



Workshop: Paternity and kinship testing including X-chromosomal markers

Cases: Part 2

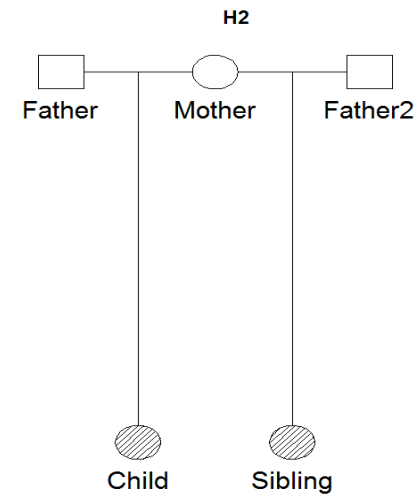
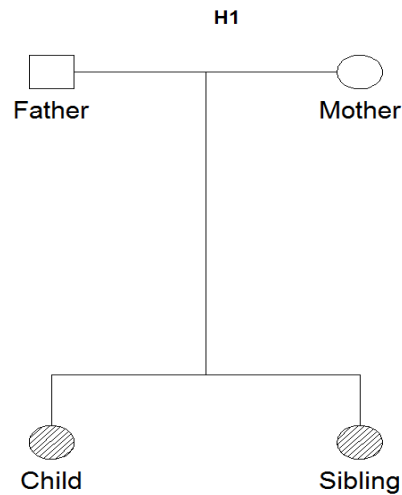
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Exercise 3

Use your knowledge about inheritance patterns to decide if X-chromosomal markers are relevant in the following scenarios.

a) Case 1

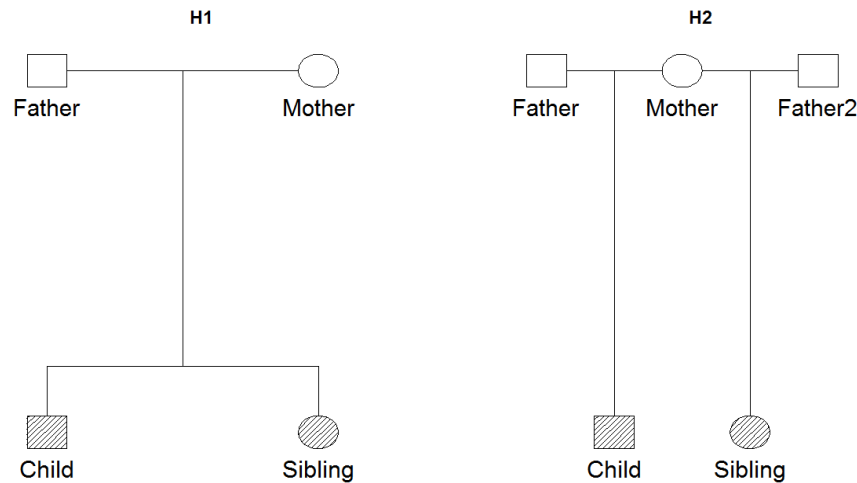


Yes!

Exercise 3

Use your knowledge about inheritance patterns to decide if X-chromosomal markers are relevant in the following scenarios.

b) Case 2

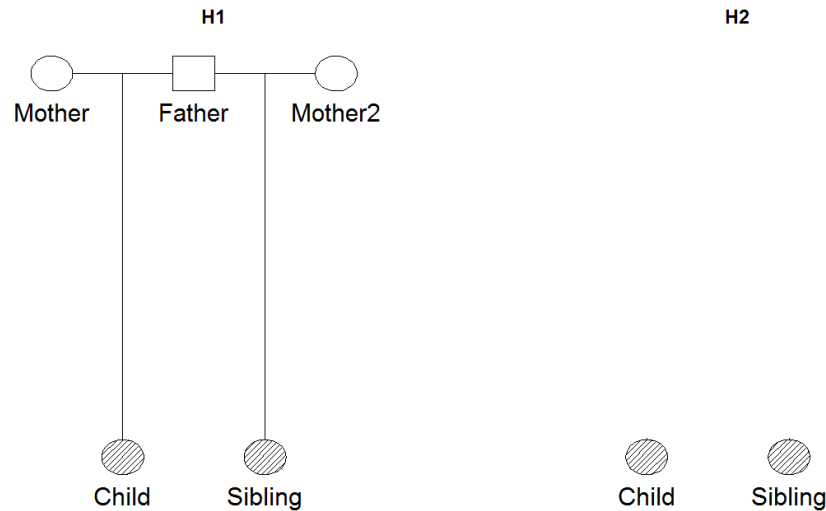


Yes!

