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1. (a)
   An agent should be:
   - Reactive, means that it responds to changes in dynamic environment, so the agent can achieve short-term goal, e.g. avoiding certain states
   - Pro-active, means that it attempts to achieve goals and not driven solely by events; so the agent can achieve its long-term goal, e.g. achieving certain states
   - Social, means that it interacts with other agents using agent communication language, so that agent can cooperate with other agents to achieve their goals.

   (b)
   Policy Iteration consists of two main steps:
   - Policy evaluation.
     This step evaluates the expected utility for each states, given the current policy of those states. The expected utility of state *s* given the policy *π(s)* is defined as the reward of state *s* (R(s)) plus sum of product of discount factor (γ) and sum of probability of *s'* and expected utility of state *s'*, where *s'* is a state connected from state *s* using action *π(s)*.
   - Policy improvement.
     This step assigns the best policy for each states, given the expected utility of other states. Best policy for a state *s* is defined as the action *a* that maximizes the sum of product of probability of state *s'* happening and expected utility of state *s'*, where *s'* is a state connected from state *s* using action *a*.

   (c)
   Benefits of reactive architectures:
   1) Simplicity
   2) Economy
   3) Computational traceability
   4) Robustness against failures
   5) Elegance

   (d) (i)
   All possible runs for Ag_1:
   - e0, α0, e1, α2, e3
   - e0, α0, e2, α3, e4
   - e0, α0, e2, α3, e5

   All possible runs for Ag_2:
   - e0, α1, e2, α3, e4
   - e0, α1, e2, α3, e5
   - e0, α1, e3, α4, e2, α3, e4
   - e0, α1, e3, α4, e2, α3, e5
   - e0, α1, e3, α4, e6

(d) (ii)

Expected Utility of Ag_1 = $\frac{4}{3+3} \times (10-3) + \frac{4}{3+3} \times (10-3) + \frac{4}{3+3} \times (10-3) = 14$

Expected Utility of Ag_2 = $\frac{3}{9} \times (10-3) + \frac{3}{9} \times (10-3) + \frac{4}{9} \times (10-4) + \frac{4}{9} \times (10-4) + \frac{3}{9} \times (10-3) = 12\frac{1}{3}$

Because expected utility of Ag_1 > expected utility of Ag_2, hence Ag_1 is more optimal, w.r.t. *Env1* and *U*.

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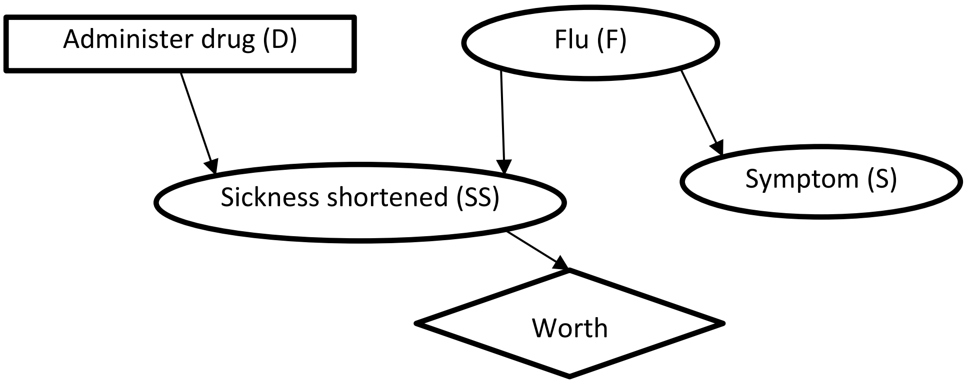
2. (a) Decision node, chance node, utility node

(b) Decision network: (sorry, I'm not so sure about this)



(c)

$$P(F) = 0.001$$
$$P(S|F) = 0.9$$
$$P(S|\neg F) = 0.05$$
$$P(SS|F, D) = 0.6$$
$$P(SS|\neg F, D) = 0$$
$$P(SS|\neg F, \neg D) = 0$$
$$P(SS|\neg F, \neg D) = 0$$
$$U(D) = -100$$
$$U(SS) = 1000$$
$$U(\neg SS) = 0$$

