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The genetics of growth to maturity in commercial sheep

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Motivation

- Mature weight is an important feature of sheep production - feed requirements
  - environmental emissions
- Modelling growth to maturity may provide useful early indications of mature weight
- Appropriate genetic parameters required

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Data set

1,390 ewes from a single flock born over a 13-year period

Weight recorded at birth, 6, 16 weeks then annually at mating, lambing and weaning

Two datasets analysed

- All available weights
- Lamb plus mating weights

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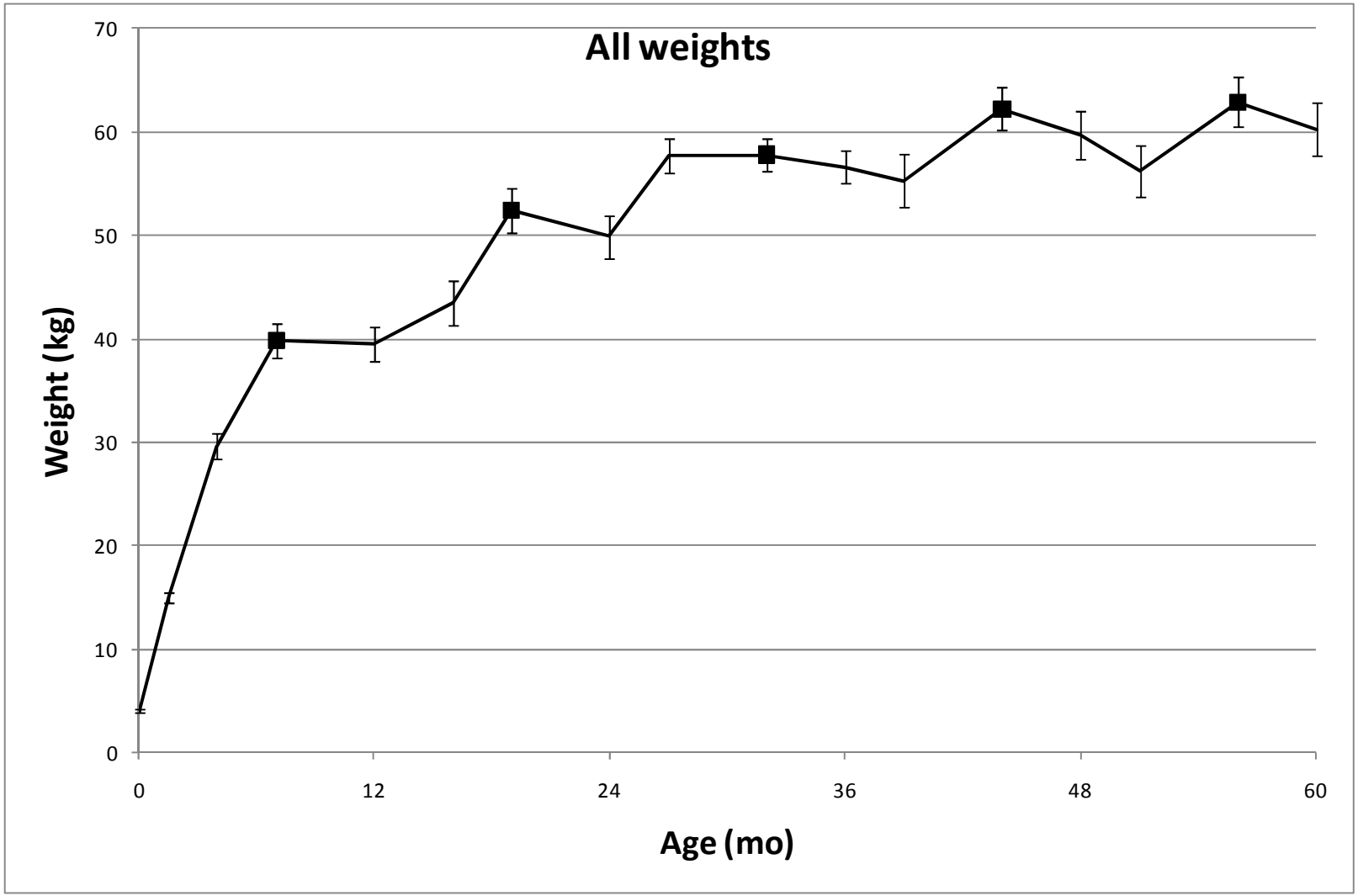
Overall growth curve of ewes - 1



