HW5 Part A

1A)

Solution:

A truck begins to move from a starting point to its destination while delivering packages along the route at the intended location/s. The truck must load the packages into the truck and unload it after reaching the destination. Hence, the primitive actions are:

- `Forward (t)`
- `Left(t)`
- `Right(t)`
- `Load(p, t, i)`
- `Unload(p, t, i)`
- `Drive(t, i)`

where `p` is a package, `t` is a truck and `i` is a location

We also define,

- `At(p,t)` → package `p` is inside the truck `t`
- `At(t,i)` → truck `t` is at the location `i`

The hierarchy of the truck is given by,

```
Refinement(Pickup(t, p, i),
PRECOND: Truck(t) ^ At(p, i))
STEPS: [ Drive(t, i), Load(p, t)])

Refinement( Deliver (p, t, i),
PRECOND: Truck(t) ^ At(t, i) ^ At(p, t)
STEPS: [ Unload(p, t)] )

Refinement(Drive(t, i),
PRECOND:Truck(t)
```

```
STEPS: [Forward(t), Drive(t, i)])

Refinement(Drive(t, i),
PRECOND:Truck(t)
STEPS: [Left(t), Drive(t, i)] )

Refinement(Drive(t, i),
PRECOND:Truck(t)
STEPS: [Right(t), Drive(t, i)] )

Refinement(Drive(t, i),
PRECOND: Truck(t) ^ At(t,i)
STEPS: [Pickup(p,t, i) or Deliver (p,t,i)])
```

- The hierarchy encodes the knowledge of how to choose which trucks deliver which packages in what order.
- The drawback of this representation to the one in the real world is that that trucks can only carry one package at a time, not multiple.

1B)

Solution:

- When you want to combine scheduling with non-deterministic planning, each of the three fields can be represented as an interval of possible values rather than a single value.
- Algorithms can be modified to work with intervals instead of quantities with the use of inequalities.
- When it comes to conditional effects, however, the fields must be treated differently.
- The DURATION and CONSUME fields both describe effects thus, they can be folded into the conditional effect description for the action
- The USE field refers to a constraint holding during the action, rather than after it is done. Thus, it has to remain a separate field,

2C)

Solution:

A plausible language might contain the following primitives:

- Temporal Predicates:
  Poss(a, s) - Predicate: Action a is possible in situation s
  Result(a, s) - Function from action a and situation s to situation
- Arithmetic: x < y, x ≤ y, x + y, 0
- Window State: *Display(window, situation), Active(window, situation),Minimized(window, situation), where w* is a window and *s* is a situation.
- Window Position:
  RightEdge(w, s), Lef tEdge(w, s), T opEdge(w, s), BottomEdge(w, s)
- Window Order:
  InFront(w1, w2, s): Predicate. Window w1 is in front of window w2 in situation s
- Actions: Visible(w), Destroy(w), Front(w), Move(w, x, y), Resize(w, l, r, u, d)

3D)

Solution:

a. There are 52 cards and 5-card hands are dealt. The number of ways to select 5-card hands is given by, $\binom{52}{5} = \frac{52!}{5!(52-5)!} = 2598960$
b. Assuming that the likeliness of the events is uniformly distributed, the probability of each event is $= \frac{1}{2598960} = 3.85 \times 10^{-7}$
c. Royal Flush : $4/2,598,960 = 1/649,740$, Four of a kind $(13 \times 48)/2598960 = 1/4165$

3E)

Solution:

	toothache		*¬toothache*	
	catch	*¬catch*	*catch*	*¬catch*
cavity	0.108	0.012	0.072	0.008
¬cavity	0.016	0.064	0.144	0.576

Figure 13.3 A full joint distribution for the *Toothache*, *Cavity*, *Catch* world.

a. When toothache is true:

   $P(toothache) = 0.108 + 0.012 + 0.016 + 0.064 = 0.2$

b. When cavity is true, $0.108 + 0.012 + 0.072 + 0.008 = 0.2$. The vector of probabilty of values as = <true, false> $=< 0.2, 0.8 >$

c. The vector of probability values for toothache when Cavity is true, $P(Toothache|cavity) =< \frac{(0.108+0.012)}{0.2}, \frac{0.072+0.008}{0.2} >=< 0.6, 0.4 >$

d. The vector of probability values for cavity, given that either toothache or catch is true.

$$P(toothache \vee catch)$$
$$= 0.108 + 0.012 + 0.016 + 0.064 + 0.072 + 0.144$$
$$= 0.416$$

$$P(Cavity|Toothache \vee catch)$$
$$= \langle (0.108 + 0.012 + 0.072)/0.416, (0.016 + 0.064 + 0.144)/0.416 \rangle$$
$$=< 0.4615, 0.5384 >$$

3F)

Solution:

- Let V be the statement that the patient has the virus and A and B returned positive
- Given: `P(V)=0.01, P(A|V)=0.95, P(A|¬V)=0.10, P(B|V)=0.90 and P(B|¬V)=0.05`
- When one's posterior probability is the largest `(P(V |A) or P(V |B))`, is more indicative of the virus being present.

`P(V |A)=0.0876 and P(V |B)=0.1538`

- The highest posterior odds ratio is given by `P(V |A) / P(¬V |A) = P(A|V )P(V ) / P(A|¬V ) P(¬V )`
- The likelihood ratios are `P(A|V )/P(A|¬V )=9.5` and `P(B|V )/P(V |¬V ) = 18.`
- Hence test `B` has the highest posterior odds ratio.
