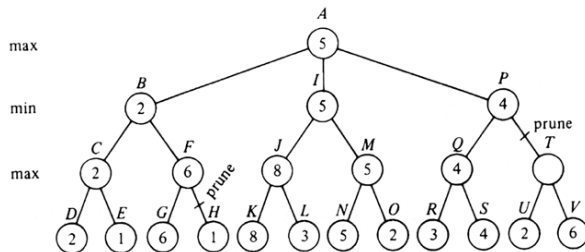Total points = 27 (two points from test 1)

Test 2 – Sample A

1. What will be the values of "alpha" and "beta" at the nodes C, F, J, M, Q, and T after the Alpha-beta pruning is executed on the graph aside. Assume that the nodes are processed from left to right.


2. Consider a problem of scheduling the assembly of a car. We need to install axles (front and back), affix all four wheels (right and left, front and back), tighten nuts for each wheel, affix hubcaps, and inspect the final assembly. Each task can be modeled as a variable, e.g. install wheel. The values of the variable is the time that the task starts. For example, AxleF = 0 indicates front axle installation begins at time 0. So, in total we have 15 variables, X = {AxleF, AxleB, WheelRF, WheelLF, WheelRB, WheelLB, NutsRF, NutsLF, NutsRB, NutsLB, CapRF, CapLF, CapRB, CapLB, Inspect}. To list all the constraints we need, we would like to produce the following types of constraints: (a) Assert that one task must occur before another (for example, a wheel must be installed before the hubcap is put on) (b) Assert that only so many tasks can go on at once (for example, when sharing tools) (c) Specify that a task takes a certain amount of time to complete. Write out all the four relevant constraints if it takes 10 minutes to install an axle.

3. Given a text we would like to determine what natural language it is written in. For each L, we build a model by counting the trigrams in a corpus of that language. This gives us P(Text | Language). How can P(Text | Language) be used to predict P(Language | Text)?

4. What are the disadvantages of building larger n-gram models such as 4-gram or 5-gram word models?

5. Write out the linear equations for calculating the page ranks of the pages A, B, and C in the following link network. Assume d = 0.7. You don't need to solve the system of linear equations - just list out the linear equations.
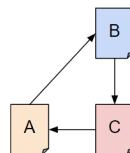
6. Given the following, what will be the optical flow at (x_0, y_0)?
    (x_0, y_0) is a pixel in the current frame (at time = t) for which we would like to compute the optical flow
    (D_x, D_y) gives how much the pixel has moved in the next frame
    (x_0+D_x, y_0+D_y) is the location of the pixel in new frame (D_t)

7. What is the principle of edge detection?

8. Active sensors usually provide more information than passive sensors but what are their two limitations?

9. Which type of optical range finder sensor captures full 3D at once?

10. List any two disadvantages of Time of Flight cameras.

11. How did Dijkstra argue that the question "Can machines think?" is ill defined?

12. Specifying the right utility function for an AI system to maximize is not so easy. Consider that you are designing an AI system with a utility function designed to minimize human suffering - expressed as an additive reward function over time. What is wrong with such a utility function?

1. Calculate the minimax values at nodes A, B, C, and D for the player MAX given the game tree below. The numbers at the leaf nodes represent the values of Utility (leafnode, MAX).
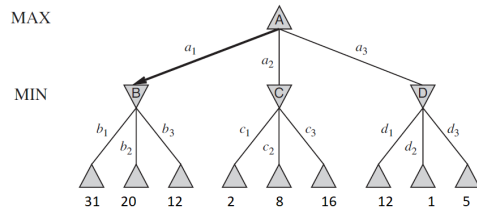
2. Given a text we would like to determine what natural language it is written in. For each L, we build a model by counting the trigrams in a corpus of that language. This gives us P(Text | Language). When building an n-gram model, if we set zero probability to uncommon n-grams such as "xgz" or "ojz" what kind of error occurs? How can linear interpolation smoothing resolve this error? Give an example by showing how the probability of "xgz" may be calculated.

