



UNIVERSITÀ
DEGLI STUDI
DI PADOVA

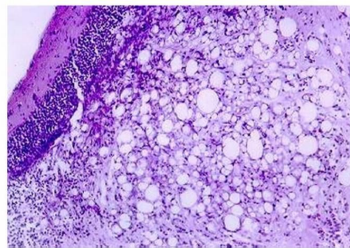
Random subsampling techniques for sea bass mortality prediction

Giovanni Gaio, Simone Moretti

July 24, 2025

1. Introduction
2. Methodology
 - Datasets description
 - Subsampling techniques
3. Results
 - Uniform subsampling
 - Uniform over chromosomes
 - Annotated subsampling
4. Conclusions

Viral nervous necrosis (VNN) is a highly spread disease among sealife.

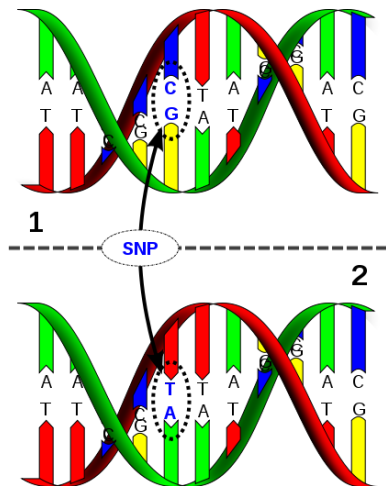


We concentrate our efforts on predicting the mortality of a population of **sea basses** affected by VNN.

SNPs for predicting mortality



UNIVERSITÀ
DEGLI STUDI
DI PADOVA



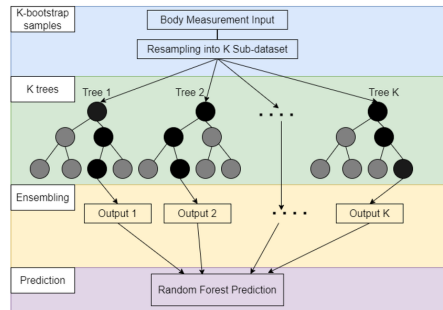
The **genome** might be useful to predict mortality.

SNPs: Single nucleotide polymorphisms.

dmlc
XGBoost

Predict if a sea bass will die by watching its genome: **Machine Learning**.

In particular, we use the **XGBoost** classifier.



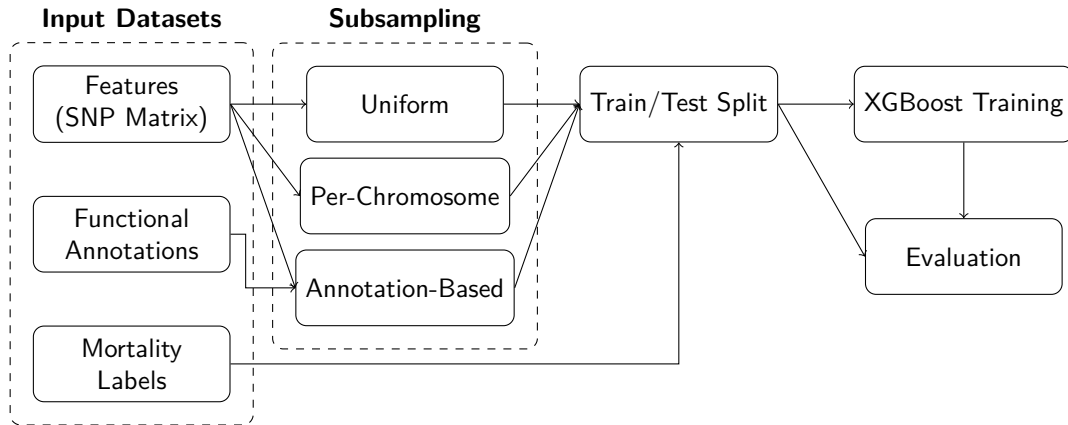
- Each fish: over **6 million** SNP positions.
- Sample size: only **990** sea bass individuals.
- Traditional models may **overfit** due to high dimensionality.
- We mitigate through **subsampling**.

