

# GWAS model **extensions**

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# GWAS for other **gene actions**



# Additive coding

Genotype	101 coding	012 coding	Centered coding
BB	$-a_i$	0	$-2p_i a_i$
Bb	0	$a_i$	$(1-2p_i)a_i$
bb	$a_i$	$2a_i$	$(2-2p_i)a_i$

## EXAMPLE

*aa Bb*

*AA bb*

*Aa bb*

*aa bb*

$$\text{101 coding: } \mathbf{Za} = \begin{pmatrix} -1 & 0 \\ 1 & -1 \\ 0 & -1 \\ -1 & -1 \end{pmatrix} \begin{pmatrix} a_1 \\ a_2 \end{pmatrix}$$

$$\text{012 coding: } \mathbf{Za} = \begin{pmatrix} 0 & 1 \\ 2 & 0 \\ 1 & 0 \\ 0 & 0 \end{pmatrix} \begin{pmatrix} a_1 \\ a_2 \end{pmatrix}$$

$$\text{centered coding: } \mathbf{Za} = \begin{pmatrix} -0.75 & 0.75 \\ 1.25 & -0.25 \\ 0.25 & -0.25 \\ -0.75 & -0.25 \end{pmatrix} \begin{pmatrix} a_1 \\ a_2 \end{pmatrix} \quad p_1=0.375; p_2=0.125;$$

# Dominance coding

Genotype	010 coding	012 coding (optional additive)	Centered coding
BB	0	0	$-2p_i^2 d_i$
Bb	$d_i$	$a_i$	$2p_i q_i d_i$
bb	0	$2a_i$	$2q_i d_i$

**EXAMPLE**

101 coding

*aa Bb*

*AA bb*

*Aa bb*

*aa bb*

$$Zd = \begin{pmatrix} 0 & 1 \\ 0 & 0 \\ 1 & 0 \\ 0 & 0 \end{pmatrix}$$

Centered coding

$$Zd = \begin{pmatrix} 0.78 & 0.22 \\ -0.28 & 1.53 \\ 0.47 & 1.53 \\ 0.78 & 1.53 \end{pmatrix}$$

$$p_1=0.375; p_2=0.125;$$

# A#A Epistasis coding

Genotype 1	AA (0)	Aa (1)	aa (2)
BB (0)	00	01	02
Bb (1)	10	11	12
bb (2)	20	21	22

## CAUTION

This codification does not necessary keep linearity (covariates is not recommended, use factors, or separate 3 gene interactions ( $x_1=\{00,01,02\}; x_2=\{10,11,12\}; x_3=\{20,21,22\}$ ))

*Centered coding is also possible with appropriate products*



# A#D Epistasis coding

Genotype 1	AA (0)	Aa (1)	aa (0)
BB (0)	00	01	00
Bb (1)	10	11	10
bb (2)	20	21	20

## CAUTION

This codification does not necessary keep linearity (covariates is not recommended, use factors, or separate 3 gene interactions ( $x_1=\{00,01,00\}$ ;  $x_2=\{10,11,10\}$ ;  $x_3=\{20,21,20\}$ ))



# D#D Epistasis coding

Genotype 1	AA (0)	Aa (1)	aa (0)
BB (0)	00	01	00
Bb (1)	10	11	10
bb (0)	00	01	00

## CAUTION

This codification does not necessary keep linearity (covariates is not recommended, use factors, or separate 3 gene interactions ( $x_1=\{00,01,00\}$ ;  $x_2=\{10,11,10\}$ ;  $x_3=\{00,01,00\}$ ))



# Other additive codifications (A#A#A, A#D#A, ...)

- Just follow the same rationale



# Genotype x Environment coding

Genotype 1	Treatment (T1)	Control
BB (0)	T_0	C_0
Bb (1)	T_1	C_1
bb (2)	T_1	C_2

## CAUTION

This codification does not necessary keep linearity (covariates is not recommended, use factors, or separate 2 covariates ( $x_1=\{T0,T1,T2\}$ ;  $x_2=\{C0,C1,C2\}$ )

*Centered coding is also possible with appropriate products*

# Genotype x Environment coding

