CSCI3220 2018-19 First Term Assignment 4

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University Guideline on Academic Honesty: http://www.cuhk.edu.hk/policy/academichonesty/

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1. (a). Not possible.

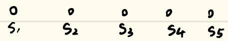
We have $d(s_2, s_3) + d(s_2, s_4) = 2 + 6 = 8 < d(s_3, s_4) = 10$.

Thus the distance Matrix doesn't meet the propertie (iv), the rule of Triangle.

Therefore it can not construct an additive tree.

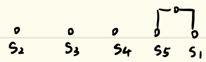
(b).

	s_1	s_2	s_3	s_4	s_5
s_1	0	8	6	8	2
s_2	8	0	2	6	8
s_3	6	2	0	10	6
s_4	8	6	10	0	6
s_5	2	8	6	6	0



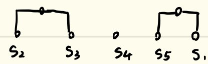
Merge $\{s_1\},\{s_5\}$ $\Rightarrow$

	$s_1 s_5$	s_2	s_3	s_4
$s_1 s_5$	0	8	6	7
s_2	8	0	2	6
s_3	6	2	0	10
s_4	7	6	10	0



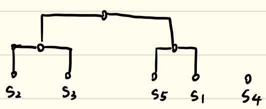
Merge $\{s_2\},\{s_3\}$

	$s_2 s_3$	$s_1 s_5$	s_4
$s_2 s_3$	0	7	8
$s_1 s_5$	7	0	7
s_4	8	7	0



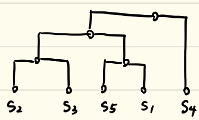
Merge $\{s_1 s_5\}$ $\{s_2, s_3\}$ $\Rightarrow$

	$s_1 s_2 s_3 s_5$	s_4
$s_1 s_2 s_3 s_5$	0	7.5
s_4	7.5	0



Merge $\{s_1, s_2, s_3, s_5\}$ $\{s_4\}$ $\Rightarrow$

	$s_1 s_2 s_3 s_4 s_5$
$s_1 s_2 s_3 s_4 s_5$	0



(c).

Distance Matrix (DM)

d	s_1	s_2	s_3	s_4	s_5
s_1	0	8	6	8	2
s_2	8	0	2	6	8
s_3	6	2	0	10	6
s_4	8	6	10	0	6
s_5	2	8	6	6	0

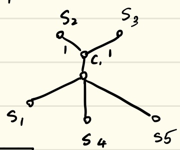
u	
s_1	24
s_2	24
s_3	24
s_4	30
s_5	22

Q matrix (QM).

Q	s_1	s_2	s_3	s_4	s_5
s_1	0	-24	-30	-30	-40
s_2	-24	0	-42	-36	-22
s_3	-30	-42	0	-24	-28
s_4	-30	-36	-24	0	-34
s_5	-40	-22	-28	-34	0

Merge $\{s_2\}, \{s_3\}$ $\Rightarrow$

$d(s_2, C_1) = \frac{1}{2}\times 2 + \frac{0}{6} = 1$, $d(s_3, C_1) = 2 - 1 = 1.$



d	$s_2 s_3$	s_1	s_4	s_5
$s_2 s_3$	0	6	7	6
s_1	6	0	8	2
s_4	7	8	0	6
s_5	6	2	6	0

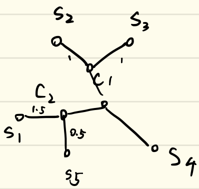
u	
$s_2 s_3$	19
s_1	16
s_4	21
s_5	14

Q	$s_2 s_3$	s_1	s_4	s_5
$s_2 s_3$	0	-23	-26	-21
s_1	-23	0	-21	-26
s_4	-26	-21	0	-23
s_5	-21	-26	-23	0