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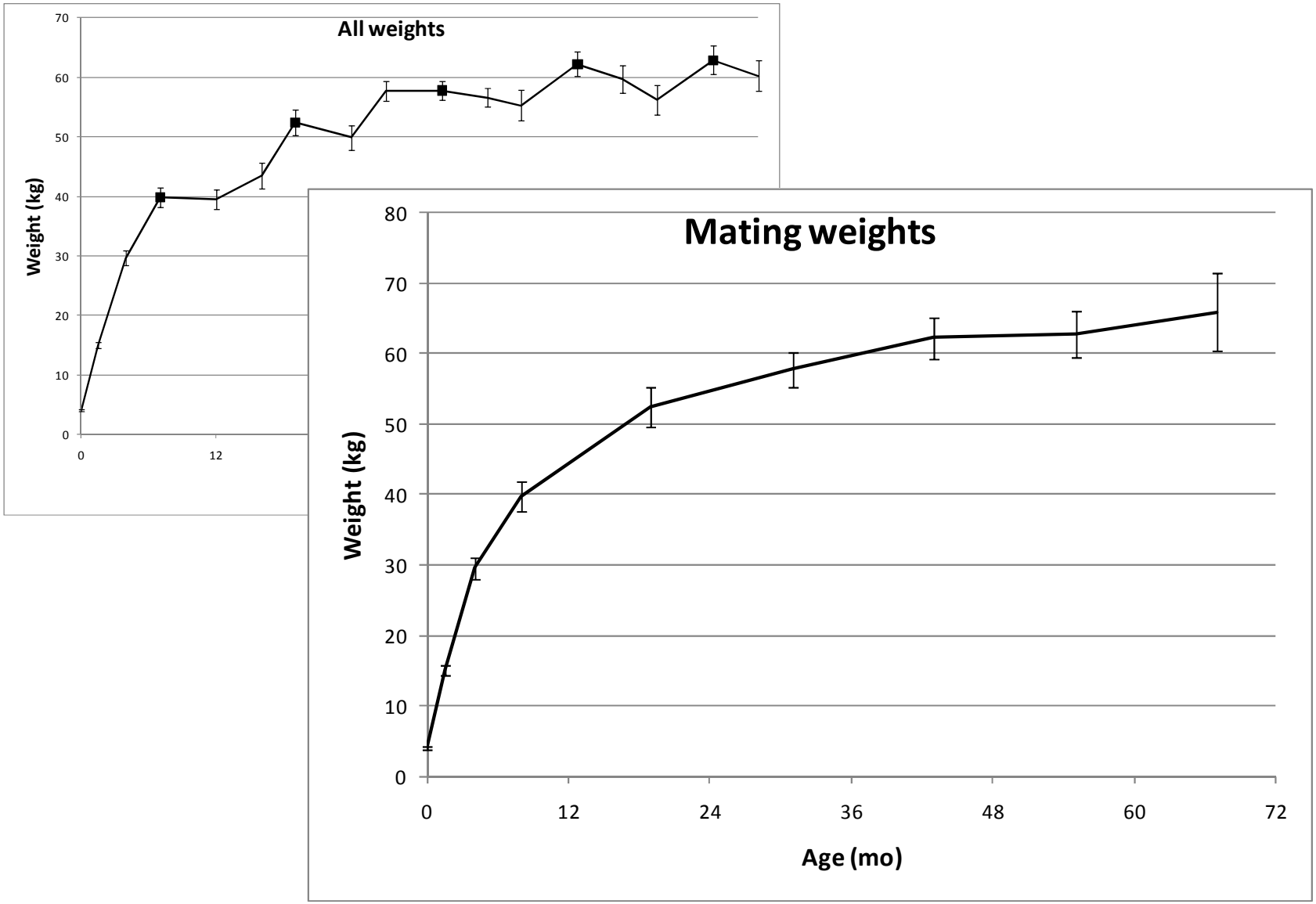
Overall growth curve of ewes - 2



