Matrices in biology / genetics:

[i] first use a punnet square to find the possibility of the offspring having - for example - a certain eye colour from different combinations of genotype.

AA = brown eyes

Aa = brown eyes the A allele is dominant

aa = blue eyes

Aa and Aa

	A	a
A	AA	Aa
a	Aa	aa

Aa and aa

	a	a
A	Aa	Aa
a	aa	aa

AA and Aa

	A	a
A	AA	Aa
A	AA	Aa

Parents genotype:	offspring genotypes: Aa	AA	aa
Aa and Aa	1/2	1/4	1/4
Aa and aa	1/2	0	1/2
AA and Aa	1/2	1/2	0

Then can form a matrix:

$$A = \begin{matrix} \text{Aa} & \text{AA} & \text{aa} \end{matrix} \begin{pmatrix} 1/2 & 1/4 & 1/4 \\ 1/2 & 0 & 1/2 \\ 1/2 & 1/2 & 0 \end{pmatrix} \begin{matrix} \longrightarrow \text{Aa and Aa} \\ \longrightarrow \text{Aa and aa} \\ \longrightarrow \text{AA and Aa} \end{matrix}$$

each ROW of the matrix represents a combination of the parents genotypes. Here, 3 combinations have been used all including Aa.

each COLUMN of the matrix then represents the possible offspring genotypes; Aa, aa, AA.

Next you find out the population distribution; how much of each genotype is present in the population. If they were equally distributed, then the initial distribution vector would be;

$$\vec{x}_0 = \begin{pmatrix} 1/3 \\ 1/3 \\ 1/3 \end{pmatrix}$$

distribution of genotypes one year later would be;

$$\vec{x}_0 \times A = \begin{pmatrix} 1/3 \\ 1/3 \\ 1/3 \end{pmatrix} \begin{pmatrix} 1/2 & 1/4 & 1/4 \\ 1/2 & 0 & 1/2 \\ 1/2 & 1/2 & 0 \end{pmatrix}$$ (multiplication by a column matrix)

$$= \begin{pmatrix} 1/3 \times 1/2 + 1/3 \times 1/4 + 1/3 \times 1/4 \\ 1/3 \times 1/2 + 1/3 \times 0 + 1/3 \times 1/2 \\ 1/3 \times 1/2 + 1/3 \times 1/2 + 1/3 \times 0 \end{pmatrix} = A\vec{x}_0 = \begin{pmatrix} 1/3(1/2 + 1/4 + 1/2) \\ 1/3(1/2 + 1/2) \\ 1/3(1/2 + 1/2) \end{pmatrix}$$

can use this to determine the distribution for any positive number of years later.

→ as time goes on, distribution will move towards a population of just one genotype, AA, because it has 2 dominant alleles.

[2] Linus to further use of a 'trihybrid cross' of 3 traits. This is an 8x8 matrix or punnett square. The 8x8 trihybrid cross matrix gives the same result as 3 punnet squares of monohybrid cross for the same 3 traits. (maternal + paternal gametes used for each trait)

- dyadic-shift decomposition can turn an 8x8 punnet square into an 8x8 sparse matrix (which contains very few non-zero elements)

Theres also the well-known 8x8 genomatrix which contains all 64 triplets of the bases A, T, C, G that code for 20 amino acids and stop sequences.

[1] https://applicationanthology516.wordpress.com/2016/02/13/matrices-genetics/

[2] Sergey V. Petoukhov, Neuroquantology, 9, 799-803, 2011.