Exercise 3

Use your knowledge about inheritance patterns to decide if X-chromosomal markers are relevant in the following scenarios.

c) Case 3

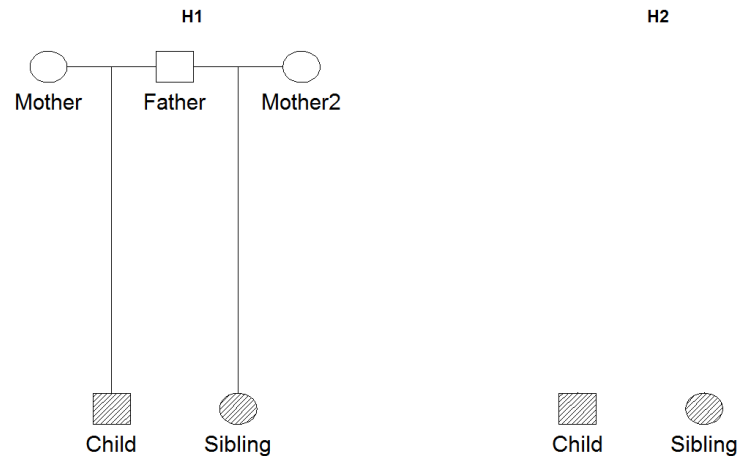


Yes!

Exercise 3

Use your knowledge about inheritance patterns to decide if X-chromosomal markers are relevant in the following scenarios.

d) Case 4

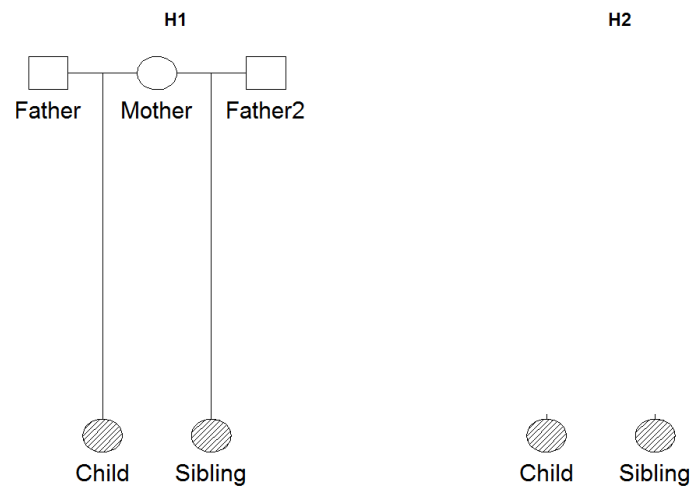


No!

Exercise 3

Use your knowledge about inheritance patterns to decide if X-chromosomal markers are relevant in the following scenarios.

e) Case 5

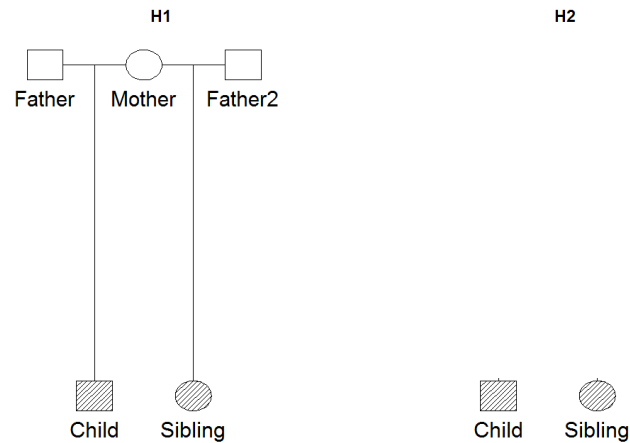


Yes!

Exercise 3

Use your knowledge about inheritance patterns to decide if X-chromosomal markers are relevant in the following scenarios.

f) Case 6

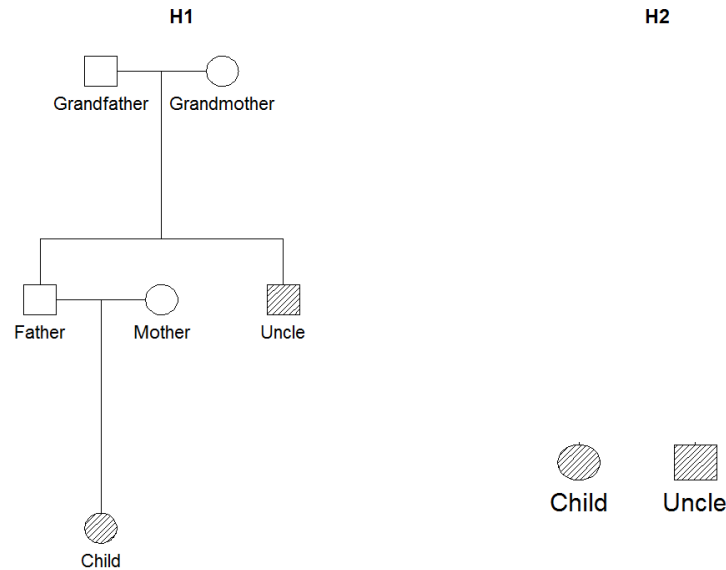


Yes!