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Modelling growth to maturity

Previous work (Pollott and Galea, 2010a and b)

- Models commonly applied to lamb growth not appropriate (Gompertz, Brody, Logistic, polynomial)

- Hill model and 2-knot spline had lower mean RMS

- Standardised data could be used to fit random regressions for growth to maturity and estimate genetic parameters of live weight

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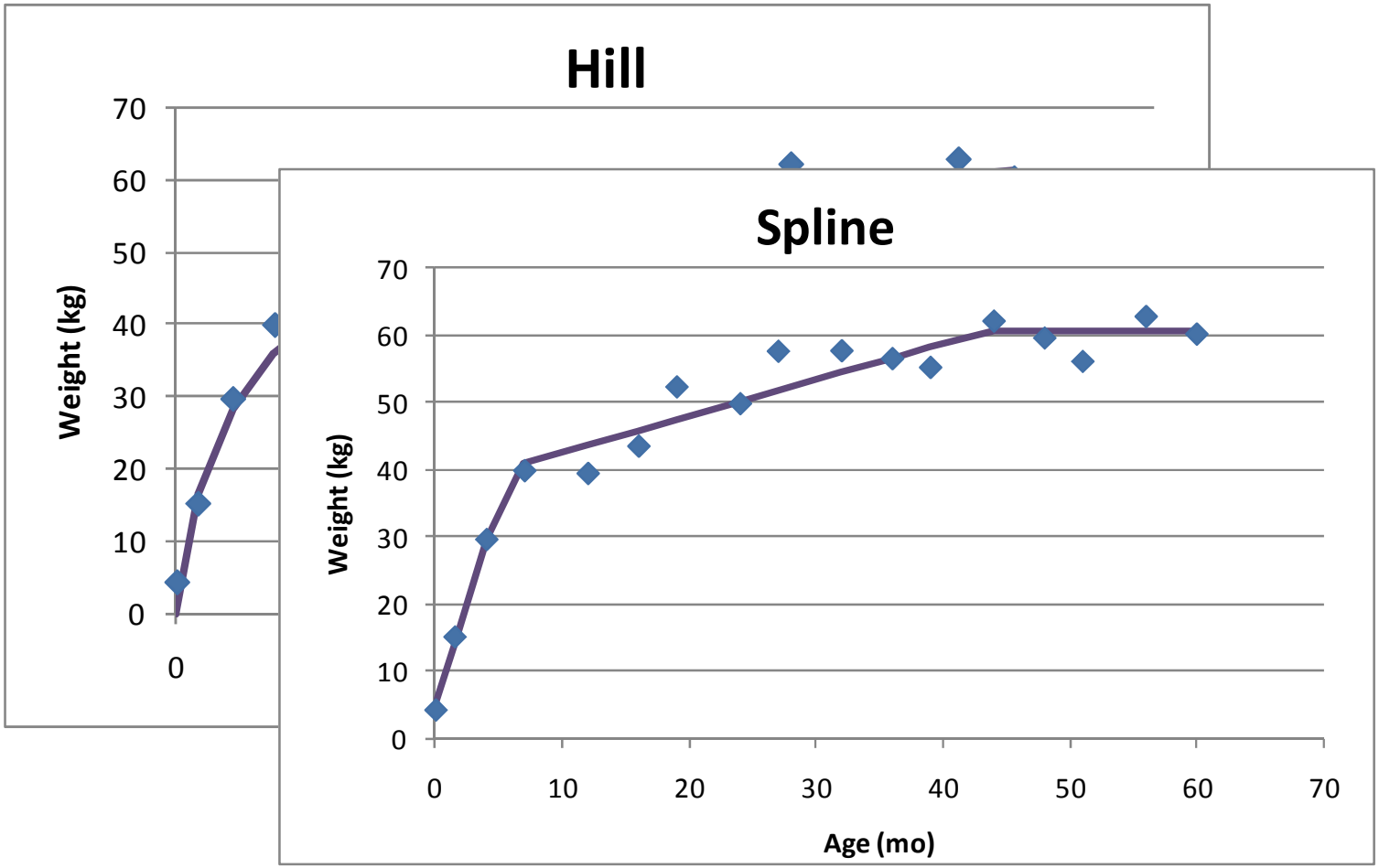
Model fit – all mean data



