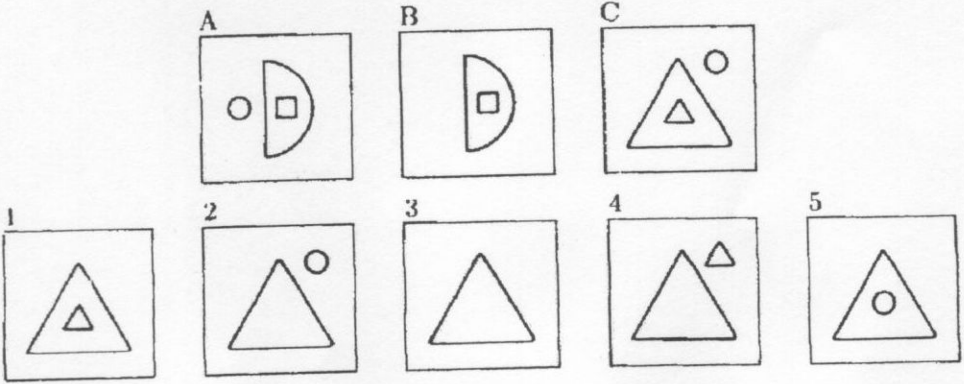
Exercise 1:

Peter, Paul and Mary have different driving behaviors:

- Mary always puts her directional blinker on before turning
- Peter never uses his blinker
- Paul looks in his mirrors and uses his blinkers only if there he observes a car, that can observes him

What type of agents are Peter, Paul and Mary?

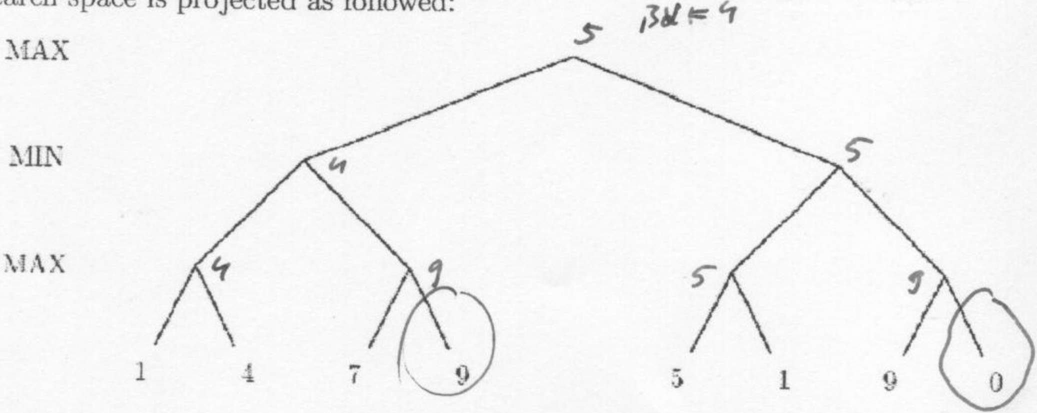
Exercise 2:
Consider the following analogy puzzle. Assume, that you already have a database with objects triangle, half-circle and square.



1. Give a symbolic representation of figure A and figure C.
2. Define a transformation from figure A to figure B.
3. Given the analogy puzzle question "figure A is to figure B like figure C is to ... ?". Which of the figure would you chosen?
4. Define a valid transformation from figure A to figure B, such that there is no perfect solution (figure C is to ....)!

Exercise 3:

MAX and MIN are playing a game. MAX is allowed to move next. The final search space is projected as followed:



1. Identify the parent value (backup value) for each node (and mark it in the tree).
2. Which move does MAX select next? Would he choose the right or the left subtree?
2. Apply the alpha-beta strategy to this tree. Draw circles around those parts of the tree which will be not considered

Exercise 4:

Consider the following problem:

Two missionaries and two cannibals are all together on one side of the river. There is one boat that can carry either on or two persons. How can hey all cross the river such that there are never less misionaries than cannibals on either side of the river?

1. Define a representation of that search problem
2. Draw the search tree for that problem.

Exercise 5:

1. Show that breadth-first search is a special case of uniform-cost search.
2. What does the A*-search guarantiee with an admissible heuristic?

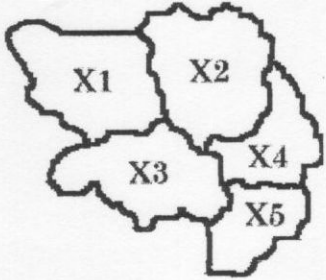
Exercise 6:

Consider the resolution rule:

$$\frac{\alpha \vee \beta \quad \neg\beta \vee \gamma}{\alpha \vee \gamma}$$

Show that the resolution rule is satisfiable.

Exercise 7:



Consider the problem to colour regions on the map with three different clours, red, yellow and blue, such that no adjacent regions have the same colour. we formulate this as a constraint satisfaction problem, with five variables X1, X2, X3, X4, X5, which all have as their domain the set $\{red, yellow, blue\}$.

1. Draw the constraint graph!

2. Is the network arc consistent?

3. We now colour X1 red. Apply forward checking to the CSP (just for this one variable assignment) and indicate the domains for X2, X3, X4 and X5!

Exercise 8:

Consider again the coloring problem from exercise 7. Assume the start configuration, where all regions are coloured red. Use the hillclimbing algorithm to find a solution. Indicate each step. Hint: As an evaluation function for states, use the number of adjacent regions that have the same colour, and minimize this value during hillclimbing.