Exercise 3

Use your knowledge about inheritance patterns to decide if X-chromosomal markers are relevant in the following scenarios.

g) Case 7

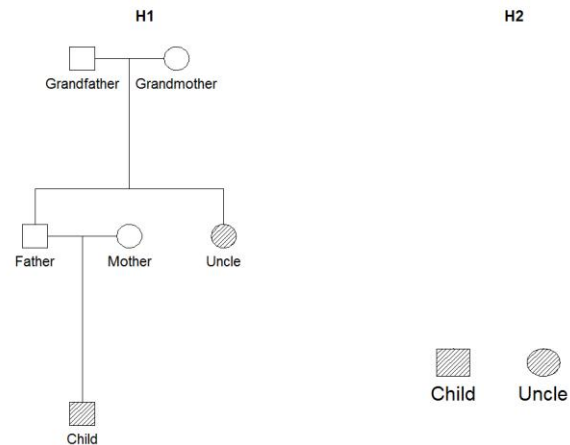


Yes!

Exercise 3

Use your knowledge about inheritance patterns to decide if X-chromosomal markers are relevant in the following scenarios.

h) Case 8 - **No**

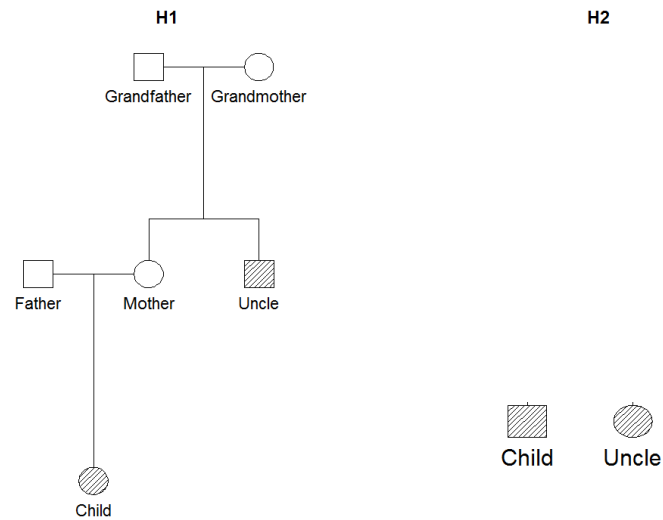


No!

Exercise 3

Use your knowledge about inheritance patterns to decide if X-chromosomal markers are relevant in the following scenarios.

i) Case 9

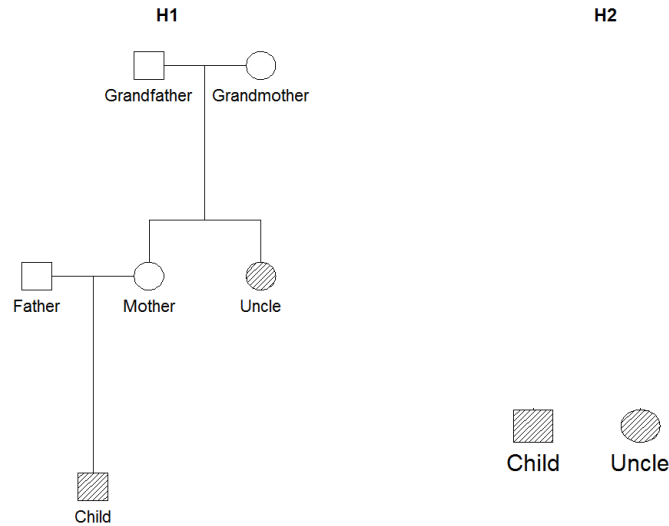


Yes!

Exercise 3

Use your knowledge about inheritance patterns to decide if X-chromosomal markers are relevant in the following scenarios.

j) Case 10

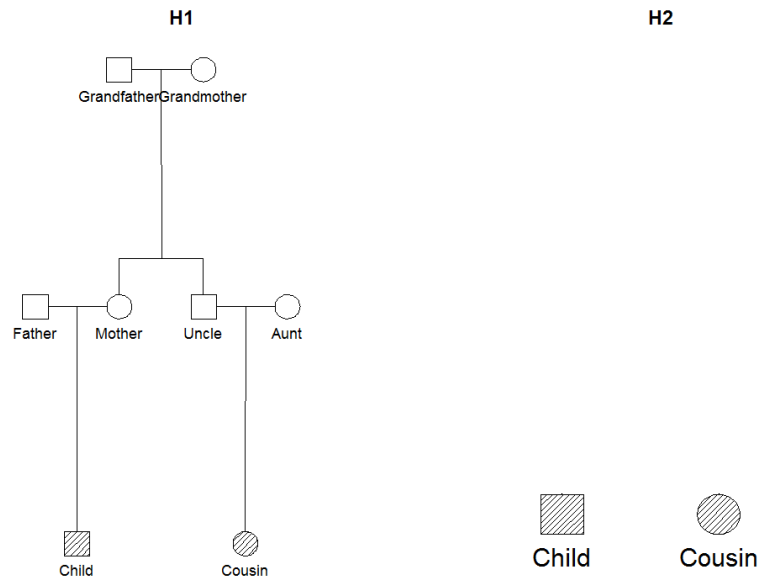


Yes!

