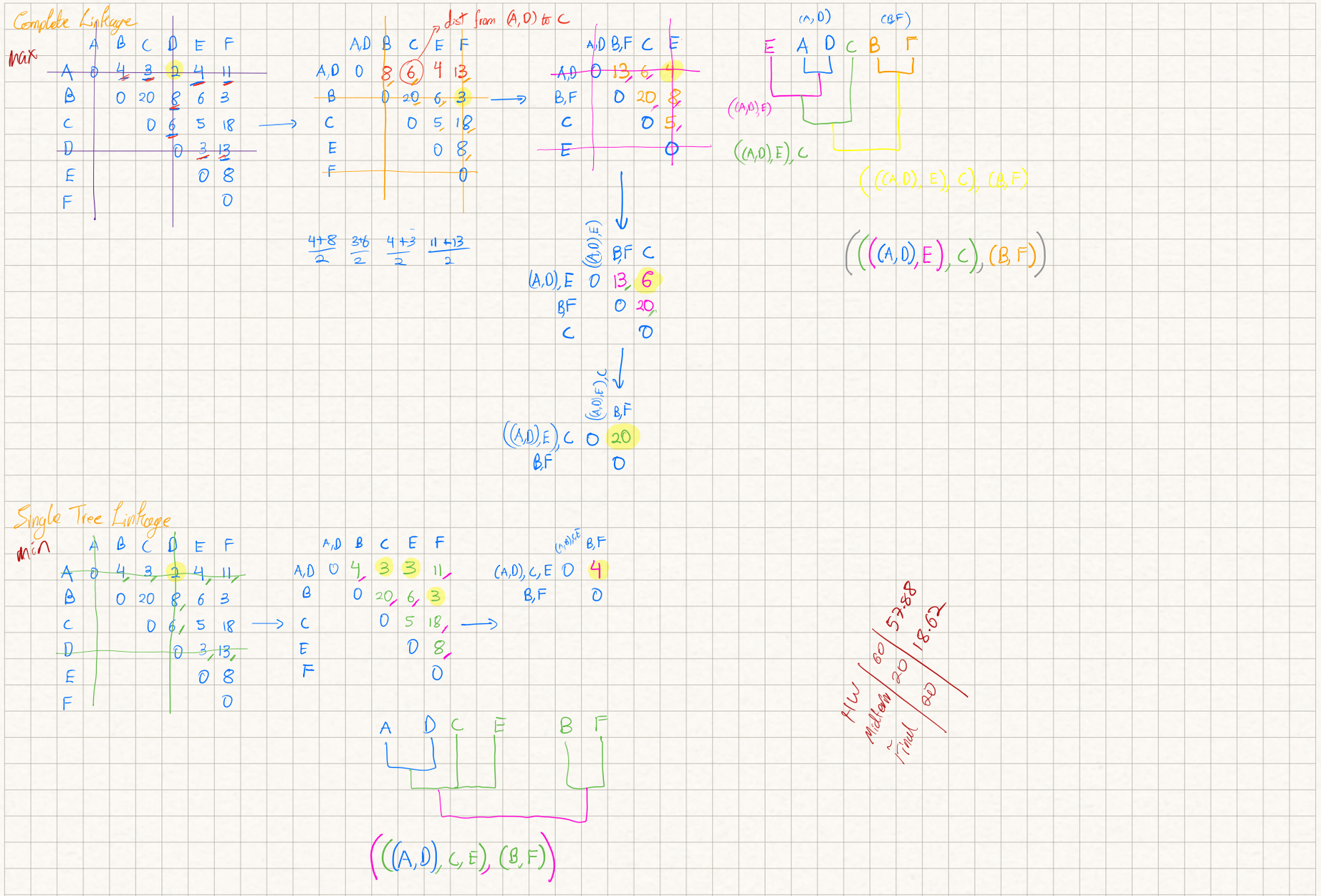
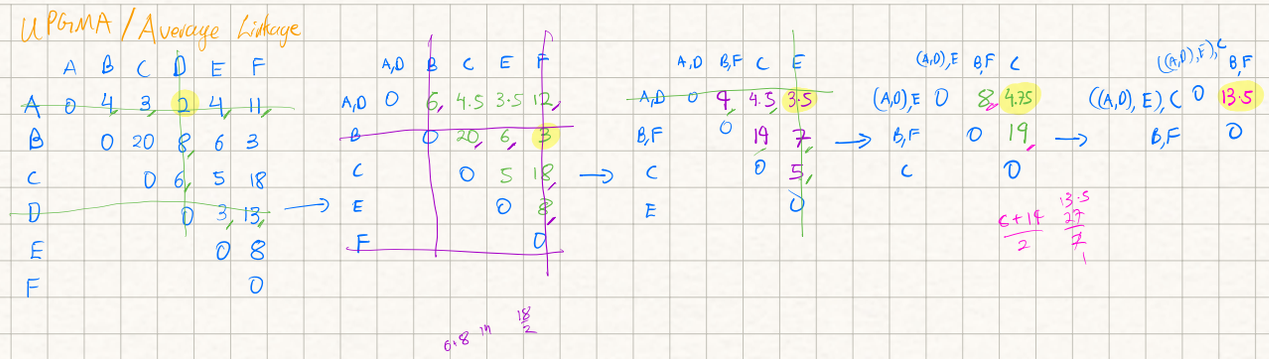