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Alternative growth models

Hill

$$\text{Weight} = (MWT_{EST}\ t^{b1}) / (b_2^{b1} + t^{b1})$$

b1 – shape parameter; b_2 – maturing rate parameter

Spline

$$\text{Weight} = MWT - [b_4\ (knot - 6)] - [b_3\ (6 - t)]$$

$$\text{or} \quad MWT - [b_4\ (knot - t)] \text{ when } t > 6 < knot$$

where MWT = mature weight; t = age (months) and $b_1 - b_4$ are constants

SAS NLIN used to fit individual ewe curves

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Model effects used

Fixed effects

Year of birth (13), Birth type (3), Age of dam (7)

Random effects

Ewe – (additive genetic effect)

Residual

Not maternal effect – not enough daughters

ASReml used for all genetic analyses

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Results

Genetic parameters – Hill curve
All weights

$$\text{Weight} = (MWT_{EST}\ t^{b1}) / (b_2^{b1} + t^{b1})$$

	MWT	MWT_{EST}	b_1	b_2
Actual mature weight (MWT)	**0.40 ±0.087**	0.91 ±0.052	0.03 ±0.928	0.44 ±0.197
Estimated mature weight (MWT_{EST})	0.77 ±0.015	**0.23 ±0.081**	0.25 ±1.52	0.76 ±0.101
b_1	-0.08 ±0.037	-0.11 ±0.036	**0.01 ±0.052**	NA
b_2	0.37 ±0.033	0.83 ±0.012	-0.04 ±0.036	**0.40 ±0.087**

b_1 – shape parameter; b_2 – maturing rate parameter

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Genetic parameters – Hill curve Mating weights

Weight = $(MWT_{EST}\ t^{b1}) / (b_2^{b1} + t^{b1})$

	MWT	MWT_{EST}	b_1	b_2
Actual mature weight (MWT)	**0.43 ±0.096**	0.92 ±0.045	-0.29 ±0.178	0.62 ±0.179
Estimated mature weight (MWT_{EST})	0.80 ±0.015	**0.33 ±0.090**	-0.64 ±0.122	0.90 ±0.063
b_1	-0.40 ±0.035	-0.65 ±0.024	**0.26 ±0.075**	-0.92 ±0.098
b_2	0.37 ±0.035	0.83 ±0.012	-0.64 ±0.023	**0.20 ±0.081**

b_1 – shape parameter; b_2 – maturing rate parameter

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Genetic parameters – Spline model
All weights

Weight = MWT – [b_4 (knot - 6)] – [b_3 (6 – t)] when t < 6
or MWT – [b_4 (knot – t)] when t > 6 < knot

	MWT	b_3	b_4
Mature weight (MWT)	**0.43 ±0.089**	0.56 ±0.149	0.51 ±0.367
b_3	0.25 ±0.037	**0.29 ±0.080**	-0.65 ±0.291
b_4	0.14 ±0.037	-0.39 ±0.031	**0.07 ±0.063**

b_3 – early growth rate; b_4 – late growth rate

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Genetic parameters – Spline model
Mating weights

$$\text{Weight} = \text{MWT} - [b_4 (44 - 6)] - [b_3 (6 - t)] \quad \text{when } t < 6$$
$$\text{or} \quad \text{MWT} - [b_4 (44 - t)] \quad \text{when } t > 6 < 44$$

	MWT	b_3	b_4
Mature weight (MWT)	**0.43 ±0.089**	0.53 ±0.145	0.53 ±0.274
b_3	0.34 ±0.037	**0.29 ±0.080**	-0.46 ±0.297
b_4	0.23 ±0.038	-0.32 ±0.035	**0.07 ±0.063**

b_3 – early growth rate; b_4 – late growth rate

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Discussion points

Hill curve gives more tractable results with mating weights dataset

Spline model results almost invariant to dataset used

Early growth more heritable than later growth

Mature weight related to both early and late growth rates – but growth rates negatively correlated