Exercise 3

Use your knowledge about inheritance patterns to decide if X-chromosomal markers are relevant in the following scenarios.

k) Case 11

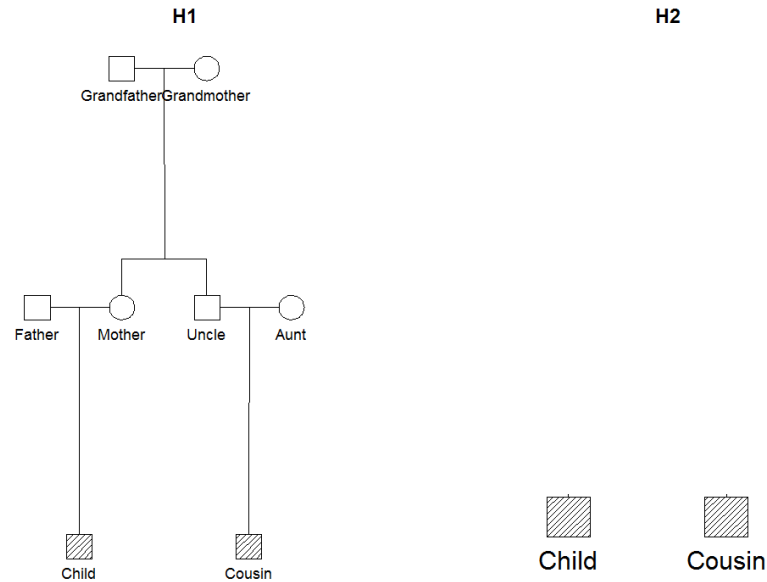


Yes!

Exercise 3

Use your knowledge about inheritance patterns to decide if X-chromosomal markers are relevant in the following scenarios.

I) Case 1

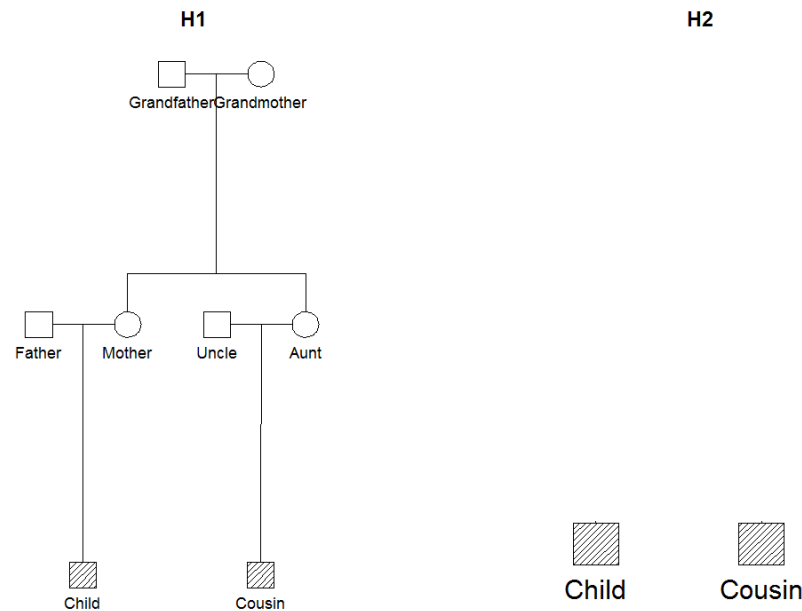


No!

Exercise 3

Use your knowledge about inheritance patterns to decide if X-chromosomal markers are relevant in the following scenarios.

