Small(x))$

- Some Ps are not Qs. $\exists x(P(x) \land \neg Q(x))$
- Some large things are not dodecs ∃x(Large(x)∧¬Dodec(x))

Everything to the right of a is a cube

Everything to the right of a is a cube

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

Everything to the right of a is a cube

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There is a dodec in the same row as b

Everything to the right of a is a cube

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

There is a dodec in the same row as b

∃x(Dodec(x) ∧ SameRow(x,b))

Everything to the right of a is a cube

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

There is a dodec in the same row as b

∃x(Dodec(x) ∧ SameRow(x,b))

a and b have a cube between them

Everything to the right of a is a cube

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

There is a dodec in the same row as b

 $\exists x(Dodec(x) \land SameRow(x,b))$

a and b have a cube between them

∃x(Cube(x) ∧ Between(x,a,b))

There aren't any dodecs in the same row as a

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There aren't any dodecs in the same row as $a = \neg \exists x (Dodec(x) \land SameRow(x,a))$

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There aren't any dodecs in the same row as a $\neg \exists x (Dodec(x) \land SameRow(x,a))$ $\forall x (Dodec(x) \rightarrow \neg SameRow(x,a))$

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There aren't any dodecs in the same row as a $\neg \exists x (Dodec(x) \land SameRow(x,a))$ $\forall x (Dodec(x) \rightarrow \neg SameRow(x,a))$ $\forall x (SameRow(x,a) \rightarrow \neg Dodec(x))$

Not every dodec is in the same row as a

There aren't any dodecs in the same row as a $\neg \exists x (Dodec(x) \land SameRow(x,a))$ $\forall x (Dodec(x) \rightarrow \neg SameRow(x,a))$ $\forall x (SameRow(x,a) \rightarrow \neg Dodec(x))$

And the second of the second

Not every dodec is in the same row as a

 $\neg \forall x (Dodec(x) \rightarrow SameRow(x,a))$

Same And State And State

Some Ps are Qs

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

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 Ps are Rs and Qs $\exists x(P(x) \land Q(x))$ $\exists x([P(x) \land R(x)] \land Q(x))$

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

Some Ps are Qs

Some Ps that are also Rs are Qs

Some Ps are Rs and Qs $\exists x(P(x) \land Q(x))$

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

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

These are obviously equivalent

Some Ps are Qs

Some Ps that are also Rs are Qs

Some Ps are Rs and Qs $\exists x(P(x) \land Q(x))$ $\exists x([P(x) \land R(x)] \land Q(x))$

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

Some Ps are Qs

Some Ps that are

also Rs are Qs

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

Some Ps are Rs and Qs

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

Some small cubes are to the right of a

 $\exists x(Small(x) \land Cubes(x) \land RightOf(x,a))$

And Store and States

There is a large cube to the left of b

There is a large cube to the left of b

$\exists x(Large(x) \land Cube(x) \land LeftOf(x,b))$

There is a large cube to the left of b

 $\exists x(Large(x) \land Cube(x) \land LeftOf(x,b))$

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

 $\exists x(Large(x) \land Cube(x) \land LeftOf(x,b))$

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

 $\exists x(Cube(x) \land LeftOf(x,b) \land SameRow(x,c))$

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b is in the same row as a large cube

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b is in the same row as a large cube

$\exists x(Large(x) \land Cube(x) \land SameRow(b,x))$

b is in the same row as a large cube

$\exists x(Large(x) \land Cube(x) \land SameRow(b,x))$

There is a small cube that isn't in the same row as a or b

Monday, March 24, 2014

b is in the same row as a large cube

∃x(Large(x)∧Cube(x)∧SameRow(b,x))

There is a small cube that isn't in the same row as a or b

 $\exists x(Small(x) \land Cube(x) \land \neg SameRow(x,a) \land \neg SameRow(x,b))$

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All Ps are Qs

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

Monday, March 24, 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

All Ps are Qs

All Ps that are also Rs are Qs

All Ps are Rs and Qs $\forall x(P(x) \rightarrow Q(x))$ $\forall x([P(x) \land R(x)] \rightarrow Q(x))$

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

All Ps are Qs

All Ps that are also Rs are Qs

All Ps are Rs and Qs $\forall x (P(x) \rightarrow Q(x))$

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

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

These are NOT equivalent

Monday, March 24, 2014

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Every cube is either large or small

Every cube is either large or small

 $\forall x(Cube(x) \rightarrow (Large(x) \lor Small(x)))$

Every cube is either large or small

 $\forall x(Cube(x) \rightarrow (Large(x) \lor Small(x))$

All small cubes are to the right of a

Every cube is either large or small

 $\forall x(Cube(x) \rightarrow (Large(x) \lor Small(x))$

All small cubes are to the right of a

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

Every cube is either large or small $\forall x(Cube(x) \rightarrow (Large(x) \lor Small(x)))$ All small cubes are to the right of a $\forall x([Small(x) \land Cubes(x)] \rightarrow RightOf(x,a))$

Every cube in the same row as a is small

Every cube is either large or small $\forall x(Cube(x) \rightarrow (Large(x) \lor Small(x)))$ All small cubes are to the right of a $\forall x([Small(x) \land Cubes(x)] \rightarrow RightOf(x,a))$

Every cube in the same row as a is small

 $\forall x([Cube(x) \land SameRow(x,a)] \rightarrow Small(x))$

The only things in back of a are large cubes

The only things in back of *a* are large cubes $\forall x(BackOf(x) \rightarrow (Large(x) \land Cube(x))$

The only things in back of *a* are large cubes $\forall x(BackOf(x) \rightarrow (Large(x) \land Cube(x))$

No small cubes are in the same row as a

The only things in back of a are large cubes $\forall x(BackOf(x) \rightarrow (Large(x) \land Cube(x)))$ No small cubes are in the same row as a

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

The only things in back of a are large cubes $\forall x(BackOf(x) \rightarrow (Large(x) \land Cube(x)))$ No small cubes are in the same row as a $\forall x([Small(x) \land Cubes(x)] \rightarrow \neg SameRow(x,a))$

Nothing in the same row as a is a small cube

The only things in back of a are large cubes $\forall x(BackOf(x) \rightarrow (Large(x) \land Cube(x))$ No small cubes are in the same row as a $\forall x([Small(x) \land Cubes(x)] \rightarrow \neg SameRow(x,a))$ Nothing in the same row as a is a small cube $\forall x(SameRow(x,a) \rightarrow \neg(Small(x) \land Cube(x))$