

Question 3

EPij/taxa-2

	Dog	Cat	Mouse	Pig	Human	Average
Dog	0	0.147	0.147	0.107	0.395	0.2134
Cat	0.147	0	0.232	0.107	0.883	0.2899
Mouse	0.147	0.232	0	0.1468	0.383	0.30311
Pig	0.107	0.107	0.1468	0	0.383	0.248
Human	0.395	0.883	0.383	0.383	0	0.493

↓ merge cat and Pig

	Dog	Pig/Cat	Mouse	Human	Average
Dog	0	0.0735	0.147	0.329	0.27475
Pig/Cat	0.0735	0	0.137	0.3295	0.2645
Mouse	0.147	0.1365	0	0.3830	0.333
Human	0.329	0.3295	0.3830	0	0.52075

↓ merge Mouse & Human

	Dog	Pig/Cat	Mouse/Human
Dog	0	0.0735	0.04175
Pig/Cat	0.0735	0	0.04175
Mouse/Human	0.044	0.04175	0

↓ There is no particular group to be made. I am arbitrarily adding Dog to cat/pig

	Dog/Pig/Cat	Mouse/Human
Dog/Pig/Cat	0	0.006125
Mouse/Human	0.006125	0

U_{kl}

$$D_{Dog/PC(MH)} = \frac{D_{Dog/MH} + D_{PC/MH} - D_{Dog/Pig/Cat}}{2}$$

$$= 0.006125$$

$$V_{cat} = \frac{1}{2} 0.1073 + \frac{1}{2} (0.289 - 0.248)$$

$$V_{cat} = 0.0745$$

$$V_{pig} = \frac{1}{2} (0.01073) + \frac{1}{2} (0.248 - 0.289)$$

$$V_{pig} = 0.0327667$$

$$\begin{matrix} cat & pig \\ 0.0745 & 0.0327 \end{matrix}$$

$$P_{ijk} = \frac{D_{ik} + D_{jk} - D_{ij}}{2}$$

Example.

$$D_{CP(Dog)} = \frac{D_{CO} + D_{PO} - D_{CP}}{2}$$

$$D_{CP(Dog)} = \frac{0.147 + 0.107 - 0.107}{2}$$

$$P_{CP(Dog)} = 0.0735$$

$$V_{Dog} = \frac{1}{2} (0.3830) + \frac{1}{2} (0.30311 - 0.493)$$

$$V_{mouse} = 0.09775$$

$$V_{Human} = 0.28525$$

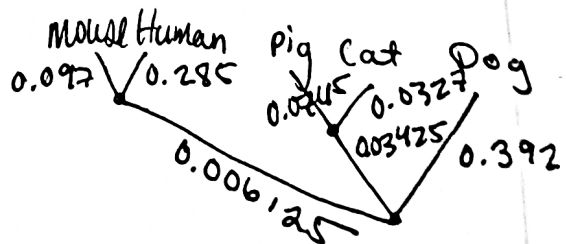
$$\begin{matrix} mouse & Human \\ 0.09775 & 0.28525 \end{matrix}$$

$$V_{Dog} = \frac{1}{2} (0.0735) + \frac{1}{2} (0.1150 - 0.119)$$

$$V_{Dog} = 0.03925$$

$$V_{Pig/Cat(Dog)} = \frac{1}{2} (0.0735) + \frac{1}{2} (0.11525 - 0.119)$$

$$= 0.03425$$



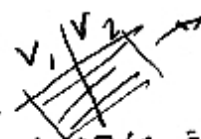
Question 2:
UPIMA

	D	C	M	P	H
D	0	0.147	0.147	0.107	0.329
C	0.147	0	0.233	0.107	0.388
M	0.147	0.233	0	0.147	0.383
P	0.107	0.107	0.147	0	0.388
H	0.330	0.383	0.383	0.383	0

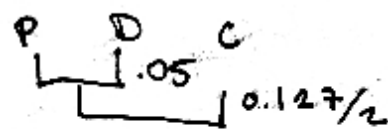
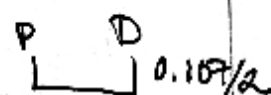
	DP	C	M	H
DP	0	0.147	0.1468	0.3563
C	0.147	0	0.233	0.383
M	0.1468	0.233	0	0.383
H	0.3563	0.383	0.383	0