m) Case 13

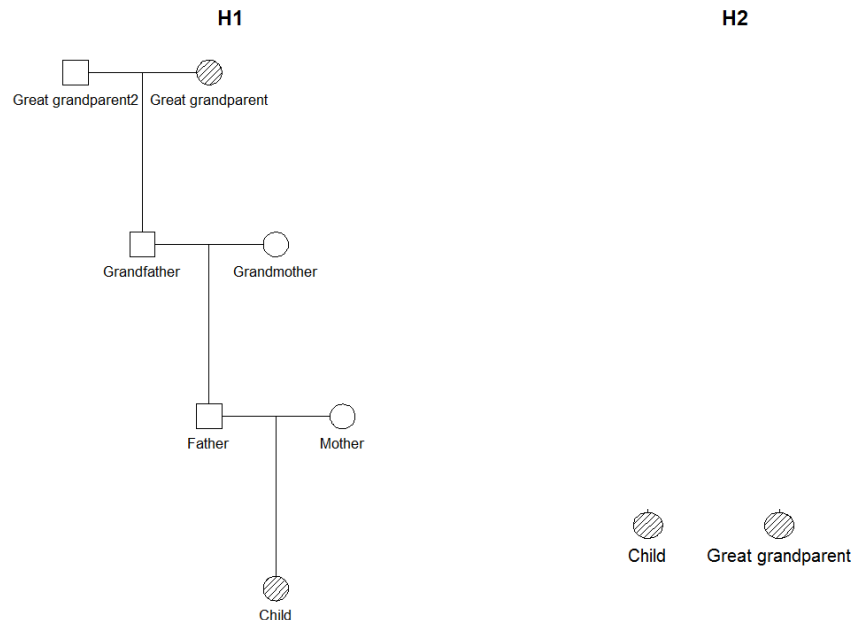


Yes!

Exercise 3

Use your knowledge about inheritance patterns to decide if X-chromosomal markers are relevant in the following scenarios.

n) Case 14



No!

Exercise 4

A woman named Daisy, residing in the city Duckburg, asks for your expertise in a case where she needs to determine the relationship between three girls, April, May and June. She has been able to obtain X-chromosomal profiles for the girls and herself.

a) Import frequency data from a Duckburg population sample and DNA data for the three girls. Mutations are unheard of in Duckburg and all rates are zero to reflect this fact.

* Estimate the lambdas for the clusters defined in the frequency database using the built-in function in FamLinkX and the R software. You may skip this part and use lambdas 315, 208, 111 and 200 for the four clusters respectively.

Exercise 4

The screenshot shows the FamLinkX software interface. The main window is titled 'FamLinkX - Exercise4_Duckburg_frequency_database'. It has a menu bar with 'File', 'Tools', and 'Help'. A table lists clusters and chromosomes:

Cluster	Chromosome
Cluster1	X
Cluster2	X
Cluster3	X
Cluster4	X

The 'Edit clusters/markers' dialog box is open, showing 'Database name: Duckburg'. It has buttons for 'Add', 'Edit', 'Remove', 'Import', 'Export', 'Options', and 'Close'. The 'Options' sub-dialog box is also open, showing 'General' settings. The 'Lambda' is set to 1, and 'Database size' is 692. The 'Use cluster specific' checkbox is checked. The 'Estimate from data' button is selected. The 'Frequency options' section shows 'New allele frequency' set to 0.01 and 'Normalise' selected. The 'Zero mutations' checkbox is unchecked.

A red arrow points from the 'Use cluster specific' checkbox in the 'Options' dialog to a text editor window titled 'Text'. The text editor contains the following R code:

```
#Download and install the package BookEKM, requires internet access
install.packages("http://familias.name/BookEKM_1.0.zip")
foo = library("BookEKM", logical.return=TRUE)
f(foo)
function(P, data, pl = TRUE, first = log(0.01), last = log(10000), ngrid = 1000)
{
  MultivariateBeta <- function(alpha) sum(gamma(alpha)) - lgamma(sum(alpha))
  loglik <- function(data, lambda, P) lMultivariateBeta(lambda * P + data) - lMultivariate
  if(!is.numeric(P) || any(P <= 0))
  stop("Frequencies must be a vector of positive numbers.")
  if(round(sum(P),6) != 1)
  stop("Frequencies must be a vector of positive numbers.")
  if(!is.numeric(P) || any(P <= 0))
  stop("Frequencies must be a vector of positive numbers.")
}
```

