# HOMEWORK 4.

1) **Question 1:**

| P(pass\|Smart,Study) | ¬smart | smart |
|---|---|---|
| ¬study | 0.2 | 0.7 |
| study | 0.6 | 0.95 |

prior probabilities: P(smart)=0.3, P(study)=0.4

a) Write out P(Smart, Study, Pass)

joint probability: P(Pass | Smart, Study) * P(Smart) * P(Study) = 0.95 * 0.3 * 0.4 =

(b) Calculate all entries in full JPT.

| | Smart | | ¬Smart | |
|---|---|---|---|---|
| | Pass | ¬Pass | Pass | ¬Pass |
| Study | 0.114 | 0.006 | 0.168 | 0.112 |
| ¬Study | 0.126 | 0.054 | 0.084 | 0.336 |

(c) Compute P(smart | pass, study) = $\frac{P(pass, \neg study \mid smart) * P(smart)}{P(pass, \neg study)}$

. P(pass, ¬study) = P(pass, ¬study | smart) * P(smart) + P(pass, ¬study | ¬smart) * P(¬smart)

= P(pass | smart, ¬study) * P(¬study) * 0.3 + P(pass | ¬smart, ¬study) * P(¬study) * 0.7

= 0.7 × 0.6 × 0.3 + 0.2 × 0.6 × 0.7 = 0.21

→ P(smart | pass, ¬study) = $\frac{0.42 \times 0.3}{0.21}$ = 0.6

(d) Calculate P(¬study | smart, ¬pass) = $\frac{P(smart, \neg pass \mid \neg study) \cdot P(\neg study)}{P(smart, \neg pass)}$

. P(smart, ¬pass) = 0.006 + 0.054 = 0.06

. P(smart, ¬pass | ¬study) = P(smart | ¬pass, ¬study) * P(¬pass) * 0.6 =

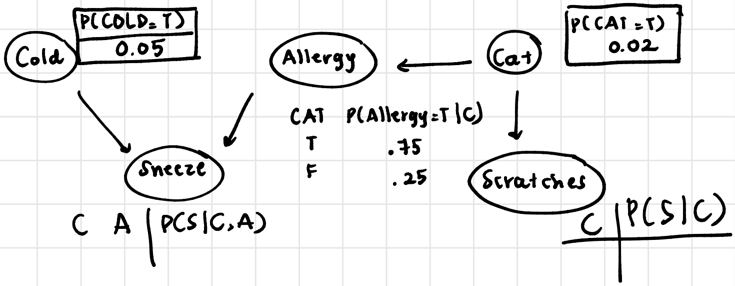
= 0.13846 * 0.508 * 0.6 = 0.0422.

(e) Compute marginal prob P(pass | smart) = $\frac{P(smart \mid pass) \cdot P(pass)}{P(smart)} = \frac{0.488 \times 0.492}{0.3} = 0.8.$

(f) P(pass | study) = $\frac{P(study \mid pass) \cdot P(pass)}{P(study)} = \frac{0.573 \cdot 0.492}{0.4} = 0.705$

## (2) Question 2:

a) Using Equation 13.2, write out expression for the joint prob for any state




(a) Write expression for the joint prob.

P(Allergy, Cold, Sneeze, Cat, Scratches)

= P(Allergy | Cat) P(Cold) P(Sneeze | Cold, Allergy) P(Cat) P(Scratches | Cat)

= .75 × .05 × .9 × .02 × .5 = 0.00034.

