homework1

problem 1

k-Mer Composition

```
#!/usr/bin/env python3
from itertools import product
import re

f = open("rosalind_kmer.txt","r")
next(f)
s = f.read().replace("\n", "")

def permutations_with_repeats(alphabet, repeatNumber):
    alph = list(alphabet)
    out = []
    for c in product(alph, repeat = repeatNumber):
        out.append("".join(c))
    return sorted(out)

bases = 'ACTG'
perms = permutations_with_repeats(bases,len(bases))

for perm in perms:
    print(len(re.findall(f'(?={perm})',s)), end=' ')
```

problem 2

Question

Please be sure to show all corresponding work.
Assume the dictionary {A, C, G, T } with the following distribution:

- P(A) = 0.1
- P(G) = 0.2
- P(C) = 0.2
- P(T) = 0.5

part a

What is the expected frequency of the sequence CG in a sequence of length 3 (i.e., probability)? Hint: how many ways can you put CG in a sequence of length 3 and what is its probability? (2 points)

answer a

$$P(C) * P(G) * 1 + 1 * P(C) * P(G)$$
$$0.2 * 0.2 * 1 + 1 * 0.2 * 0.2 = 0.08$$

part b

What is the expected frequency of the sequence CG in a sequence of length 5? (3 points)

answer b

There are 4 ways that `CG` can appear in a sequence of length 5 once.

$$CG***$$
$$*CG**$$
$$**CG*$$
$$***CG$$

There are 3 ways that `CG` can appear in a sequence of length 5 twice.

$$CGCG*$$
$$CG*CG$$
$$*CGCG$$

$$P(X = 1) =$$
$$P(CG*** \mid *CG** \mid **CG* \mid ***CG) -$$
$$2 * P(CGCG* \mid CG*CG \mid *CGCG)$$

$$P(X = 1) = 4 * (0.2 * 0.2 * 1 * 1 * 1) - 2 * 3 * (0.2 * 0.2 * 0.2 * 0.2 * 1) \quad (1)$$
$$= 0.1504 \quad (2)$$

$$P(X = 2) = P(CGCG* \mid CG*CG \mid *CGCG) \quad (3)$$
$$= 3 * (0.2 * 0.2 * 0.2 * 0.2 * 1) \quad (4)$$
$$= 0.0048 \quad (5)$$

$$E(X) = \sum_{x \in X} x * P(x) \tag{6}$$
$$= 1 * P(X = 1) + 2 * P(X = 2) \tag{7}$$
$$= 1 * 0.1504 + 2 * 0.0048 \tag{8}$$
$$= 0.16 \tag{9}$$

problem 3

Question

Assume the following DNA sequence:

$$ATGATCGAGATC$$

part a

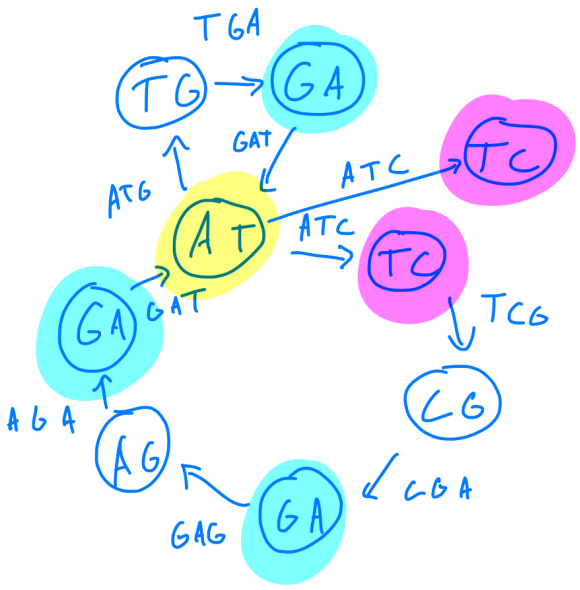
Draw the simple de Bruijn graph with `k = 3`, aka, `DeBruijn3(ATGATCGAGATC)`, that does not collapse any nodes. (1 point)

answer a

part b

Draw all intermediate collapsed graphs that collapse on common nodes. There are three such cases so be sure to provide three such graphs. (3 points)