Expected utility of administering drug, given that person have flu symptoms

$$\mathrm{P(D) = 1\ (assumed)}$$
$$P(S) = P(S, F) + P(S, \neg F) = P(S|F) \times P(F) + P(S|\neg F) \times P(\neg F) = 0.05085$$
$$\begin{aligned} P(SS, S, D) &= P(SS, S, D, F) + P(SS, S, D, \neg F) = P(SS, S, D|F) \times P(F) + P(SS, S, D|\neg F) \times P(\neg F) \\ &= P(SS|D, F) \times P(D) \times P(S|F) \times P(F) \\ &\quad + P(SS|D, \neg F) \times P(D) \times P(S|\neg F) \times P(\neg F) = 5.4 \times 10^{-4} \end{aligned}$$
$$P(SS|S, D) = \frac{P(SS, S, D)}{P(S, D)} = \frac{P(SS, S, D)}{P(S) \times P(D)} = 0.01062$$
$$EU = -\$100 + \$1000 \times 0.01062 = -\$89.38$$

Expected utility of not administering drug, given that person have flu symptoms:

$$EU = \$0$$

Because "worth" can only be obtained when sickness is shortened and there is no way to shorten a sickness without administering drug.

(d) Because the expected utility of administering drug (-$89.38) is less than not administering drug ($0), hence the doctor should not administer the drug to this person.

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3. (a)
One of the example of need of coordination/cooperation protocol while building multi-agent system is NetRads, a network of short-range weather radars over a wide area. Those radars need to coordinate and cooperate with each other, e.g. by sharing sensory, in order to achieve their goal in detecting tornado in a short time.

(b)
CONTRACT NET protocol operation consists of:
(1) Recognition: recognition of problem, whether the agent is incapable of doing (cannot achieve goal in isolation) or prefer not to achieve goal in isolation due to quality or deadline constraint; and wants involve other agents
(2) Announcement: announcement/broadcast of task, a task specification consists of a description, constraints (deadline, quality), and meta-data
(3) Bidding: bidding for task/ submitting tender; factors involved are capability, and quality & price (constraints information)
(4) Awarding: awarding contract decided by the announcer/manager
(5) Expediting: expediting the task by successful contractor, may involve subcontracting

(c) "Incentive compatibility" is an important property of an auction mechanism because it will make the auction "fair" in the sense that the bidder will bid on their true valuation of the items and they will do so because it is the optimal action to do so.

(d) Pareto property in voting theory states that if everyone prefer ωi over ωj (in their personal preference), then in the social outcome, ωi shall perform better than ωj.

(e) "The core" of a coalitional game is a set of feasible distribution of payoff such that no sub-coalition can reasonably object the grand coalition. Objection is defined as having a sub-coalition with all of its members having better payoff in the sub-coalition than that in the grand coalition. There are two properties of the core: efficiency, and coalitional rationality.

In this example, Ag = {1, 2}, v({1}) = 5, v({2}) = 5, v({1, 2}) = 20,

The core is having a coalition of {1, 2} in which the payoff ranges from <5, 15> to <15, 5>. Doing so will make sure that there is no sub-coalition that will outperform payoff in the grand coalition.

4. (a) Dominant strategy

Payoff matrix A	Payoff matrix B
(i cooperate) is a dominant strategy for i (j defect) is a dominant strategy for j	No dominant strategy for i No dominant strategy for j

(b) Nash Equilibrium

Payoff matrix A	Payoff matrix B
(i cooperate, j defect) (i cooperate, j cooperate)	(i cooperate, j defect) (i defect, j cooperate)

(c) Pareto optimal

Payoff matrix A	Payoff matrix B
(i defect, j defect) (i cooperate, j defect)	(i cooperate, j defect)

(d) Maximize social outcome

Payoff matrix A	Payoff matrix B
(i defect, j defect) Social welfare: 8	(i cooperate, j defect) Social welfare: 8

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