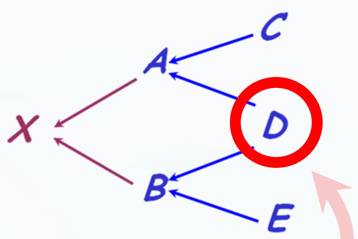
Inbreeding Coefficient

F



- Normally it is 0 (zero)

- If it is > 0, that means that an individual's parents have a common ancestor (i.e., they are related to each other!)

- The inbreeding coefficient of an individual is equal to ½ of the relationship between the two parents of the individual

- The Inbreeding Coefficient of "X" is defined as:

$$F_X = \tfrac{1}{2}(R_{X_M X_F})$$

= ½ of the relationship between X's Mother and X's Father

Rules for using the Tabular Method

to compute relationships

COMPLETE !

- Draw a box for the number of individuals involved
- Write down the individuals along the top from OLDEST to YOUNGEST as well as down the side
- Write down the parents of each individual on the top row (use 0 for any unknown parents)
- Put 1 in each *diagonal* cell. Then add ½ of any relationship that exists between the parents of the individual
- Finish each row by inserting ½ of each of the relationships between the individual and *each* of the other individual's parents
- Copy the value for R_{AB} to R_{BA} since the Table is symmetric

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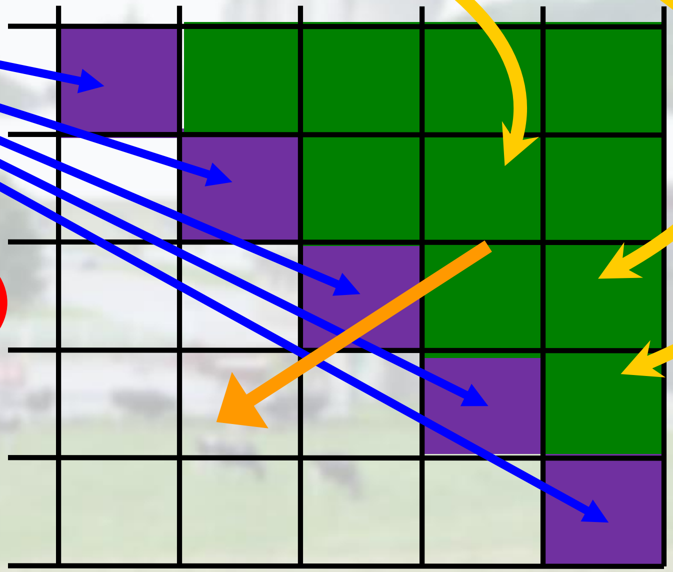
So, the "Three Rules" are...

A must be older than B
(or, at least, not younger)

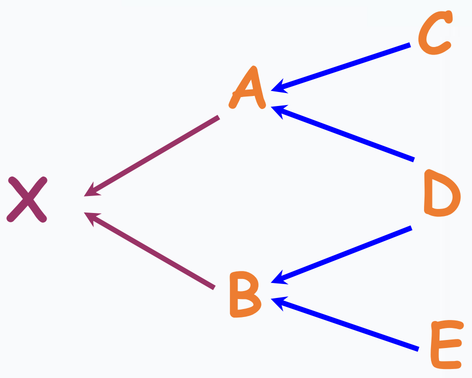
$$R_{AB} = \tfrac{1}{2}(R_{AB_M} + R_{AB_F})$$

$$R_{AA} = 1 + F_A$$

$$F_A = \tfrac{1}{2}(R_{A_M A_F})$$



"A" and "B" are two different "Individuals"
"M" = "Mother" and "F" = "Father"



