1. * 1. UA = N

RA = { (i, j, k) | i + j > k }

BA = { (m, n) | m + n = 0 }

Model

* + 1. UA = N

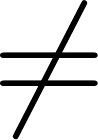
RA = { }

BA = { N \* N }

model

* + 1. UB = N

RB = { (1, 2, 1) }

BB = { (m, n) | m [](https://www.codecogs.com/eqnedit.php?latex=%20%5Cneq%20%0) n }

Not model

* + 1. UB = N

RB = { N \* N \* N }

BB = { }

Not model

* 1. 1. UA = 😊

AA = { (😊,😊) }

BA = { (😊,😊) }

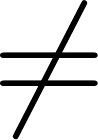
CA = { (😊,😊,😊) }

model

* + 1. UA = N

AA = { (3, 4) }

BA = { (5, 4) }

CA = { (m, n, o) | m [](https://www.codecogs.com/eqnedit.php?latex=%20%5Cneq%20%0) o }

Not model

1. 1. Yes, it is a model if the following holds:

aB ∈ PB and (sB(sB(aB)), sB(aB)) ∈ QB

Thus, 😊 ∈ PB and (🙁, 🙁) ∈ QB

* 1. Yes, if the following holds:

y is 🙁 then Ɐx(🙁,s(x)) ∈ QB, Ɐx(s(x)) ∈ PB, and 🙁 ∈ PB

1. Translate the following sentences into first-order logic: ∃x Ɐx
   1. David is friends with Alice.

IsFriendsWith(david, alice)

* 1. Everyone who studies logics is cool

Ɐx∃y(studies(x, y) ^ logics(y) -> Cool(x))

* 1. Everyone with cool friends is also cool.

Ɐx∃y (IsFriendsWith(x, y) ^ Cool(y) -> Cool(x))

* 1. Everybody who is friends with a bunny is nuts.

Ɐx (IsFriendsWith(bunny, x) -> Nuts(x))

* 1. Alice is friends with some bunny.

∃x (bunny(x) ^ IsFriendsWith(alice, x))

* 1. Friendship is a transitive and symmetric relationship!

ⱯxⱯy (isFriendsWith(x,y) ^ isFriendsWith(y,z) -> isFriendsWith(x,z))

ⱯxⱯy (isFriendsWith(x,y) -> isFriendsWith(y,x))

* 1. Everybody who eats ramen is either homeless or a grad student.  
      Ɐx∃y(eats(x,y) ^ ramen(y) -> (homeless(x) v gradStudent(x)))
  2. David eats ramen, is not homeless and studies logics  
      ∃x∃y [eats(david,x) ^ ramen(x) ^ ~homeless(david) ^ logics(y) ^ studies(david,y))]

1. Sketch how you could formally prove, using the formulas from Exercise 54, that David is both nuts and a grad student; and that somewhere, there must be some cool bunny!

Proof Sketch: From looking at the lines: g and h, this proves that David is not homeless but also a grad student. For g and h state that david eats ramen and is not homeless. Anyone that eats ramen is either homeless or a grad student. So, David is a grad student.

By (e), Alice is friends with a bunny and by (a) David is friends with Alice. Because by (f) friendship is transitive, David is friends with a bunny. Then by (d) David is nuts.

There is a bunny! This is proven by line e where Alice is friends with some bunny! The above shows that the bunny is friends with David. By (h) and (b), David is cool because he studies logics. By (c), the bunny is cool because its friend David is cool.