Activates cluster specific lambdas

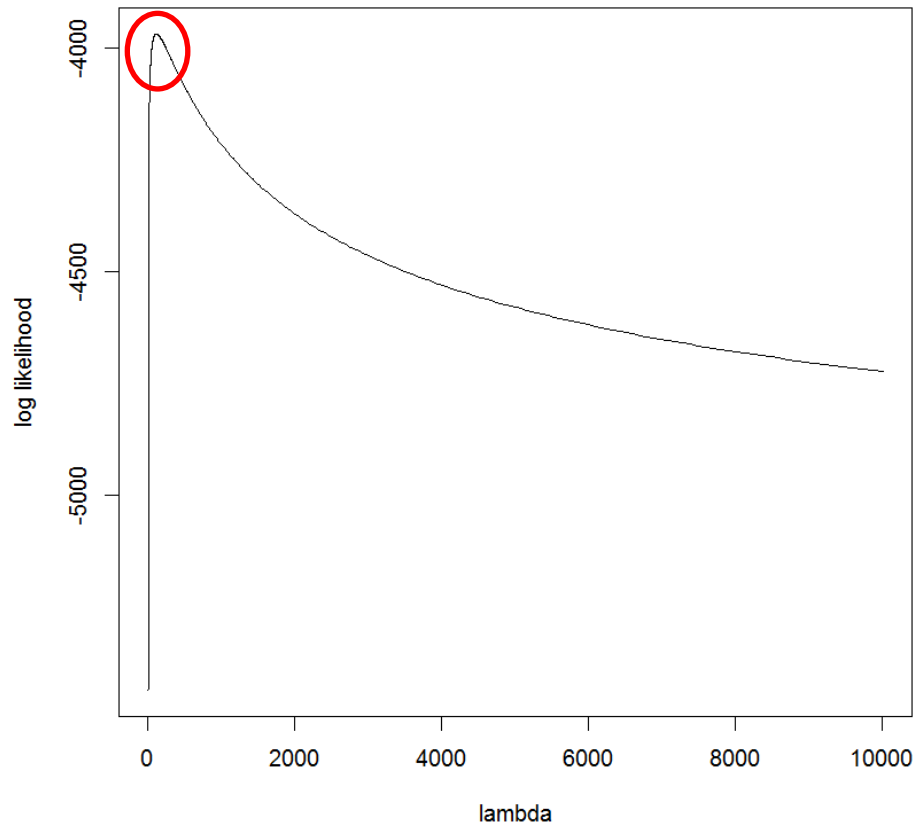
Paste code into R

Exercise 4

```
R Console
> dat4[8,16,3] <- 1; dat4[8,7,0] <- 2; dat4[29,10,4] <- 1; dat4[9,21,2] <- 1; d$
> dat4[28,23,4] <- 1; dat4[17,10,2] <- 1; dat4[25,20,2] <- 1; dat4[12,23,4] <- $
> dat4[2,14,3] <- 1; dat4[23,11,2] <- 1; dat4[22,11,1] <- 1; dat4[9,16,1] <- 1;$
> dat4[21,19,1] <- 1; dat4[2,14,0] <- 1; dat4[25,23,2] <- 1; dat4[0,23,1] <- 1;$
> dat4[8,16,1] <- 1; dat4[7,10,2] <- 1; dat4[13,2,1] <- 1; dat4[5,19,2] <- 1; d$
> dat4[4,11,3] <- 1
> lambdaCluster1<- lambdaEst(P1,dat1)$lambda.est
> dev.new()
> lambdaCluster2<- lambdaEst(P2,dat2)$lambda.est
> dev.new()
> lambdaCluster3<- lambdaEst(P3,dat3)$lambda.est
> dev.new()
> lambdaCluster4<- lambdaEst(P4,dat4)$lambda.est
> lambdaCluster1
[1] 315.1363
> lambdaCluster2
[1] 208.1222
> lambdaCluster3
[1] 111.6987
> lambdaCluster4
[1] 199.6642
> lambdaAverage = (lambdaCluster1 + lambdaCluster2 + lambdaCluster3 + lambdaCluster4)/4
> lambdaAverage
[1] 208.6554
> |
```

Exercise 4

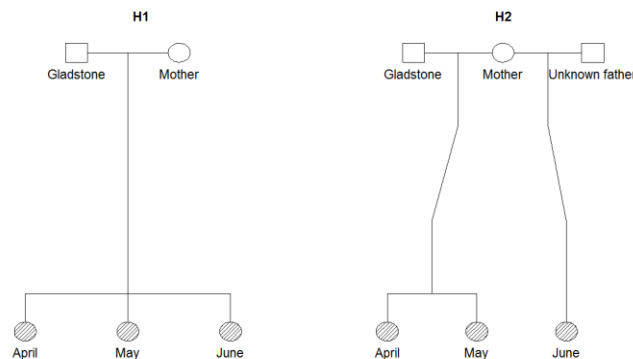
Maximum likelihood estimate for lambda



Exercise 4

- b) Our first task is to decide what hypotheses to test. We have information that they all share the same mother, but whether or not they share the same father is uncertain. In practice we would now need to test all the different combinations where two of the girls are full siblings and the third girl maternal half sibling to those two. However, Daisy further tells us that she is also certain that April and May shares the same father, Gladstone, while she is uncertain if he is also father of June or if another man, is the father (both are unavailable for testing). Compute the LR for the two relevant pedigrees (This part does not involve DNA data from Daisy).

Hypotheses:

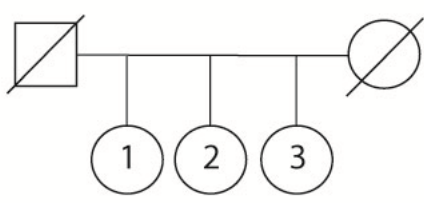


They both exist in
FamLinkX!

