James Villemarette
CISC 481 Homework 2
Due: April 28, 2022

Problem 1a

The statements convert to FOL (as provided in hw2.pdf).

#	Original Statement	FOL
1	All dogs have a breed	$\forall x(Dog(x) \rightarrow \exists y\, Breed(x,y))$
2	A dog is a mutt only if it is not purebred	$\forall x([Dog(x) \land Mutt(x)] \rightarrow \neg Purebred(x))$
3	A dog is purebred if both of its parents are purebred and are the same breed	$\forall x,y,z\,(\big(Dog(x) \land Mother(x,y) \land Father(x,z) \land Purebred(y) \land Purebred(z) \land \exists w\big(Breed(y,w) \land Breed(z,w)\big)\big) \rightarrow Purebred(x))$ NOTE: I use w instead of u because "u"'s become hard to read instead of a nice distinctive w. Just from my experience with CISC 304 (Logic).
4	A Yellow Labrador is a purebred	$\forall x(Breed(x,Lab) \rightarrow Purebred(x))$
5	Brandi was a dog	$Dog(Brandi)$
6	Brandi's mother was Tabatha,	$Mother(Brandi,Tabatha)$
7	and her father was Moondog Moses	$Father(Brandi,MoonDogMoses)$
8	Moondog Moses was a Yellow Labrador	$Breed(Tabatha,Labrador)$
9	Tabatha was a Yellow Labrador	$Breed(MoonDogMoses,Labrador)$

Now we convert FOL to CNF.

#	CNF
1	$Mutt(Brandi)$ $[Mutt(Brandi)]$ NOTE: I'm putting the first given base case as #1 here. The rest of FOL statements are appended below in this table.
2	$\forall x\big(Dog(x) \rightarrow \exists y\, Breed(x,y)\big)$ $\forall x\big(\neg Dog(x) \lor \exists y\, Breed(x,y)\big)$ $\forall x\big(\neg Dog(x) \lor Breed(x,a)\big)$ $\neg Dog(x) \lor Breed(x,a)$ $[\neg Dog(x), Breed(x,a)]$
3	$\forall x([Dog(x) \land Mutt(x)] \rightarrow \neg Purebred(x))$ $\forall x\big(\neg[Dog(x) \land Mutt(x)]\big] \lor \neg Purebred(x))$ $\forall x(\neg Dog(x) \lor \neg Mutt(x) \lor \neg Purebred(x))$

	$\neg Dog(x) \vee \neg Mutt(x) \vee \neg Purebred(x)$ $[\neg Dog(x), \neg Mutt(x), \neg Purebred(x)]$
4	$\forall x, y, z \ \left(Dog \wedge Mother(x,y) \wedge Father(x,z) \wedge Purebred(y) \wedge Purebred(z) \cap \exists w\big(Breed(y,w) \wedge Breed(z,w)\big)\right) \rightarrow Purebred(x)$ $\forall x, y, z \neg \left(Dog(x) \wedge Mother(x,y) \wedge Father(x,z) \wedge Purebred(y) \wedge Purebred(z) \cap \exists w\big(Breed(y,w) \wedge Breed(z,w)\big)\right) \vee Purebred(x)$ $\forall x, y, z \neg Dog(x) \vee \neg Mother(x,y) \vee \neg Father(x,z) \vee \neg Purebred(y) \vee \neg Purebred(z) \vee \exists w\big(\neg Breed(y,w) \vee \neg Breed(z,w)\big) \vee Purebred(x)$ $\forall x, y, z \neg Dog(x) \vee \neg Mother(x,y) \vee \neg Father(x,z) \vee \neg Purebred(y) \vee \neg Purebred(z) \vee \neg Breed(y, f(x)) \vee \neg Breed(z, f(x)) \vee Purebred(x)$ $\neg Dog(x) \vee \neg Mother(x,y) \vee \neg Father(x,z) \vee \neg Purebred(y) \vee \neg Purebred(z) \vee \neg Breed(y, f(x)) \vee \neg Breed(z, f(x)) \vee Purebred(x)$ $[\neg Dog(x), \neg Mother(x,y), \neg Father(x,z), \neg Purebred(y), \neg Purebred(z), \neg Breed\big(y, f(x)\big), \neg Breed\big(z, f(x)\big), Purebred(x)]$
5	$\forall x(Breed(x, Lab) \rightarrow Purebred(x))$ $\forall x\big(\neg Breed(x, Lab) \vee Purebred(x)\big)$ $\neg Breed(x, Lab) \vee Purebred(x)$ $[\neg Breed(x, Lab), Purebred(x)]$
6	$Dog(Brandi)$ $[Dog(Brandi)]$
7	$Mother(Brandi, Tabatha)$ $[Mother(Brandi, Tabatha)]$
8	$Father(Brandi, MoonDogMoses)$ $[Father(Brandi, MoonDogMoses)]$
9	$Breed(Tabatha, Labrador)$ $[Breed(Tabatha, Labrador)]$
10	$Breed(MoonDogMoses, Labrador)$ $[Breed(MoonDogMoses, Labrador)]$

Problem 1b

Start a proof with a base of "Brandi was not a mutt" by resolution, solve using resolution only to the first two levels of the three. Explore the negated goal and its children. Number resolvents in the order they're generated. Keep track of bindings.

Goal: $[\neg Mutt(Brandi)]$
Inverted goal: $[Mutt(Brandi)]$

1. $[Mutt(Brandi)], \{\}$

Resolving 1 & 3

11. $[\neg Dog(Brand), \neg Purebred(Brandi)], \{x|Brandi\}$

Resolving 11 & 5

12. $[\neg Breed(Brandi, Lab), \neg Dog(Brandi)], \{x|Brandi\}$

Resolving 11 & 6

Resolving 11 & 4

14. $[\neg Purebred(Brandi)], \{x|Brandi\}$

13. $[\neg Dog(Brandi), \neg Mother(Brandi, y), \neg Father(Brandi, z), \neg Purebred(y), \neg Purebred(z), \neg Breed(y, f(Brandi)), \neg Breed(z, f(Brandi))], \{x|Brandi\}$

Problem 2a

Our initial state description

$$Charged(Full) \wedge Connected(mower) \wedge \neg Mowed(Lawn) \wedge \neg Edged(Lawn) \\ \wedge Sweep(Driveway) \wedge Sweep(Sidewalk)$$

Our goal state description

$$Mowed(Lawn) \wedge Edged(Lawn) \wedge Sweep(Sidewalk) \wedge Sweep(Driveway)$$

Problem 2b

Six action schemas

$Mow(X_i)$
Precondition: $\neg Mowed(X_i) \wedge Charged(Full) \wedge Connected(Mower)$
Effect: $Mowed(X_i) \wedge \neg Sweep(X_i) \wedge Charged(Empty)$

$Edge(X_i)$
Precondition: $\neg Edged(X_i) \wedge \neg Charged(Empty) \wedge Connected(Trimmer)$
Effect: $Edged(X_i) \wedge \neg Sweeped(X_i) \wedge Charged(Partial)$

$Connect(t)$ … where “t” means tool
Precondition: $Connected(None)$
Effect: $Connected(t)$

$Charge()$
Precondition: $\neg Charged(Full)$
Effect: $Charged(Full)$

$Remove()$
Precondition: $\neg Connected(None)$
Effect: $Connected(None)$

$Sweep(X_i)$
Precondition: $\neg Sweeped(X_i)$
Effect: $Sweeped(X_i)$