(b) Use the joint prob to calculate prob of all 32 entries in the JPT.

| Cold | Sneeze | Allergy | Scratch | Cat | JP |
|---|---|---|---|---|---|
| 0 | 0 | 0 | 0 | 0 | 0.8318252249999999 |
| 0 | 0 | 0 | 0 | 1 | 0.00235125 |
| 0 | 0 | 0 | 1 | 0 | 0.043780275 - |
| 0 | 0 | 0 | 1 | 1 | 0.00235125 |
| 0 | 0 | 1 | 0 | 0 | 0.013266749999999997 |
| 0 | 0 | 1 | 0 | 1 | 0.0021374999999999996 |
| 0 | 0 | 1 | 1 | 0 | 0.00069825 |
| 0 | 0 | 1 | 1 | 1 | 0.0021374999999999996 |
| 0 | 1 | 0 | 0 | 0 | 0.008402274999999999 |
| 0 | 1 | 0 | 0 | 1 | 2.375e-05 |
| 0 | 1 | 0 | 1 | 0 | 0.00044222500000000003 |
| 0 | 1 | 0 | 1 | 1 | 2.375e-05 |
| 0 | 1 | 1 | 0 | 0 | 0.030955749999999994 |
| 0 | 1 | 1 | 0 | 1 | 0.004987499999999999 |
| 0 | 1 | 1 | 1 | 0 | 0.0016292499999999998 |
| 0 | 1 | 1 | 1 | 1 | 0.004987499999999999 |
| 1 | 0 | 0 | 0 | 0 | 0.0088445 |
| 1 | 0 | 0 | 0 | 1 | 2.5000000000000005e-05 |
| 1 | 0 | 0 | 1 | 0 | 0.00046550000000000004 |
| 1 | 0 | 0 | 1 | 1 | 2.5000000000000005e-05 |
| 1 | 0 | 1 | 0 | 0 | 0.00023275000000000002 |
| 1 | 0 | 1 | 0 | 1 | 3.750000000000001e-05 |
| 1 | 0 | 1 | 1 | 0 | 1.2250000000000003e-05 |
| 1 | 0 | 1 | 1 | 1 | 3.750000000000001e-05 |
| 1 | 1 | 0 | 0 | 0 | 0.035378 |
| 1 | 1 | 0 | 0 | 1 | 0.00010000000000000002 |
| 1 | 1 | 0 | 1 | 0 | 0.0018620000000000002 |
| 1 | 1 | 0 | 1 | 1 | 0.00010000000000000002 |
| 1 | 1 | 1 | 0 | 0 | 0.0020947500000000007 |
| 1 | 1 | 1 | 0 | 1 | 0.0003375000000000007 |
| 1 | 1 | 1 | 1 | 0 | 0.00011025000000000005 |
| 1 | 1 | 1 | 1 | 1 | 0.0003375000000000007 |

- P(Sneeze) = 0.0084
- P(Allergy) = 0.013
- P(Sneeze, Allergy) = 0.037

(c) Calculate P(allergic | sneeze, ¬cold, scratches)

. $P(\text{allergic} | \text{sneeze}) = \frac{P(\text{sneeze} | \text{Allergic}) P(\text{allergic})}{P(\text{sneeze})} = \frac{(0.031/0.0013) * 0.013}{2.38 * 0.0013 + 0.071 * (1-0.013)} = 0.424$

## 3, Question 3:

**Starting a car: You have to be at the car and have the key, and the car has to have a charged battery and the tank has to have gas. Afterwards, the car will be running, and you will still be at the car and have the key after starting the engine.**

(a) Write a PDDL operator to describe this action.

. Start( x ):

+ pre-conds: at( x), have (keyof (x)), charged (batteryof(x)), has (gastankof(x))

+ effects: run(x), at (x), have(keyof (x))

(b) Describe the same operator using Situation Calculus (remember to add a situation argument to predicate

$\forall s, x \;\; at(x, s) \wedge have(keyof(x), s) \wedge charged(batteryof(x), s) \wedge has(gastankof(x), s)$

$\rightarrow do(run(x), s) \wedge at(x, s) \wedge have(keyof(x), s)$

(c) Add a Frame Axiom that says that starting this car will not changes whether any other car is out of gass.

. Frame Axioms:

(1) running a car does not affect other cars' gas.

$\forall s, a, z \; Poss(run(a), s) \wedge a \neq z \wedge has(gastankof(z), s) \rightarrow has(gastankof(z), s)$