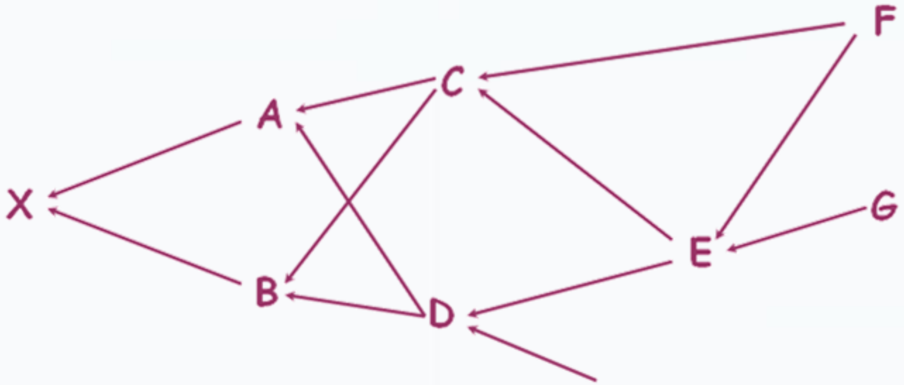
$$F_X = \tfrac{1}{2}(R_{X_M X_F})$$
$$= \tfrac{1}{2}(R_{AB})$$
$$= \tfrac{1}{2} \times \tfrac{1}{4} = 1/8$$

	0 0	0 0	0 0	D E	C D	A B
	E	**D**	**C**	**B**	**A**	**X**
E	1	0	0	$\frac{1}{2}$	0	$\frac{1}{4}$
D	0	1	0	$\frac{1}{2}$	$\frac{1}{2}$	$\frac{1}{2}$
C	0	0	1	0	$\frac{1}{2}$	$\frac{1}{4}$
B	$\frac{1}{2}$	$\frac{1}{2}$	0	1	$\frac{1}{4}$	$\frac{5}{8}$
A	0	$\frac{1}{2}$	$\frac{1}{2}$	$\frac{1}{4}$	1	$\frac{5}{8}$
X	$\frac{1}{4}$	$\frac{1}{2}$	$\frac{1}{4}$	$\frac{5}{8}$	$\frac{5}{8}$	$1\frac{1}{8}$

÷2

$R_{XX} = 1\ 1/8$ (i.e., "the whole box")

$F_X = 1/8$ (i.e., "the whole box" – 1)



Another Example...

$$R_{AB} = \tfrac{1}{2}(R_{AB_M} + R_{AB_F})$$

$$R_{AA} = 1 + \tfrac{1}{2}(R_{A_F A_M})$$

$$F_A = \tfrac{1}{2}(R_{A_F A_M})$$

	0 0	0 0	G F	E 0	F E	D C	D C	A B
	G	**F**	**E**	**D**	**C**	**B**	**A**	**X**
G	1	0	$\frac{1}{2}$	$\frac{1}{4}$	$\frac{1}{4}$	$\frac{1}{4}$	$\frac{1}{4}$	$\frac{1}{4}$
F	0	1	$\frac{1}{2}$	$\frac{1}{4}$	3/4	$\frac{1}{2}$	$\frac{1}{2}$	$\frac{1}{2}$
E	$\frac{1}{2}$	$\frac{1}{2}$	1	$\frac{1}{2}$	3/4	5/8	5/8	5/8
D	$\frac{1}{4}$	$\frac{1}{4}$	$\frac{1}{2}$	1	3/8	11/16	11/16	11/16
C	$\frac{1}{4}$	3/4	3/4	3/8	$1\frac{1}{4}$	13/16	13/16	13/16
B	$\frac{1}{4}$	$\frac{1}{2}$	5/8	11/16	13/16	1 3/16	3/4	31/32
A	$\frac{1}{4}$	$\frac{1}{2}$	5/8	11/16	13/16	3/4	1 3/16	31/32
X	$\frac{1}{4}$	$\frac{1}{2}$	5/8	11/16	13/16	31/32	31/32	1 3/8