	DPC	M	H
DPC	0	0.175	0.3645
M	0.175	0	0.383
H	0.3645	0.383	0

	DPCM	H
DPCM	0	0.3738
H	0.3738	0

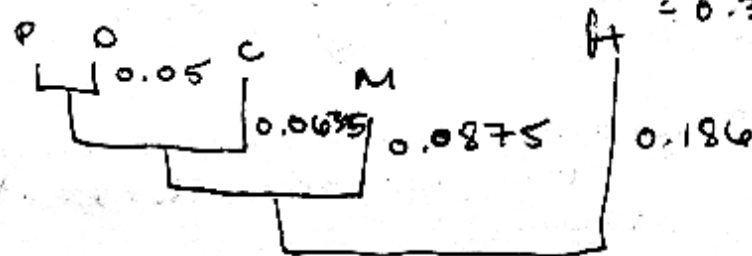


$$\begin{aligned}
 0.107/2 &= 0.05365 \\
 0.107 + 0.147/2 &= 0.127 \\
 0.0.147 + 0.147/2 &= 0.1468 \\
 0.330 + 0.383/2 &= 0.3563
 \end{aligned}$$



$$\begin{aligned}
 \frac{2}{3}(0.1468) + \frac{1}{3}(0.233) \\
 0.0978 + 0.07689 &= 0.17469
 \end{aligned}$$

$$\begin{aligned}
 \frac{2}{3}(0.3563) + \frac{1}{3}(0.383) &= 0.237 + 0.127539 \\
 &= 0.3645
 \end{aligned}$$



Jukes Cantor model

$$P_p = (1/4 \quad 1/4 \quad 1/4 \quad 1/4)$$

equal probabilities

$$Q = \begin{pmatrix} -\alpha & \alpha/3 & \alpha/3 & \alpha/3 \\ \alpha/3 & -\alpha & \alpha/3 & \alpha/3 \\ \alpha/3 & \alpha/3 & -\alpha & \alpha/3 \\ \alpha/3 & \alpha/3 & \alpha/3 & -\alpha \end{pmatrix}$$

continuous time model
rate matrix

$$M(t) = e^{Qt} \rightarrow \text{use to get the Markov matrix}$$

$$M(t) = e^{Qt} = \begin{pmatrix} 1-\alpha & \alpha/3 & \alpha/3 & \alpha/3 \\ \alpha/3 & 1-\alpha & \alpha/3 & \alpha/3 \\ \alpha/3 & \alpha/3 & 1-\alpha & \alpha/3 \\ \alpha/3 & \alpha/3 & \alpha/3 & 1-\alpha \end{pmatrix} \quad \text{Markov matrix}$$

$$a = a(t) = \frac{3}{4} (1 - e^{-4/3 \alpha t})$$

Table 1

Dog	ATG	ACE	AAC	ATT	CGA	AAA	ACC
Cat	ATG	ACC	AAC	ATT	CGA	AAA	ACA
Mouse	ATG	ACC	AAC	ATT	CGA	AAA	ACA
Pig	ATG	ACC	AAC	ATT	CGA	AAA	ACA
Human	ATG	ACC	AAC	ATT	CGA	AAA	ACT

$$d_{JC}(S_0, S_1) = -\frac{3}{4} \ln(1 - \frac{4}{3} \hat{a})$$

example from book

$$d_{JC}(S_0, S_1) = -\frac{3}{4} \ln(1 - \frac{4}{3} \hat{a})$$

$$S_0 = ATTAGC$$

$$S_1 = ATGACC$$

$$\hat{a} = 2/6 = 0.3333$$

$$d_{JC}(S_0, S_1) = -\frac{3}{4} \ln(1 - \frac{4}{3} (\frac{2}{6})) = 0.4408 \text{ sub st bases}$$

	Dog	Cat	Mouse	Pig	Human
Dog	0	4/30	4/30	4/30	8/30
Cat	4/30	0	4/30	3/30	9/30
Mouse	4/30	4/30	0	4/30	9/30
Pig	3/30	3/30	4/30	0	9/30
Human	8/30	9/30	9/30	9/30	0

	D	C	M	P	H
D	0	0.147	0.147	0.107	0.329
C	0.147	0	0.233	0.107	0.383
M	0.147	0.233	0	0.147	0.383
P	0.107	0.107	0.147	0	0.383
H	0.329	0.383	0.383	0.383	0

distance matrix