A practical introduction to Genome-Wide Association Studies applied to plants

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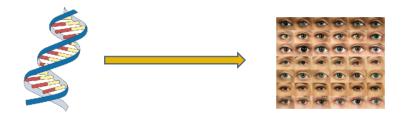
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August 28, 2020

Methods

- ► Genome-Wide Association Studies (GWAS)
- ► Genomic Selection (GS)

Genotype and Phenotype

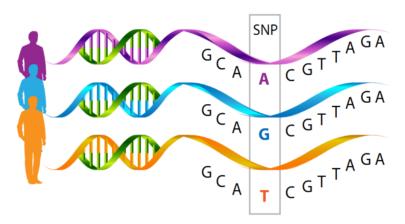


Genotypes are the genetic make-up of an individual⁵.

Phenotypes are the physical traits and characteristics of an individual and are influenced by their genotype and the environment⁶.

Single nucleotide polymorphisms (SNPs)

- ► The most common type of genetic variation among people.
- It is a substitution of a single nucleotide that occurs at a specific position in the genome



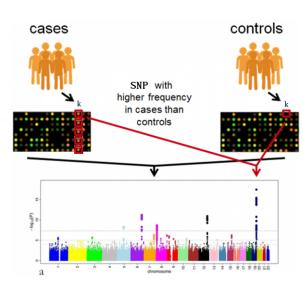
SNPs in Whole Genomes

<u>Plant</u>	Sequence
1	GAATTCCGCAATGCAGGTTAAGAGCTCTGTGAAAGAGGAAAACGAAAAAC
2	GAATTCCGCAATGCAGGTTAAGAGCTCTGTGAAAGAGGAAAACGAAAAAC
3	GAATTCCGCAATGCAGGTTAAGAGCTCTGTGAAAGAGGAAAACGAAAAAC
4	GAATTCCGCAATGCAGGTTAAGAGCTTTGTGAAAGAGGAAAAACGAAAAAC
5	GAATTCCGCAATGCAGGTTAAGAGCTCTGTGAAAGAGGAAAACGAAAAAC
6	GAATTCCGCAATGCAGGTTAAGAGCTCTGTGAAAGAGGAAAACGAAAAAC
7	GAATTCCGCAATGCAGGTTAAGAGCTTTGTGAAAGAGGAAAAACGAAAAAC
8	GAATTCCGCAATGCAGGTTAAGAGCTCTGTGAAAGAGGAAAACGAAAAAC

GWAS: Genome-Wide Association Studies

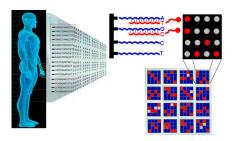
An approach used in genetics research to associate specific genetic variations (SNPs) with particular traits (e.g. diseases, agronomic trait).

GWAS involves scanning the genomes from many different people and looking for SNPs that can be used to predict the presence of a disease.

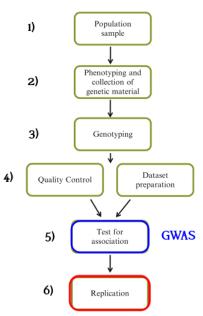


SNP-chips (DNA microarray)

The DNA microarray is a tool used to determine whether the DNA from a particular individual contains a mutation in genes



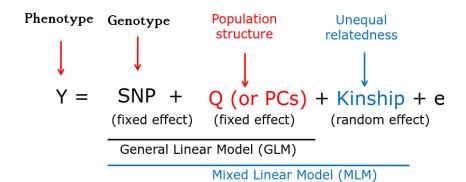
WGAS Process



GWAS Methods (Methods for test associations)

- Linear Models
- ► Linear Regression
- Logistic Regresion
- Linear Mixed Models
- Bayesian Mixed Models

Linear Mixed Model

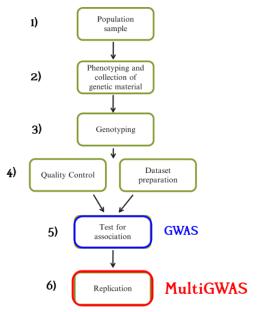


Genomic Data Tetraploid Potato

- Example of tetraploid potato (Four set of chromosomes):
- ► Humans are diploids (Father and Mother)

Pheno	Genotype							
	agrosavia-genotype-checked-tetra-ACGT.csv						Y A X	
Name example-phenoty	tuber shape	Markers	Chrom	Position	And_292	And_454	And_579	_And_
A97066-42	4.71	c1_1	11	33993379	TTTT	TTTT	CTTT	CTTT
ACBrador		c1_10000	8	45242018	GGGG	GGGG	GGGG	GGGA
	3.59	c1_10001	8	45239915	TTTT	TTTT	TTTT	ATTT
AdirondackBlue	4.07	c1_10011	8	45147009	GGGG	GGGG	GGGG	GGAA
AF2291-10	2.81	c1_10012	8	45146936	TTTT	TTTT	TTTT	CCTT
AF2376-5	2.81	c1_10020	8	45145834	AAAA	AAAA	AAAA	AAAA
AF2574-1	3.73	c1_10031	8	45539006	TTTT	CTTT	CTTT	CCCT
AllBlue	4.73	c1_10042	6	1438051	TTTT	TTTT	TTTT	TTTT
AlpineRusset	4.85	c1_10050	13	42295148	TTTT	CTTT	TTTT	TTTT
Alturas	4.46	c1_10054	13	45972706	cccc	cccc	cccc	cccc
Andover	2.54	c1_10069	12	2259927	GGGG	GGGG	GGGA	GGAA
A096141-3	5	c1_10109		49795337	CCTT	CTTT	CTTT	CCCT
A096160-3	5	c1_10130	7	49910701	NA	CCCT	cccc	CCCT
A096164-1	5	c1_10144	12	10767532	cccc	CCCC	CCCT	cccc
Atlantic	2.41	c1_10178	5	70199242	AAAA	AAAA	GGAA	GGAA
AWN86514-2	4.46	c1 10180	5	70199444	AAAA	AAAA	AAAA	AAAA
B1829-5	2.68	c1 10181	5	70200587	TTTT	TITI	TTTT	TTTT
BannockRusset	4.86	c1 1019	10	348392	cccc	cccc	cccc	cccc
BeaconChipper	2.54	c1 1020	10	348287	GGAA	GAAA	GGGA	GAAA
Bintje	4.07	c1 10202	1.5	70396887	I CCCC	I CCCA	I CAAA	CCCA
exampl KEY RESIZE	187 rows			ecked-tetra-A		BUTTON1 REL		605 row

MultiGWAS: a tool for integrating multiple GWAS tools



Popular Tools for GWAS analysis

1. **GWASP**oly

Relatively new R library for GWAS in polyploid.

2. PLINK:

- Popular Program for GWAS in diploids
- Mainly used in humans.

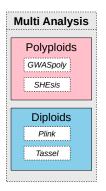
3. TASSEL:

- Popular Java Package and program for GWAS in diploids
- Mainly use in plants.

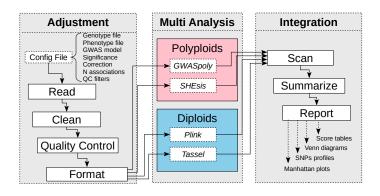
4. SHEsis:

Simple Program for GWAS analysis in polyploids.

MulitiGWAS: A tools for GWAS analysis integrating four GWAS tools



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MultiGWAS outputs

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file:///home/lg/agrosavia/docs/presentations/
biomedicine/multiGWAS-report.html
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What next?

► Genomic Selection