FACULTEIT INGENIEURSWETENSCHAPPEN
EN ARCHITECTUUR

Lab algorithms
dynamic programming

1 Introduction

This lab session is the second on dynamic programming, focusing on the analysis of the problem to determine the different sub problems. Three smaller problems that can be solved with dynamic programming are given.

2 Perfect information blackjack

Your friend invites you to a blackjack night and you are ready to win some money. For every hand a bet of 1 euro is placed and you want to maximize your chances of winning. The cards are shuffled at the moment you arrive at the location and you are able to quickly check the order of the cards before the game really starts. Try to determine the best strategy for the game later and maximize your output.

2.1 Blackjack rules

Blackjack is a card game played against the dealer. Every card has a specific value, the numerical cards (1-10) have a value corresponding with their number, the face cards (Jack, Queen, King) count 10. The goal is to have a score closer to 21 as the dealer without scoring higher than 21. If the player has the cards 4,5 and 10, his score equals 19. in this case the players wins if the dealer has a score of 18 or lower and when the dealer is "busted" (higher than 21). When the player wins, his bet is doubled. The player loses when the dealer scores higher then him: if the dealer scores 20 or 21 and the players loses his bet. When both scores are equal, the player get his bet back.

A blackjack game is played in a specific order:

- Every hand starts with the dealer giving one card to the player, one card to himself, a second card to the player and a second card for himself.
- The player can choose to "stand" or to "hit". If a player "hits", he add an extra card to his hand and his score increases.

- After the players turn, the dealer will have to choice to "stand" or to "hit". Statistically, the on-17-stand policy has high dealer win chances and our dealer will use this scheme. He will "hit" until he reaches the score of 17 or higher.

REMARK 1: Think thoroughly about the problem before you start programming. What is the situation in a specific hand, which scenarios are possible for both player and dealer and which subproblems could be used to solve the problem.

REMARK 2: Your strategy should still be found in a reasonable time when using 4 deck of cards.

3 DNA-sequences humans and chimps

Humans and chimps are biologically very related. The goal is to compare different human dna sequences with dna sequences from chimps to see which one corresponds with the other. We would now like to know how many changes need to be made to go from the chimp dna to the human dna. A change is defined as (i) adding a character to the string, (ii) deleting a character from the string or (iii) replacing a character of the string.

For example with strings: "sunday" and "saturday" the output would be 3. The last three and first character are the same, so we basically need to convert "un" to "atur". This can be done using three operations: replace 'n' with 'r', insert t and insert a. The image below shows some other examples.

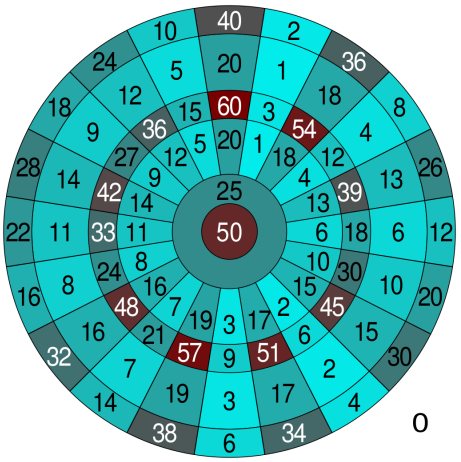
In the files human.dna and chimp.dna, 2 times 75 DNA sequences are listed. Find for every human DNA sequence the corresponding DNA sequence from the chimp that requires the least number of changes.
The expected output is:
Human 0 corresponds to chimp 69 with distance 24
Human 1 corresponds to chimp 63 with distance 10
Human 2 corresponds to chimp 27 with distance 25
Human 3 corresponds to chimp 45 with distance 26
Human 4 corresponds to chimp 46 with distance 12
Human 5 corresponds to chimp 25 with distance 30
Human 6 corresponds to chimp 61 with distance 10
Human 7 corresponds to chimp 57 with distance 12
Human 8 corresponds to chimp 74 with distance 35
...
Human 74 corresponds to chimp 28 with distance 18

4 Darts

Darts or dart-throwing is a competitive sport in which two or more players bare-handedly throw small sharp-pointed missiles known as darts at a round target known as a dartboard. The standard dartboard is divided into 20 numbered sections, scoring from 1 to 20 points. Various games can be played using the standard dartboard. However, in the official game, any dart landing inside the outer wire scores as follows:

- Hitting one of the large portions of each of the numbered sections scores the point value of that section.
- Hitting the thin outer portions of these sections, colored red or green, scores double the point value of that section.
- Hitting the thin inner portions of these sections, roughly halfway between the outer wire and the central circle colored red or green, scores triple the point value of that section.
- The central circle is divided into a green outer ring worth 25 points (known as "outer", "outer bull", or "single bull") and a red or black inner circle (usually known as "bull", "inner bull" or "double bull"), worth 50 points.

A dart game is started with a score of 301, 501, 701. Every turn, a player throws three darts to the board and his score is lowered with the points scored during this turn. The highest score possible with three darts is 180, obtained when all three darts land in the triple 20. To finish the game, a player needs to end with a double or in the "bull". The possible scores of the last dart are: 2,4,6,...,40, 50. A score of 170 is the maximal score where a player can finish in his turn.



Calculate the minimal number of darts that a player needs to finish a game of 501, 701 or 901 points and count the number of possible ways to finish with this amount of darts. For example, a game of 501 points can be finished on 3944 different ways with 9 darts.