Exercise 9:
Solve the following unification problem:

$$f(x, g(x), g(c)) =^? f(f(y, g(y), c), g(f(z, g(b), y')), z)$$

Indicate for each step which of the rules you are using (i.e. Deleting, Decomposition, Orientation, Substitution, Occur-Check or Clash).

Exercise 10:
Refute the following clause set via resolution.

1. $p(a, z)$
2. $\neg q(u) \vee \neq p(u, a)$
3. $r(a)$
4. $\neg r(v) \vee g(g(v))$
5. $\neg p(y, g(y)) \vee p(g(x), y)$

For each inference give the parent clause numbers and the resulting clause.

Exercise 11:

Formalize each group of sentences (using the given function and predicate symbols, then prove the last clause from the others using resolution and paramodulation.

($T(x)$ = the teacher of x; $G(x) = x$ is a good student)

- Mrs. Abbey only teaches good students
- John and Mary have the same teacher
- Mrs. Abbey is Mary's teacher
- Therefore, John is a good student

Exercise 12:

Consider the following production system:

- $A(x) \wedge B(x) \wedge C(x) add(D(x))$
- $A(x) \wedge B(x) \wedge E(x, y) \wedge A(x) add(D(x))$

1. Identify combinations of predicates that occur in both facts. Introduce a new predicate as an abbreviation for such a common subformula, and re-formulate the production system accordingly
2. Construct a RETE network for the production system from part (1).

Exercise 13:

Consider the TBox below:

- mscCourse$\equiv$ course $\sqcap\exists$ consists.Of.msc.Mods
- mscStudent $\equiv$ student $\sqcap\exists$ enrolledOn.mscCourse
- *p*hdStudent $\equiv$ student $\sqcap\exists$ studiesFor.phdDegree
- *p*gStudent $\equiv$ mscStudent $\sqcup$ phdStudent

1. Expand the definition of pgStudent

2. Draw the subsumption hierarchy of the concept names mscStudent, student, phdStudent and pgStudent

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Exercise 14:
Translate the following text into a set of ABox and TBox formulas:

Britney is a superstar. She dislikes Christina. A superstar is a person who is famous, attractive, and either very talented or managed by a clever person. Also, every superstar dislikes at least one rich but untalented superstar. Anyone who manages Britney is bound to be very rich.

Use the following vocabulary:

- **individuals:** *britney*, *christina*
- **roles:** *dislikes*, *managed-by*
- **concept names:** *Attractive*, *Clever*, *Famous*, *Person*, *Rich*, *Superstar*, *Talented*

Exercise 15:
Consider the following statement:

Paul leant his new CD to his best friend

Represent these statements as a semantic net (in shortform) . Use only binary relations!

Exercise 16:
Name three of the planning problems and give an example for each one!

Exercise 17:

It's in the morning. Sam is still lying in his bed. Sam has to go to work. Before he can go to work he has to have a breakfast, take a shower and of course, wake up. How can he do that?

1. Define the problem by specifying the environment and operators. The environment should comprehend the states *clean*, *sleeping*, *hungry*.

2. Create a Minimal Partial Order Plan. How many Total Order Plans can be obtained from it?

Exercise 18:

Consider the following problem:

- A Block must be painted an sanded
- Sanding removes paint

with operators:

PAINT(X):	
Pre:	Block(X)
Effect:	Painted(X)

SAND(X):	
Pre:	Block(X)
Effect:	¬Painted(X)

The initial state is: $Block(x)$, $\neg painted$, $\neg sanded$

The goal state is: *sanded*, *painted*

Construct a planning graph (until it levels off)! Indicate all links.

Exercise 19:

The following probabilities are given:

- $P(a, b) = 0.3$
- $P(a, \neg b) = 0.4$
- $P(\neg a, b) = 0.2$
- $P(\neg a, \neg b) = 0.1$

1. Compute $P(a) and P(b)$
2. Compute $P(a|b)$
3. Compute $P(b|a)$

Exercise 20:

Lisa, a girl who owes the mafia a lot of money, likes to eat in an italian restaurant. If she goes eating, with a probablity of 0.1 she will be killed by the mafia. If she doesn't go eating, the mafia will find and kill her with probability 0.01. When she goes eating, she will certainly see her boyfriend, since they always go for a meal together. Otherwise, the probability of seeing her boyfriend is 0.5.

1. Draw a Bayes network including the conditional probability tables), with the above probabilities! Abbreviate the random variables by letters E (eating), K (Killed), B (seeing her boyfriend). Small letters, e.g. e and $\neg e$ stand for the values of the random variables.

2. Calculate $P(b)$

Exercise 21:

The following dataset will be used to learn a decision tree for predicting whether a person is happy (H) or sad (S) based on the color of their shoes, whether they wear a wig and the number of ears they have.

Color	Wig	Num. Ears	Emotion
G	Y	2	S
G	N	2	S
G	N	2	S
B	N	2	S
B	N	2	H
R	N	2	H
R	N	2	H
R	N	2	H
R	Y	3	H

1. What is $H(EmotionWig = Y)$?
2. What is $H(EmotionEars = 3)$?
3. Which attribute would the decision tree building algorithm choose to use for the root of the tree (assume no pruning)
4. Draw the full decision tree that would be learned for this data (assume no pruning)