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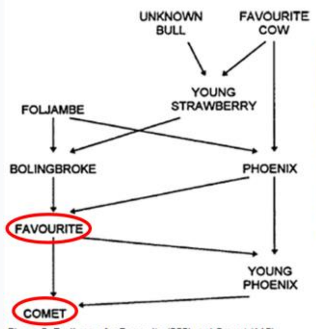
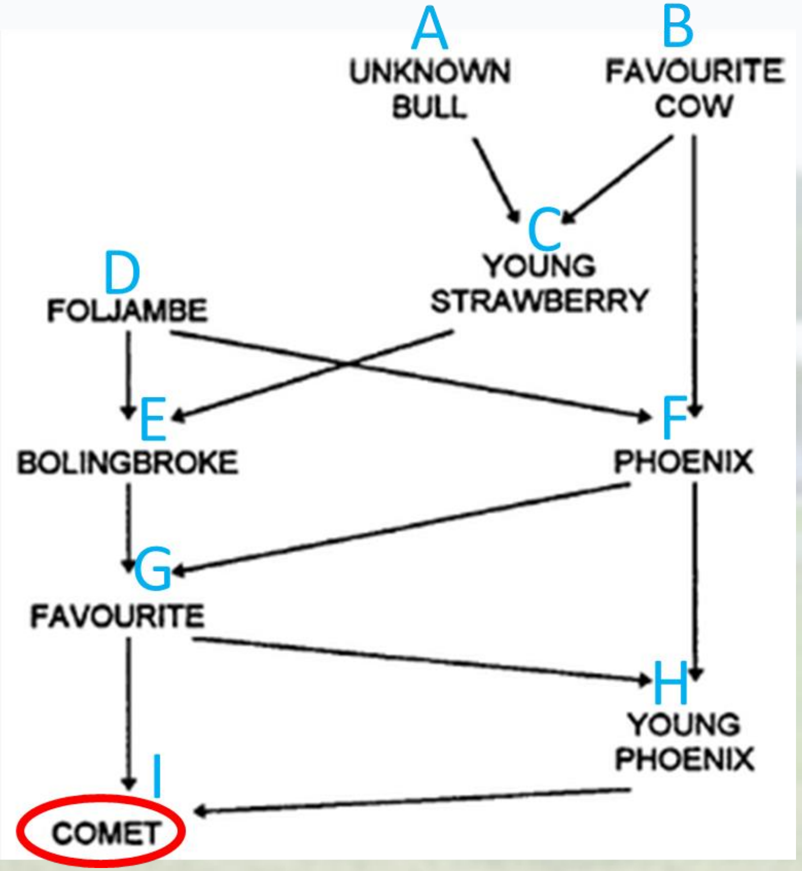


Figure 2. Pedigrees for Favourite (252) and Comet (115).

Figure 2 illustrates a portion of the pedigrees for two founding bulls for the Shorthorn breed, Favourite (252) and his son Comet (115). Both bulls are inbred. The parents of Comet share common ancestors (Favourite, Phoenix, Foljambe, Favourite Cow) in their known pedigree. The parents of Favourite share common ancestors, Foljambe and Favourite Cow. This diagram is a common format for examining inbreeding. The paths between the sire and dam of the individual of interest are used to calculate the inbreeding coefficient.



	0 0 A	0 0 B	A B C	0 0 D	C D E	B D F	E F G	F G H	G H I
A	1	0	½	0	¼	0	1/8	1/16	3/32
B	0	1	½	0	¼	½	3/8	7/16	13/32
C	½	½	1	0	½	¼	3/8	5/16	11/32
D	0	0	0	1	½	½	½	½	½
E	¼	¼	½	½	1	3/8	11/16	17/32	39/64
F	0	½	¼	½	3/8	1	11/16	27/32	49/64
G	1/8	3/8	3/8	½	11/16	11/16	1+ 3/16	15/16	1+ 1/16
H	1/16	7/16	5/16	½	17/32	27/32	15/16	1+ 11/32	1+ 9/64
I	3/32	13/32	11/32	½	39/64	49/64	1+ 1/16	1+ 9/64	1+ 15/32

Comet has an inbreeding coefficient of almost 47% !!

