Translating natural language sentences into first-order logic

Course material for Computational Semantics
Katrin Erk

March 27, 2020

1. Some individual is happy.

   $existx\big(happy(x)\big)$

2. Some cat is happy.

   $\exists x\big(cat(x)\ \&\ happy(x)\big)$

3. Sam loves some cat.

   $\exists x\big(cat(x)\ \&\ love(S,x)\big)$

4. Some cat loves Sam.

   $\exists x\big(cat(x)\ \&\ love(x,S)\big)$

5. Sam loves every cat.

   $\forall x\big(cat(x) \rightarrow love(S,x)\big)$

6. Every cat loves Sam.

   $\forall x\big(cat(x) \rightarrow love(x,S,)\big)$

7. Every dog has a toy.

   $\forall x\big(dog(x) \rightarrow \exists y\big(toy(y)\ \&\ have(x,y)\big)\big)$

8. Some dog loves all toys.

   $\exists x\big(dog(x)\ \&\ \forall y\big(toy(y) \rightarrow love(x,y)\big)\big)$

9. A brown mouse is sleeping.

   $\exists x\big(mouse(x)\ \&\ brown(x)\ \&\ sleep(x)\big)$

10. A live oak is in a yard.

    $\exists x \exists y \big(oak(x) \,\&\, live(x) \,\&\, yard(y) \,\&\, in(x,y) \big)$

    Or should it be this? Let's discuss.

    $\exists x \exists y \big(liveoak(x) \,\&\, yard(y) \,\&\, in(x,y) \big)$

11. A brown mouse lived under a live oak.

    $\exists x \exists y \big(mouse(x) \,\&\, brown(x) \,\&\, liveoak(y) \,\&\, liverunder(x,y) \big)$

12. All mice are gray.

    $\forall x \big(mouse(x) \rightarrow gray(x) \big)$

13. Mice are mammals.

    $\forall x \big(mouse(x) \rightarrow mammal(x) \big)$

14. Dolphins are not fish.

    $\forall x \big(dolphin(x) \rightarrow -fish(x) \big)$

15. Dolphins live in pods.

    $\forall x \big(dolphin(x) \rightarrow \exists y \big(pod(y) \,\&\, livein(x,y) \big) \big)$

16. If someone is happy, then Kim is happy.

    $\big(\exists x happy(x) \big) \rightarrow happy(K)$

17. Everyone is happy, or Amalasuntha and Kim are fighting.

    $\big(\forall x \big(happy(x) \big) \big) \mid fight(A,K)$

The tricky cases:

1. Each cat has at most one toy.

   $\forall x \big(cat(x) \rightarrow \forall y \forall z \big(\big(toy(y) \,\&\, have(y,x) \,\&\, toy(z) \,\&\, have(z,x) \big) \rightarrow y = z \big) \big)$

2. Each cat has exactly one toy.

   $\forall x \big(cat(x) \rightarrow \exists y \big(toy(y) \wedge have(x,y) \big) \& \forall y \forall z \big(\big(toy(y) \& have(y,x) \& toy(z) \& have(z,x) \big) \rightarrow y = z \big) \big)$

3. All cars that lose all their tires are inspected.

   $\forall x \big(\big(car(x) \,\&\, \forall y \big(\big(tire(y) \,\&\, have(x,y) \big) \rightarrow lose(x,y) \big) \big) \rightarrow inspected(x) \big)$