answer b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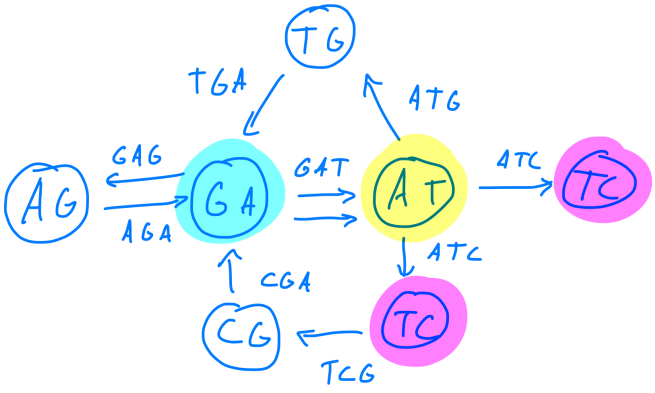
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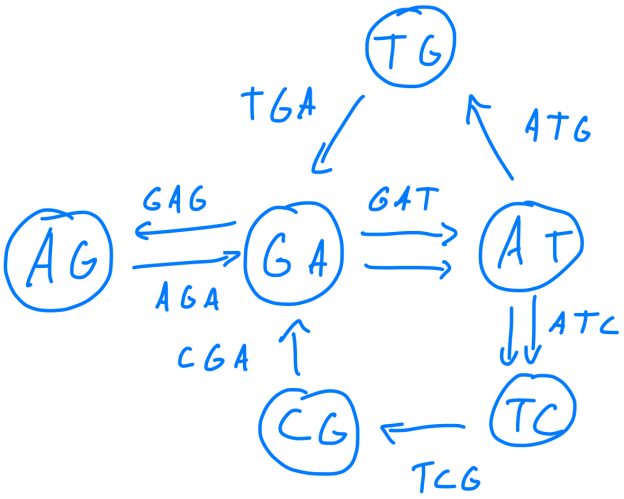
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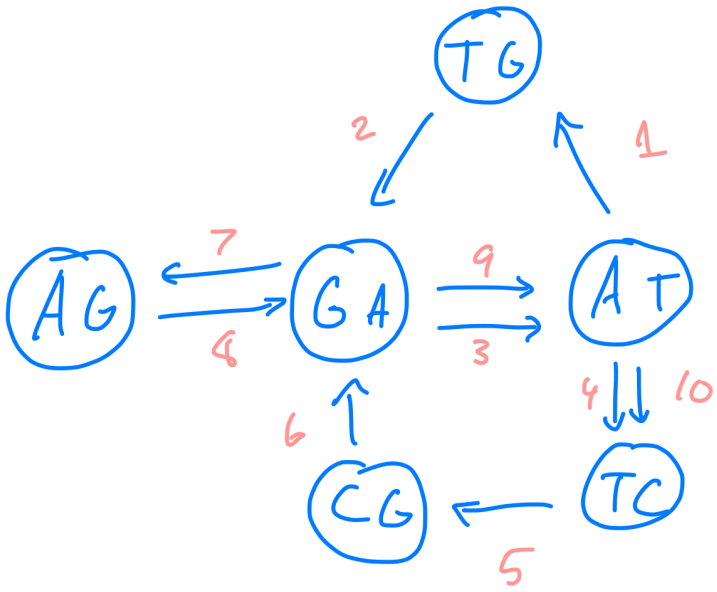
part c

Redraw your final graph from (b) and find the Eulerian path that corresponds to the original sequence but do not label the edges with their corresponding k-mer. Instead, label the edges on the Eulerian path edges with unique increasing integers starting with 1 (e.g. 1, 2, ...). (2 points)

answer c



part d

Find an Eulerian path that starts with a different k-mer. You can simply write down the edge labels here and make sure to write down the corresponding sequence. (2 points)

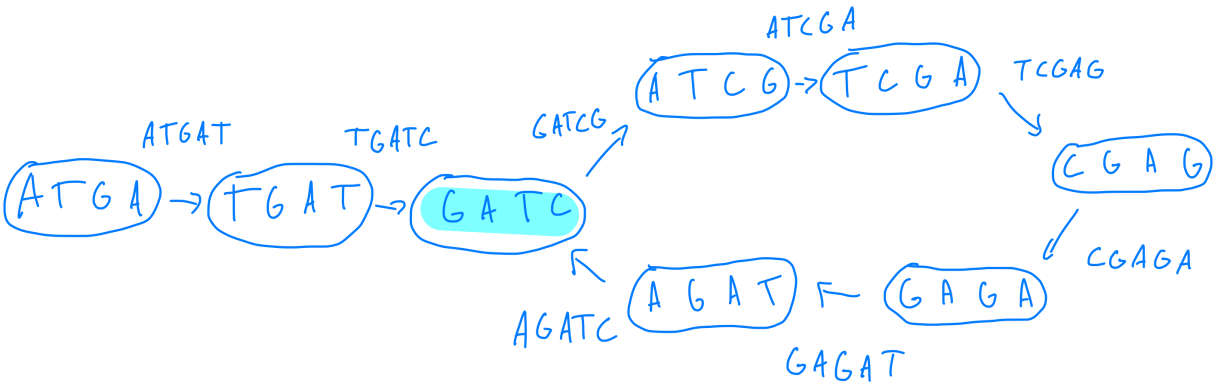
answer d

$$ATCGAGATGATC$$

part e

Draw the final Bruijn graph with `k = 5`, `DeBruijn5(ATGATCGAGATC)`, that collapses any duplicated nodes. (1 point)

answer e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