Exercise 4

Add DNA data

Basic hypothesis [Three Full Siblings]



<- Prev Close

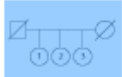
View data (Beta)

Marker	1. April	2. May	3. June	
Cluster1				
DXS10148	18, 25.1	18, 25.1	18, 25.1	
DXS10135	20, 21	20, 21	20, 21	
DXS8378	10, 11	10, 11	10, 11	
Cluster2				
DXS7132	13, 13	13, 13	13, 13	
DXS10079	19, 19	19, 19	19, 21	
DXS10074	16, 17	16, 17	16, 19	
Cluster3				
DXS10103	16, 17	16, 17	16, 17	
HPRTB	12, 12	12, 12	12, 12	
DXS10101	25.2, 27	25.2, 27	25.2, 27	
Cluster4				
DXS10146	27, 28	27, 28	27, 28	
DXS10134	34, 35.2	34, 35.2	34, 35	
DXS7423	14, 14	14, 14	14, 15	


Save Close

Exercise 4

Results



Three Full Siblings
LR (Exact):
1.63361e+007
LR (Cluster):
9.40977e+006
LR (LE):
1.52015e+006



Two Full Siblings
One Half Sibling...

Actions

Calculate

Simulate

Options

LR/Posterior

Scale

Set prior

View results

Save results

<- Prev

Close

Exercise 4

Results

Three Full Sib
LR (Exact): 1.

<- Prev

View data (Beta)

Marker	Accumulated LR	Marginal LR	Single
Cluster1			
DXS10148	12.8958	12.8958	
DXS10135	178.311	13.8271	
DXS8378	626.434	3.51315	
Cluster2			
DXS7132	3309.1	5.28244	
DXS10079	558.18	0.16868	
DXS10074	692.154	1.24002	
Cluster3			
DXS10103	6577.13	9.5024	
HPRTB	25915.6	3.94026	
DXS10101	1.84379e+007	711.46	
Cluster4			
DXS10146	2.40583e+008	13.0483	
DXS10134	1.70307e+007	0.0707891	
DXS7423	1.63361e+007	0.959219	
	1.62261e+007	1.62261e+007	6.64176

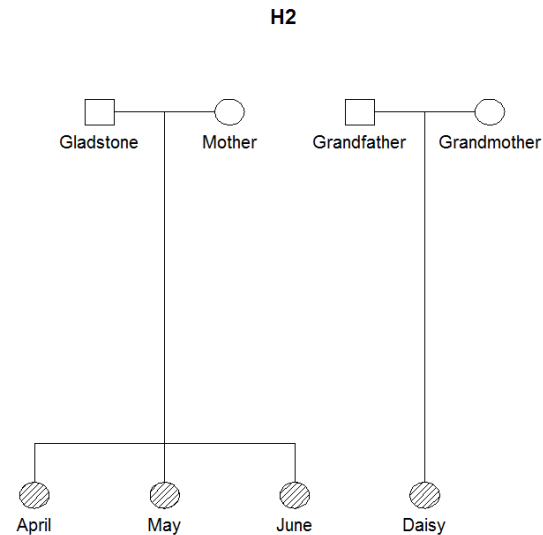
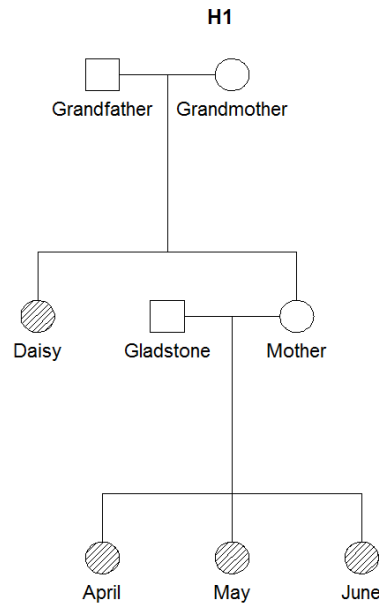
Save Close

Calculate
Simulate
R/Posterior
Scale
Set prior
View results
Save results

Exercise 4

- c) Assume the three girls are full siblings and construct the pedigree to test whether or not Daisy is their maternal aunt.

Hypotheses:



They do not exist in FamLinkX!

Exercise 4

Select basic hypothesis (Only one pedigree) X

Edit pedigree X

Add persons X

Name	Gender
Grandfather	Male
Grandmother	Female
Daisy	Female
Gladstone	Male
Mother	Female
April	Female
May	Female

Remove

Edit

Add person

Name

Gender ☐ Male ☒ Female

Add

gs

Close

Next ->

Create/Edit pedigree

Display full image

Import ped file

Exercise 4

Edit pedigree

H1

Parent	Child	
Grandfather	Daisy	
Grandmother	Daisy	
Mother	April	
Mother	May	
Mother	June	
Gladstone	April	
Gladstone	May	
Gladstone	June	
Grandfather	Mother	
Grandmother	Mother	

Remove

Edit

Copy relations

Persons

Add relation

Select parent... Select child... Add

«Known relations»

Exercise 4

Edit pedigree

H2

Parent	Child	
Grandfather	Daisy	
Grandmother	Daisy	
Mother	April	
Mother	May	
Mother	June	
Gladstone	April	
Gladstone	May	
Gladstone	June	