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Conclusions

Growth to maturity has different genetic properties to lamb growth

Early growth and mature weight moderately correlated

Both sets of curve parameters are heritable

Hill curve parameters highly correlated

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Thank you for your attention

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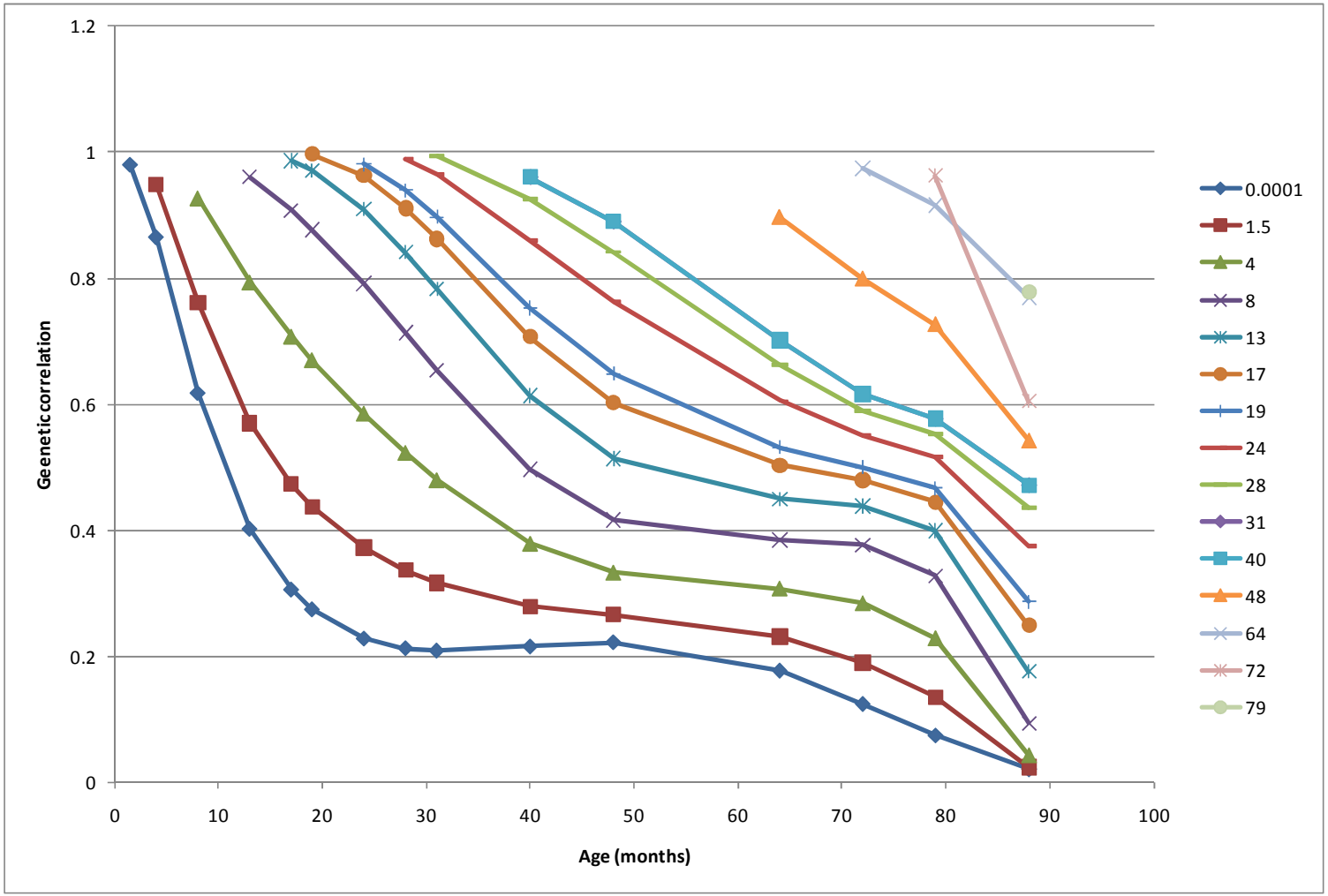
Genetic correlation structure from random regression model



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