Merge $\{s_1\}, \{s_5\}$ $\Rightarrow$

$$d(s_1, C_2) = \frac{1}{2}\times 2 + \frac{16-14}{4} = 1 + \frac{1}{2} = 1.5$$

$$d(s_5, C_2) = 2 - 1.5 = 0.5$$



d	$s_1 s_5$	$s_2 s_3$	s_4
$s_1 s_5$	0	5	6
$s_2 s_3$	5	0	7
s_4	6	7	0

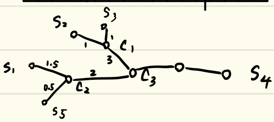
u	
$s_1 s_5$	11
$s_2 s_3$	12
s_4	13

Q	$s_1 s_5$	$s_2 s_3$	s_4
$s_1 s_5$	0	-18	-18
$s_2 s_3$	-18	0	-18
s_4	-18	-18	0

Merge $\{s_1, s_5\}$ $\{s_2, s_3\}$

$$d(s_1 s_5, C_3) = \frac{1}{2}\times 5 + \frac{11-12}{2} = 2$$

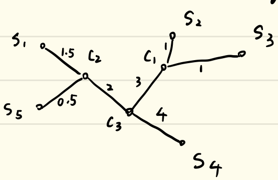
$$d(s_2 s_3, C_3) = 5 - 2 = 3.$$



d	$s_1 s_2 s_3 s_5$	s_4
$s_1 s_2 s_3 s_5$	0	4
s_4	4	0

u	
$s_1 s_2 s_3 s_5$	4
s_4	4

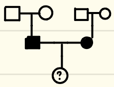
Merge the $\{s_1, s_2, s_3\ s_5\}$ and $\{s_4\}$. We get the final graph



3. (a). Yes.

Assumed the disease is recessive which determined by a single locus, and both of the parents have a genotype Aa, then it is possible for their children to both have & have not disease.

(b). Yes, it is possible because we may determine the genotype of parents by the grandparents. For instance, gives a pedigree chart as follow:



From the status of grandparents, we can know the disease is recessive and both the parents of child has a genotype aa.

Therefore, their children is bound to have a disease.

(c). In some situations, yes.

Situation	Location	Trait Dominance	Daughter genotype	Infer	Father genotype	Father's Phenotype
1	X-linked	Recessive	$X^A X^A$	$\longrightarrow$	$X^A Y$	Unaffected
2.	X-linked	Recessive	$X^a X^a$	$\longrightarrow$	$X^a Y$	Affected
3.	X-linked	Dominant	$X^A X^A$	$\longrightarrow$	$X^A Y$	Affected
4.	X-linked	Dominant	$X^a X^a$	$\longrightarrow$	$X^a Y$	Unaffected

(d). Assumed that

P : Both parents are heterozygous.

F_1 : First child is heterozygous.

F_2 : Second child is heterozygous.

$$Pr(F_1 \wedge F_2 \mid P) = \frac{1}{2} \times \frac{1}{2} = \frac{1}{4}.$$

$$Pr(F_1 \vee F_2 \mid P) = 1 - Pr(\neg F_1 \wedge \neg F_2 \mid P) = 1 - \frac{1}{4} = \frac{3}{4}.$$

$$Pr((F_1 \wedge F_2) \wedge (F_1 \vee F_2) \mid P) = Pr(F_1 \wedge F_2 \mid P) = \frac{1}{4}.$$

$$Pr(F_1 \wedge F_2 \mid (F_1 \vee F_2) \wedge P) = \frac{Pr((F_1 \wedge F_2) \wedge (F_1 \vee F_2) \mid P)}{Pr(F_1 \vee F_2 \mid P)} = \frac{\frac{1}{4}}{\frac{3}{4}} = \frac{1}{3}.$$

(e). Explanation 1:

The situation just happened by chance. In fact, all the decendants have same probability to have a disease, but all the females were lucky while all the males were unlucky.

Explanation 2:

The desease is X-Linked, and it is recessive. The parents have a genotype X^AY and X^aX^a. Thus all the femele descendants have a genotype X^AX^a, which is not affacted. But all the male descendants have a genotype X^aY, which is affacted.

Explanation 3:

All the descendants actually have the disease genotype aa, but there is another gene (Marked B, b) which is X-linked and dominant, which have a effect that can cover the disease phenomenon.

Gives father aaX^BY, mother aaX^bX^b.

All the females have the genotype aaX^BX^b, which is not affacted.

All the males have the genotype aaX^bY, which is affacted.