

ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)
ORGANISATION OF ISLAMIC COOPERATION (OIC)
Department of Computer Science and Engineering (CSE)

MID SEMESTER EXAMINATION
DURATION: 1 Hour 30 Minutes

WINTER SEMESTER, 2020-2021
FULL MARKS: 75

CSE 4711: Artificial Intelligence

Programmable calculators are not allowed.

There are **3 (three)** questions. Answer all **3 (three)** of them.

Figures in the right margin indicate marks of each question.

The square brackets on the start of each question denotes the corresponding CO and PO.

1. There are around 4.3×10^{19} possible configurations of a 3×3 Rubik's cube. However, if played optimally, any configuration can be solved in 20 moves or less. Here, one single move consists of a rotation of one of the faces of the cube. There are 27 possible rotations from a single configuration. We can pose the problem of solving Rubik's cube as a search problem. Assume that the closest solution from our start state requires exactly 20 moves.

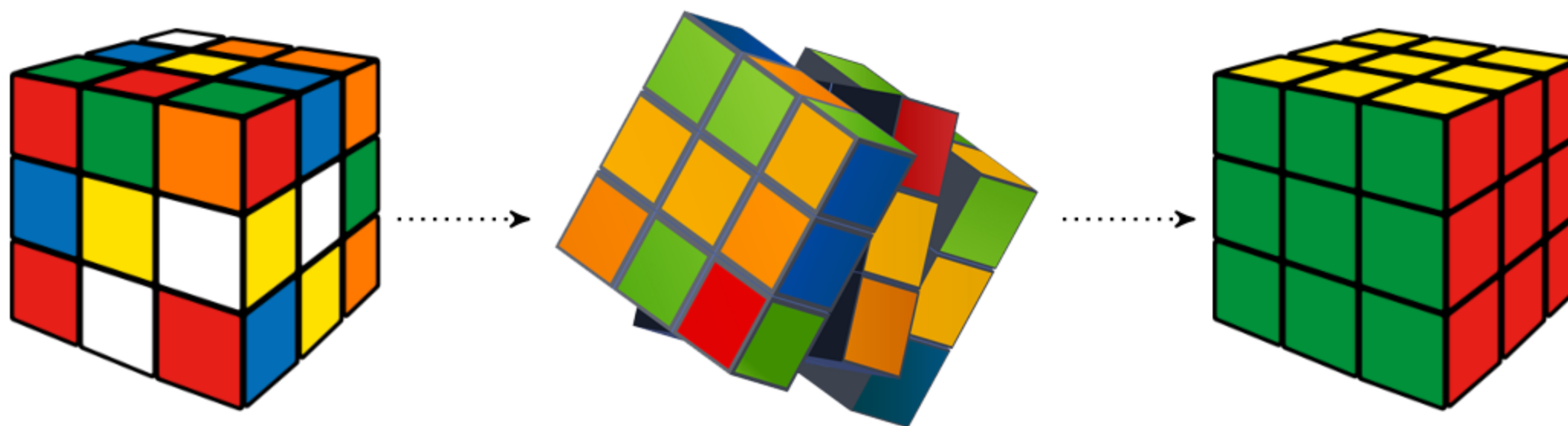


Figure 1: Rubik's Cube

- a) [CO2, PO4] Model the state space graph for this problem. 10
 - b) [CO2, PO4] Model the search tree from the state space graph. 3
 - c) [CO3, PO2] Considering both the tree search and graph search variants of Breadth-First Search (BFS) and Depth-First Search (DFS), which algorithm will you prefer to find the solution? Justify your choice. 12
2. Zahid (Z), Ishrak (I), Farabi (F), and Nafisa (N) came to Chini-Come, a restaurant near their university. The restaurant serves Special Rice (S), Biryani Rice (B), Kashmiri Naan (K), and Paratha (P). You overhear their conversations, and come up with the following preferences:
- i. Zahid does not like Paratha.
 - ii. Ishrak and Farabi want to grab a bite of each other's food. So they want to order different dishes.
 - iii. Farabi likes Rice items. So he'll either take Special Rice or Biryani Rice.
 - iv. Zahid wants to take a unique dish. However, he loves to copy Ishrak and will order the same dish as Ishrak.
 - v. Nafisa will not order Kashmiri Naan as she had them earlier.

Now you want to figure out who will order what using CSP.

- a) [CO2, PO4] Draw the constraint graph considering each person as a variable. 5
- b) [CO1, PO1] Show the remaining values in the domains of each variable after enforcing the unary constraints. 8

- c) [CO1, PO1] Based on the result in Question 2(b), determine the cutset that will result in the least number of residual CSPs and provide brief reasoning for your choice. How many residual CSPs will you get? 2 + 1
- d) [CO3, PO2] Let's say Ishrak orders Biriyan Rice. Based on the result in Question 2(b), perform Arc Consistency and show the remaining values for the domain of each variable. What would have been the difference if we performed Forward Checking here? 8 + 1

3. Consider that you have an encryption software that takes a string, and converts it to an encrypted string. You used this software to encrypt your password and store it in a file, but somehow you forgot the password. You know that the password contains only the letters X , Y , and Z . The only way to recover the password is to provide a guess to the software, which will give you the encrypted string and then compare it with the string stored in the file. You are trying to recover your password using search.

You formulate your search problem in this manner:

State: Each possible string consisting of the letters X , Y , Z

Start State: An empty string

Successor Function: Appends one letter (X , Y , or Z) to the string

Path Cost: You suspect that some letters are more likely to occur than others. To encode this in your search, you set $cost(X) = 1$, $cost(Y) = 2$, $cost(Z) = 3$.

Goal Test: Verify a candidate password using the decryption software.

Your search algorithm will keep generating different passwords and send them to the encryption software for checking until you find the first match. Assume that all ties are broken alphabetically.

- a) [CO3, PO3] Assume that your search algorithm predicts up to 10 character strings. There are 6 correct passwords: $XXXZZZ$, $XYZZZ$, $YXYXY$, $YZXYXZY$, $ZYXZ$, and $ZYXZY$. Matching with any one of them will do. With a brief explanation, select the one that will be returned by: 6 × 3
- i. Depth-First Search (DFS)
 - ii. Breadth-First Search (BFS)
 - iii. Uniform Cost Search (UCS)
- b) [CO1, PO1] Assume that there is a single correct password of length 10, chosen uniformly at random from the state space. That means you do not know about the likelihood of the letters. The correct password is unknown, but a candidate password can be checked using your decryption software. Justify the statement: Given any heuristic, A* search will, on average, expand the same number of states as Depth-First Search. 7