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Selection Systems

(1) Mass Selection

(Selection based on the individuals' <u>own</u> phenotype)

Natural Selection

Evolution

Survival of the fittest

Method of Selection

(Selection Systems)

Artificial Selection

Practiced by humans

"Best" animals mated together

Hardy-Weinberg ?

- It uses the individuals' *own* records and performance
- It's a good strategy when the trait has a *high* heritability
- It's good when the economic value can be determined *early* in the life of the animal
- It's good for traits that can be measured in both sexes
- The <u>*accuracy*</u> of *this method* of selection is equal to the square root of the heritability for that trait

$$\sqrt{h^2} \neq \boldsymbol{h} \text{ !!}$$

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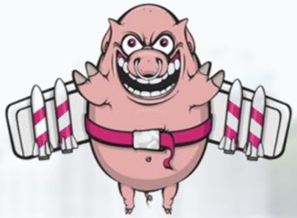
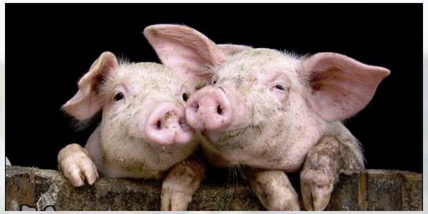
Selection Systems

(2) Pedigree Selection

(Selection based on the individual's <u>ancestors and current relatives</u>)

- Selection of an individual is based on the individual's pedigree (current or former relatives)
- It's based on the performance of *ancestors* and current *relatives* (***<u>but not progeny</u>***)
- It's useful for traits that are *not* measured on the individual when *alive* or traits that are expressed *late* in life
- It may be helpful to detect carriers of recessive genes
- It's generally complex and often has a low accuracy, *especially* if information on relatives is <u>missing</u>

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Selection Systems

(3) Progeny Selection

(Selection based on the individual's progeny)

- It uses the records of the individual's *progeny*
- It's a useful strategy when the trait has a moderate heritability
- It's good when the species has a high reproductive potential
- The accuracy can be very high, especially with many progeny
- Its disadvantage is cost and time required

  BUT it may often be worth it

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It may be useful to use all three together!

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How do we calculate the ***Accuracy*** of Genetic Progress (ΔG) ?

Genetic Progress for Quantitative Traits

Genetic Progress = ΔG ("delta G")

Increasing the frequencies of desired genes for a specific trait

It is "influenced" by 4 main factors

ΔG {
1. Heritability (h^2)
   (amount of phenotypic variation due to genetic variation)
2. Selection Differential (S)
   (how big a "risk" we are willing to take in choosing the parents)

3. Generation Interval (L)
   (the "waiting period")
4. Accuracy of Prediction (A)
   (our confidence in our ability to choose better animals *precisely*)

- Accuracy is the amount of agreement between how well we predict that the animal will perform, and how well it *actually* does
- It ranges between 0 and 1 (or 100%)
  - 0 when we guess!
  - 1 when we predict perfectly
- It's affected by the ***heritability*** of the trait in question
- It's affected by the ***number of observations*** available
- It's affected by the quantity of information available on relatives of the animal being evaluated
- It's affected by the Method of Selection.

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Examples of *Accuracy* for different situations

Really Important Slide !!

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Method of Selection	Examples of different h^2		
	0.10	0.30	0.50
Mass Selection using Individuals' records	0.316	0.548	0.707
Pedigree Selection: Example using only records of 2 Parents and 4 Grandparents	0.265	0.434	0.534
Progeny Test Selection			
1 Progeny	0.158	0.274	0.354
5 Progeny	0.337	0.537	0.646
10 Progeny	0.452	0.669	0.767
50 Progeny	0.749	0.896	0.937
100 Progeny	0.848	0.944	0.967

You don't need to know how to calculate these numbers ! EXCEPT for…

?

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