171 HW5

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I tried doing as much work in mardown as possible, but it got very math-y so I used latex for part of it. The first set of problems (9.9, 13.8, and 14.1) are done in markdown. The second set of problems (8.8, 8.10, 8.28, 9.20, and 13.13) are done in latex. I couldn't merge the two too cleanly, but it is what it is.

9.9

note: I'll be referring to goals and axioms as Gx and Ax where x is the identifier.

a)
```
G1: 7 <= 3 + 9; A8{x1 / 7, z1 / (3 + 9)}
G2: 7 <= y1; A4{x2 / 7, y1 / (7 + 0)} (success)
G3: 7 + 0 <= 3 + 9; A8{x3 / (7 + 0), z3 / (3 + 9)}
G4: 7 + 0 <= y3; A6{x4 / 7, y4 / 0, y3 / (0 + 7)} (success)
G5: 0 + 7 <= 3 + 9; A7{w5 / 0, x5 / 7, y5 / 3, z5 / 9}
0 <= 3; A1 (success)
7 <= 9; A2 (success)
G1, G3, G5 (success)
```

b)
```
infer from A1, A2, A7 {w / 0, x / 7, y / 3, z / 9}
A9: 0 + 7 <= 3 + 9
infer from A9, A6, A8 {x1 / 0, y1 / 7, x2 / (0 + 7), y2 / (7 + 0), z2 / (3 + 9)}
A10: 7 + 0 <= 3 + 9
infer from A4, A10, A8
{x3 / 7, x4 / 7, y4 / (7 + 0), z4 / (3 + 9)}
A11: |7 <= 3 + 9
```

13.8

```
a) P(Toothache) = 0.108 + 0.012 + 0.016 + 0.064
                = 0.2
b) P(Cavity) = <0.2, 0.8>
             = 0.108 + 0.012 + 0.072 + 0.008
             = 0.2
c) P(Toothache|Cavity) = <(.108+.012)/2, (0.072+0.008)/0.2>
                       = <0.6, 0.4>
                       = .6
d) P(Cavity V Catch) = 0.108 + 0.012 + 0.016 + 0.064 + 0.072 + 0.144
                     = 0.416
  therefore,
  P(Cavity|Toothache V Catch) = <(0.108 + 0.012 + 0.072) / 0.416, (0.016 + 0.064 + 0.144) /
                              = <0.4615, 0.5384>
```

13.13

note: I originally did this problem in latex, but when merging the pdfs, I got a font type error so I ended up posting an image of the latex output to markdown. Sorry if it's messy.

13.13

$P(TestA = pos \mid Virus = Present) = .95$
$P(TestA = pos \mid Virus = Absent) = .1$
$P(TestB = pos \mid Virus = Present) = .9$
$P(TestB = pos \mid Virus = Absent) = .05$
$P(Virus = Present) = .01$
$P(Virus = Present \mid TestA = pos)$
$= \frac{P(TestA=pos|Virus=Present)*P(Virus=Present)}{P(TestA=pos|Virus=Present)\times P(Virus=Present)+P(TestA=pos|Virus=Absent)\times P(Virus=absent)}$
$= \frac{.0095}{.1085} = .088$
$P(Virus = Present \mid TestB = pos)$
$= \frac{P(TestB=pos|Virus=Present)*P(Virus=Present)}{P(TestB=pos|Virus=Present)\times P(Virus=Present)+P(TestB=pos|Virus=Absent)\times P(Virus=absent)}$
$= \frac{.009}{.0585} = .15$

Figure 1:

14.1

a) `let RV C have domain {a, b, c}`
`In the network, C is the root and X1, X2, X3 are the children.`
`CPT for C:`

C	P(C)
a	1/3
b	1/3
c	1/3

`CPT for Xi`

C	X1	P(C)
a	heads	.2
b	heads	.6
c	heads	.8

b) "‘ P(X1=tails, X2=heads, X3=heads | C=a) = .8 * .2 * .2 = .032 P(2 heads, 1 tails | C=a) = 3 * .032 = .096 P(" " " | C=b) = .432 P(" " " | C=c) = .384

therefore, b is most likely to be drawn "‘

hw5

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8.8

$Jim \neq George$
$Spouse(Jim, Laura)$
$\forall X : X \neq Jim \wedge \ Spouse(X, Laura)$
$therefore\ Spouse(George, Laura)$

8.10

$a) Occupation(Emily, Surgeon) \vee Occupation(Emily, Lawyer)$
$b) Occupation(Joe, Actor) \wedge \exists! X : X \neq Actor \wedge Occupation(Joe, X)$
$c) \forall X : Occupation(X, Surgeon) \Rightarrow Occupation(X, Doctor)$
$d) \forall X : Occupation(X, Lawyer) \Rightarrow Customer(Joe, X)$
$e) \exists! X : Boss(X, Emily) \Rightarrow Occupation(X, Lawyer)$
$f) \exists X, \forall Y (Occupation(X, Lawyer) \Rightarrow (Customer(Y, X) \Rightarrow Occupation(Y, Doctor)))$
$g) \forall X, \exists Y : Occupation(X, Surgeon) \Rightarrow Customer(X, Y)$

8.28

$b) \neg Wrote(Gershwin, EleanorRigby.)$
$d) \exists X : Wrote(Joe, X)$
$g) \forall X, \exists Y : Sings(Y, X, Revolver) \Rightarrow Y \neq Gershwin$
$h) \forall X, \exists Y \ : \ Wrote(Gershwin, X) \ \Rightarrow \ Sings(Gershwin, X, Y) k) \forall X, \exists Y, \exists Z \ :$
$Sings(McCartney, X, Y) \Rightarrow (CopyOf(Z, Y) \wedge Owns(Joe, Z))$