Remove

Edit

Copy relations

Persons

Add relation

Select parent... ▼ Select child... ▼ Add

Copy relations from H1

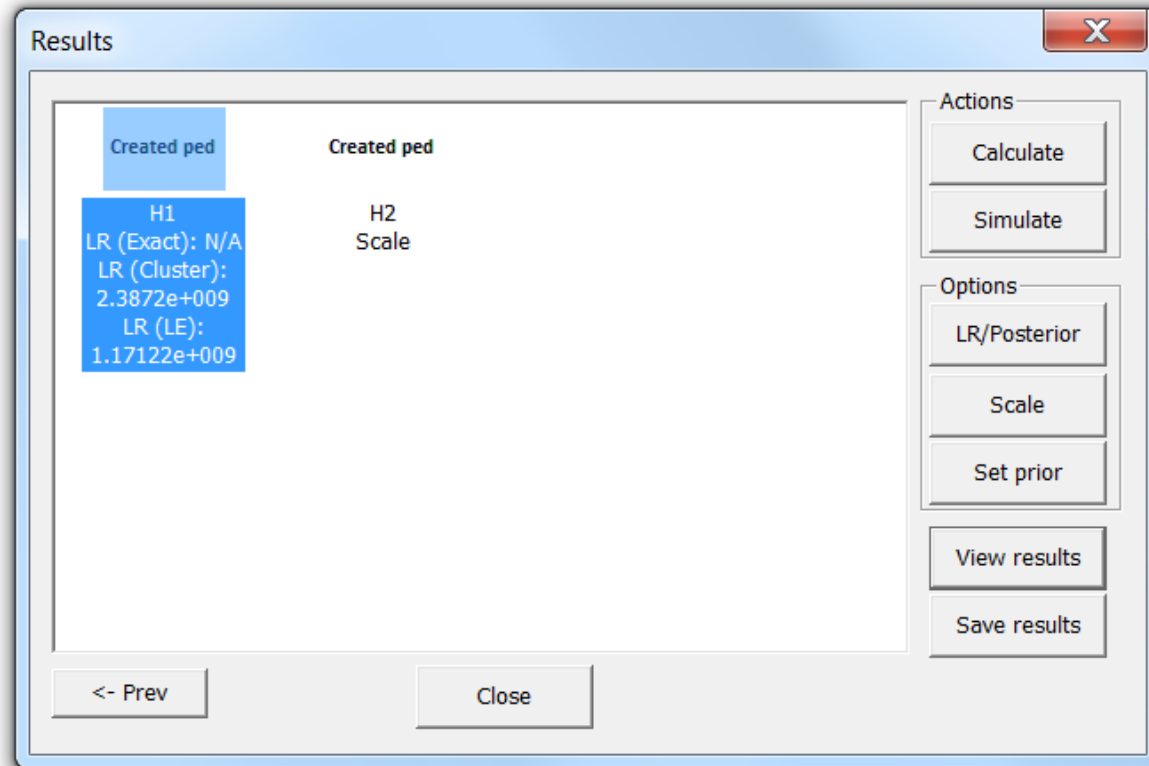
Exercise 4

View data (Beta) X

Marker	3. Daisy	6. April	7. May	8. June
Cluster1				
DXS10148	25.1, 25.1	18, 25.1	18, 25.1	18, 25.1
DXS10135	18, 21	20, 21	20, 21	20, 21
DXS8378	11, 13	10, 11	10, 11	10, 11
Cluster2				
DXS7132	12, 13	13, 13	13, 13	13, 13
DXS10079	19, 20	19, 19	19, 19	19, 21
DXS10074	17, 18	16, 17	16, 17	16, 19
Cluster3				
DXS10103	17, 20	16, 17	16, 17	16, 17
HPRTB	12, 12	12, 12	12, 12	12, 12
DXS10101	27, 30	25.2, 27	25.2, 27	25.2, 27
Cluster4				
DXS10146	28, 28	27, 28	27, 28	27, 28
DXS10134	35, 35.2	34, 35.2	34, 35.2	34, 35
DXS7423	14, 15	14, 14	14, 14	14, 15

Save Close

Exercise 4



Check created pedigree in report!

Exercise 4

Report generated by FamLinkX version 2.6

Reference 1: Kling D, Tillmar A, Egeland T, Mostad P. Int J Legal Med. 2015 Sep;129(5):943-54.

Reference 2: Kling D, Dell'Amico B Tillmar AO. Forensic Sci Int Genet. 2015 Jul;17:1-7.

Timestamp: Fri Aug 17 13:17:51 2018

Database: Duckburg

File: P:/Prosjekt/Italian2018/Solutions/Exercise4c.sav

Created pedigrees

Pedigree 1 : (H1)

Parent	Child
Grandfather	Daisy
Grandmother	Daisy
Mother	April
Mother	May
Mother	June
Gladstone	April
Gladstone	May
Gladstone	June
Grandfather	Mother
Grandmother	Mother



Workshop: Paternity and kinship testing including X-chromosomal markers

Cases: Part 2

Thore Egeland⁽¹⁾ and Daniel Kling⁽²⁾

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