Introduction to Intelligent Systems: Exam 2

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Problem 1

Consider differences in policy between politicians and the Federal Reserve Board. Politicians can expand or contract fiscal policy, while the feds can expand or contract monetary policy (and of course, each side can choose to do nothing). Each side also has preferences for who should do what - neither side wants to look like the "bad guy". The payoff matrix for the two sides is shown below (P = politicians, F = federal reserve).

	Fed: contract	Fed: do nothing	Fed: expand
Pol: contract	$P = 1, F = 7$	$P = 4, F = 9$	$P = 6, F = 6$
Pol: do nothing	$P = 2, F = 8$	$P = 5, F = 5$	$P = 9, F = 4$
Pol: expand	$P = 3, F = 3$	$P = 7, F = 2$	$P = 8, F = 1$

1. Find the pure strategy Nash equilibrium. Assuming that both sides play their Nash equilibrium, what will each side decide to do?

   Fed: expand is eliminated first because it is a dominated strategy for the feds.

	Fed: contract	Fed: do nothing
Pol: contract	$P = 1, F = 7$	$P = 4, F = 9$
Pol: do nothing	$P = 2, F = 8$	$P = 5, F = 5$
Pol: expand	$P = 3, F = 3$	$P = 7, F = 2$

   Pol: contract and Pol: do nothing are eliminated next because they are dominated by Pol: expand.

	Fed: contract	Fed: do nothing
Pol: expand	$P = 3, F = 3$	$P = 7, F = 2$

   Fed: do nothing is eliminated since it is dominated by Fed: contract. Thus the pure strategy Nash equilibrium is Fed: contract, Pol: expand.

	Fed: contract
Pol: expand	$P = 3, F = 3$

2. Is this a Pareto optimal solution? If yes, explain why. If no, explain why not.

   This is not a Pareto optimal solution because there exist situations that give both of them a higher payoffs. (Fed: do nothing, Pol: contract), (Fed: expand, Pol: contract), (Fed: do nothing, Pol: do nothing), and (Fed: expand, Pol: do nothing) all have higher payoffs for both players.

Problem 2

Construct a formal **direct** proof of validity for the following. For each line in your proof you must include the ruel you are using AND the line(s) it refers to:

Steve took the bus or the train. If he took the bus or drove his own car, then he arrived late and missed the first session. He did not arrive late. Therefore, he took the train.

$B \vee T$	Assumption: (Steve took the bus or the train)	(1)
$(B \vee C) \rightarrow (L \wedge M)$	Assumption: (If he took the bus or drove his own car,	(2)
	then he arrived late and missed the first session)	(3)
$\neg L$	Assumption: (He did not arrive late)	(4)
$\neg L \vee \neg M$	Or-Introduction on line 4	(5)
$\neg(L \wedge M)$	De Morgan's Law on line 5	(6)
$\neg(L \wedge M) \rightarrow \neg(B \vee C)$	Contraposition on line 2	(7)
$\neg(B \vee C)$	Modus Ponens on line 7 using line 6	(8)
$\neg B \wedge \neg C$	De Morgan's Law on line 8	(9)
$\neg B$	And-Elimination on line 9	(10)
T	Disjunctive Syllogism using lines 10 and 1	(11)
	Conclusion: T (Therefore, he took the train)	(12)

Problem 3

Give the *most general unifier* for each pair of atomic sentences, if it exists. If it does not exist, explain why. You may assume that an uppercase letter represents a variable and a lowercase letter represents a constant.

1. $p(a, b, b)$ and $p(X, Y, Z)$

$$\{X/a, Y/b, Z/b\}$$

2. $q(Y, g(a, b))$ and $q(Z, g(X, X))$
   Does not exist, this would require the variable Z to be bound to another variable and the variable X to be bound to two different constants.

3. Convert the following to PNF:

$$(\forall X)(a(X) \vee \neg b(X)) \rightarrow (\exists Y)(a(Y))$$

$\neg(\exists Y)(a(Y)) \vee (\forall X)(a(X) \vee \neg b(X))$	Implication Elimininination	(13)
$\neg(\exists Y)a(Y) \vee (\forall X)a(X) \vee \neg b(X)$	Logical Equivalence	(14)
$(\forall Y)\neg a(Y) \vee (\forall X)a(X) \vee \neg b(X)$	Negation of quantifiers	(15)
$(\forall Y)(\forall X)(a(Y) \vee a(X) \vee \neg b(X))$	Logical Equivalence	(16)

If you have any questions, comments, or concerns, please contact me at alvin@omgimanerd.tech