

Part1

September 15, 2020

1 Assignment 1.1

1.0.1 Question 1

```
[1]: def suffix_array(DNA):  
    """Takes in a sequence with/without $ and returns the suffix array.  
    Can also return sorted suffixes"""  
    n = len(DNA)  
    indexes = list(range(n)) #create list of indexes for all suffixes  
    suffixes = []  
  
    #build suffixes in reverse order  
    for i in range(n):  
        s = DNA[i:n]  
        suffixes.append(s)  
  
    SA = []  
    sorted_suffixes = []  
    #sort indexes according to suffixes  
    for s, i in sorted(zip(suffixes, indexes)):  
        SA.append(i)  
        sorted_suffixes.append(s)  
  
    #print(sorted_suffixes)  
    #print(SA)  
    return SA
```

1.0.2 Question 2

```
[2]: def binary_search(query, genome, SA):  
    """Takes in a query string, a genome string with one or more $ and  
    a suffix array (list of indexes of the genome suffixes)  
    """  
    #variables  
    global depth  
    n = len(query)  
    #Base case
```

```

if len(SA) >= 1: #suffix array contains 1 or more objects so search
    #mid = int(np.floor(len(SA)/2))
    #mid = int(np.ceil(len(SA)/2 - 1))
    mid = len(SA)//2 #get midpoint of SA
    #match
    if query == genome[SA[mid]:SA[mid]+n]:
        matches = []
        #matches.append(SA[mid])
        start = mid # find all matches after the starting point
        while query == genome[SA[mid]:SA[mid]+n]:
            matches.append(SA[mid])
            mid += 1
        mid = start - 1 #find all matches before the starting point
        while query == genome[SA[mid]:SA[mid]+n]:
            matches.append(SA[mid])
            mid -= 1
        return matches
    elif query < genome[SA[mid]:SA[mid]+n]: #search smaller half
        depth +=1
        return binary_search(query, genome, SA[0:mid])
    else: # search bigger half
        depth +=1
        return binary_search(query, genome, SA[mid+1:len(SA)])
else: #no match
    return []

```

[]: *### Question 3*

```

[3]: def read_fasta(file):
    """
    Takes in a text file amnd returns a string where all chromosomes are
    seperated by $
    """

    f = open(file, "r")
    lines = f.readlines()
    f.close()
    genome = ""
    for line in lines:
        line = line.rstrip() # get rid of \n
        #print(line)
        if line[0] == ">" and len(genome) == 0: # dont add $ if genome is empty
            pass
        elif line[0] == ">": # add $ for all new chromosomes
            genome = genome + "$"
        else:
            genome = genome + line
    genome = genome + "$" #add $ at the end

```

```
return genome
```

```
[4]: genome = read_fasta("genome.fasta")
sa = suffix_array(genome)
hits = binary_search('ACCGT',genome,sa)
hits
```

```
[4]: []
```

1.0.3 Question 4

```
[7]: def print_suffixInterval(genome,sa,i,j,length=10):
    ''' Print small part of a suffix array '''
    while i < j and i<len(genome):
        print('{:5}{:5} '.format(i,sa[i]),genome[sa[i]:sa[i]+length])
        i += 1

    # Here your suffix_array function is called
    sa = suffix_array(genome)
    # Here a small arbitrary part of it is printed
    print_suffixInterval(genome,sa,10,20)

    # Here your binary_search program is tested with the query sequence 'AACC'
    hits = binary_search('AACC',genome,sa)
    # The result is printed
    print("\nHits found:\n Pos  Seq")
    for i in hits:
        print('{:5} '.format(i),genome[i:i+4])
```

```
10  228  AAATCGGGGG
11  631  AAATGCGCTC
12  332  AAATGGCCGT
13  597  AAATTCCCGG
14  274  AACAAACTGG
15  391  AACACCGCGC
16  315  AACCGACTAC
17  415  AACCTG$GTA
18  359  AACGTGCTGC
19  245  AACTCTG$GT
```

Hits found:

```
Pos  Seq
315  AACC
415  AACC
```

1.0.4 Question 5

A genome of length L must be halved at most $\log_2(L)$ times.

A genome of length $2 \times 6 \times 10^9$ must be halved at most 34 times.

A genome of length 688 (this assignment) must be halved at most 10 times.

```
[9]: depth = 0
     binary_search('ACCGT',genome,sa)
     print("Length of Genome:", len(genome))
     print("Search Depth:", depth)
```

Length of Genome: 688

Search Depth: 10