Complete Linkage
max
dist from (A,D) to C
(A,D)
(B,F)
((A,D),E),C
((A,D),E),C),(B,F)
(((A,D),E),C),(B,F)
Single Tree Linkage
min
((A,D),C,E),(B,F)
FLW
Median
Final
57.88
18.62

UPGMA / Average Linkage



number of unrooted trees

$$\prod_{i=3}^{n} (2i-5)$$

n sequences

u = n-1 trees

v = 2n-3 Branches

→ distinct trees = (n-1)(2n-3)

rooted = unrooted - 1

Gamma dist correct Zvelbi 295

Poisson - end of phylo slides

Linkage methods → Zvelbi 665

Final Exam

③

A C A G A G
A G T G A G
T A T C A G
T A T C A A

$f_{1,A} = 0.5$

$f_{1,T} = 0.5$

$$\sum f_{C,A} \log_2 f_{C,A} = 1$$

④

$I_C = \log_2 4 - H_C = 3.3219$

$I_A = 0.5 \times 3.32 = 1.6610$

$I_A = 0.5(\log_2(4) - 1) = 0.5$

①

a: A T T C
b: A − C A
c: A − − C

a: A T T C
b: A − C A
10 −5 −1 −1
3

a: A T T C
c: A − − C
10 −5 −5 10
10

b: A − C A
c: A − − C
10 −5 −5 −1
−5
−6

Sum all Pairs = 7

Correct

② a: A T T C
b: A - C A
10 -5 -1 -1
3

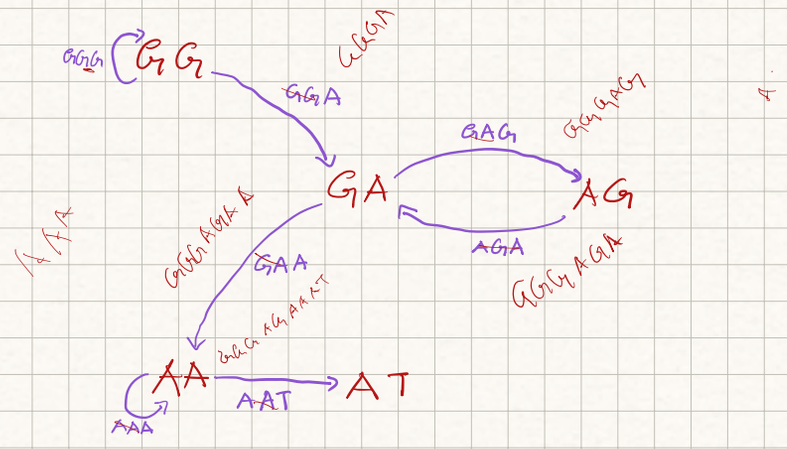
a: A T T C
c: A - - C
10 -5 -1 10
14

b: A - C A
c: A - - C
10 -5 -1 -1
-5
-2
affine

Sum all pairs = 15

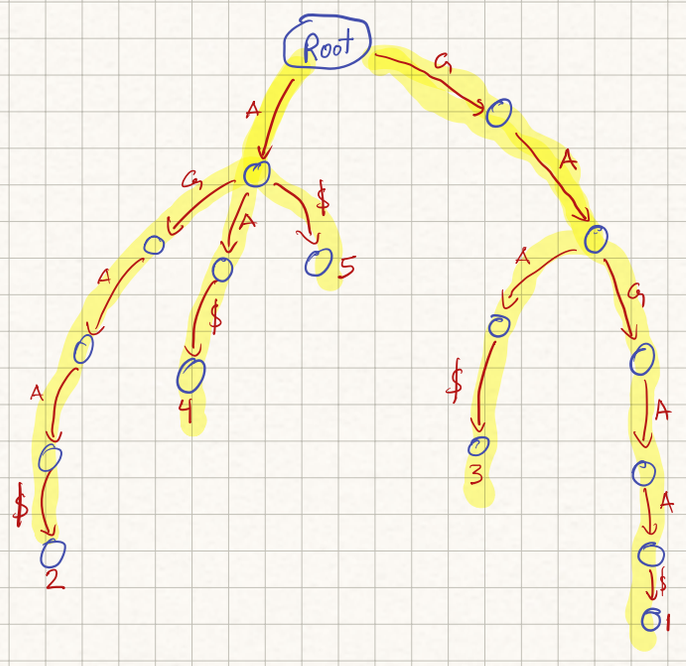
⑤ AAA AAT AGA GAA GAG GGA GGG

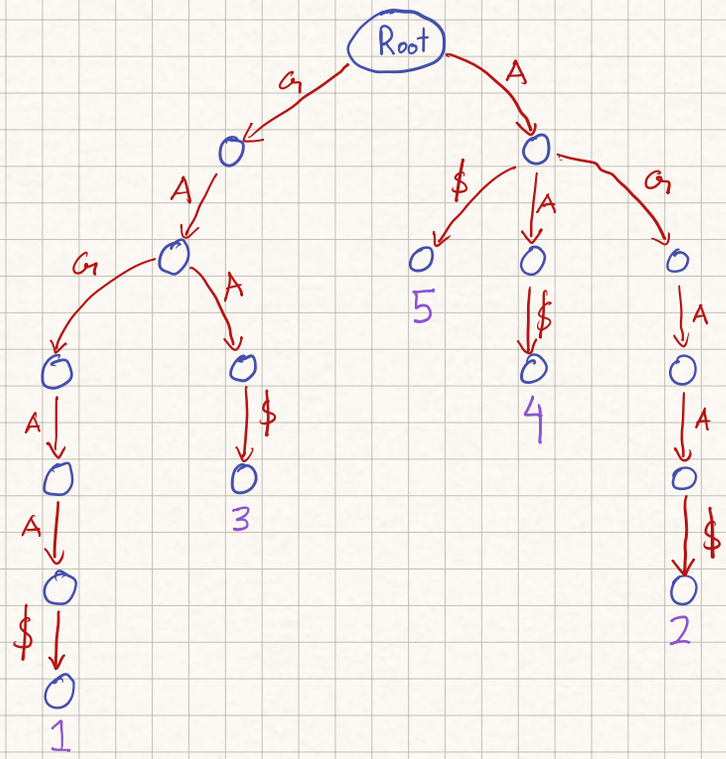
AA AA AA AT AG GA GA AA GA AG GG GA GG GG

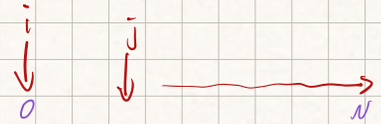


⑥ GGGAGAAAT

⑦ 1 2 3 4 5
GA GAA $

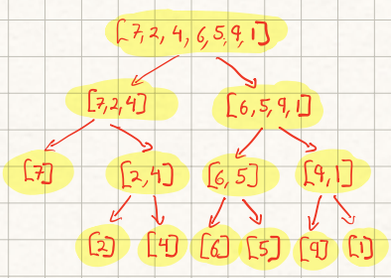






list of alignments ["...", "...", ..., "..."]

```
for i in range(N-1)
    for j in range(i+1, N)
```


[7,2,4,6,5,9,1]
[7,2,4]
[6,5,9,1]
[7]
[2,4]
[6,5]
[9,1]
[2]
[4]
[6]
[5]
[9]
[1]