3. We can define the probability of a sequence of characters $P(c_{1:N})$ under the trigram model by first factoring with chain rule, and then using the Markov assumption. What will be the probability of the the sequence "abc" if P("a") = 0.1, P("b") = 0.2, P("c") = 0.3, P("b"| "a") = 0.4, and P("c" | "ab") = 0.5?

$$P(c_{1:N}) = \prod_{i=1}^{N} P(c_i \mid c_{1:i-1}) = \prod_{i=1}^{N} P(c_i \mid c_{i-2:i-1})$$

4. Give examples two "low-level" image processing operations.

5. Given the input image intensities I(x) and a filter N(d) what will be the new intensity of the pixel in the center after we convolve N(d) over I(x)?
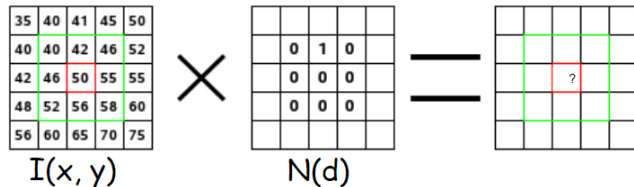
6. How many degrees of freedom does a rigid autonomous underwater vehicle have? How?

7. Give an advantage and a disadvantage of a holonomic robot.

8. What is wrong with the three laws of robotics: (1) A robot may not injure a human being or, through inaction, allow a human being to come to harm (2) A robot must obey orders given to it by human beings, except where such orders would conflict with the First Law (3) A robot must protect its own existence as long as such protection does not conflict with the First or Second Law?

1. In the following tree, apply the Alpha-beta pruning algorithm. Which of the following nodes will be pruned - T, U, V? Assume that the nodes are processed from left to right.
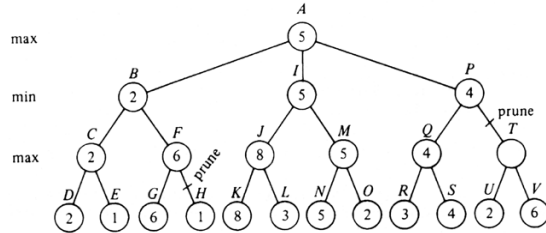
2. Provide the steps (with numbering) how you will apply the Cutset Conditioning Algorithm and the Tree-CSP-Solver algorithm to color the following map with 4 colors - blue, white, red or green - such that no two neighboring countries have the same color.

3. Suppose there are 3 characters in a language L, and we have built a unigram model. The probabilities for the 3 characters are given by the models are P("A") = 0.25, P("B") = 0.50, and P("C") = 0.25. What will be the perplexity of for the sequences "AAA" and "ABA"? How will the perplexity change for the two sequences if the probabilities were equal for the 3 characters?

4. What are the disadvantages of building larger n-gram models such as 4-gram or 5-gram word models?

5. A search query "president lincoln" is being scored against a document D. The terms "president" and "lincoln" both appear just once in D. The length of this document D is 90% of the average length of all documents in the corpus. There are 40,000 documents that contain the term "president" and there are 300 documents that contain the term "lincoln". Assume that IDF for all queries is 1, and k = 1.2 and b = 0.75. What is the BM25 score for the query against the document D?

6. What does optical flow measure and what is its unit?

7. To detect edges, we can simply convolve the image with the derivative of the smoothing function and we don't need to "first smooth using a filter, then detect edges". Why?

8. "Many industrial manipulators have seven degree of freedom, not six." Why?

9. When is the "Reactive control" method for robot movement more appropriate?

10. Why do the authors (Russel and Peter) don't fully agree with philosopher John Searle's statement - "No one supposes that a computer simulation of a storm will leave us all wet . . . Why on earth would anyone in his right mind suppose a computer simulation of mental processes actually had mental processes?"