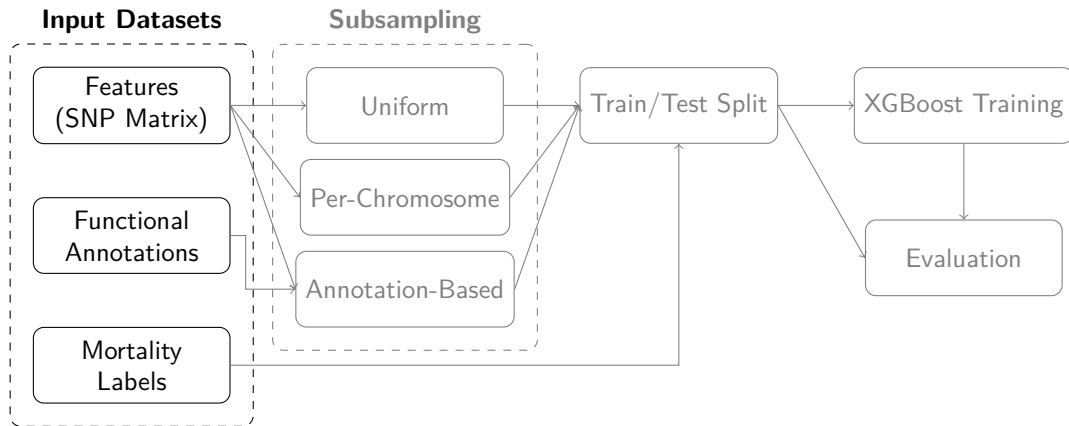


Pipeline Overview



UNIVERSITÀ
DEGLI STUDI
DI PADOVA





SNP Dataset Structure



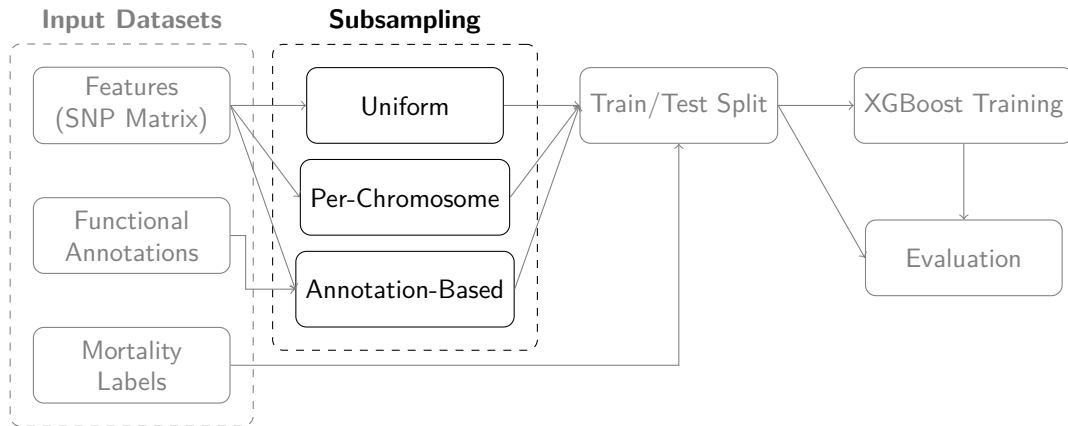
- 990 rows (fish), each with 6,072,853 SNP features.
- SNP values: 0 (no mutation), 1 (heterozygous), 2 (homozygous alt).
- Each fish is paired with a mortality label.

id	mortality
PL06-B12	1
PL06-B06	1
PL06-E06	1
PL08n-B05	0
PL08n-G09	0
⋮	⋮

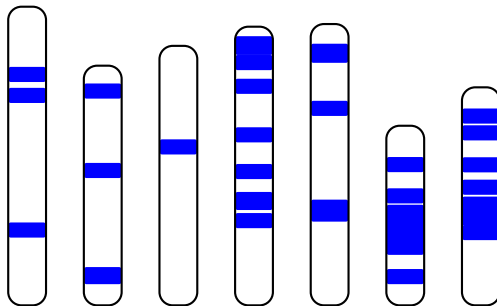
	CAJNNU010000001.1:299	CAJNNU010000001.1:903	CAJNNU010000001.1:986	...
PL04-A06	1	0	0	...
PL04-A08	0	0	1	...
PL04-A09	0	1	1	...
PL04-A10	0	0	0	...
PL04-A11	2	2	1	...
⋮	⋮	⋮	⋮	⋮

- Annotations include function: Promoter, Enhancer, Open Chromatin.
- Tissue number (0–25) indicates location-specific relevance.

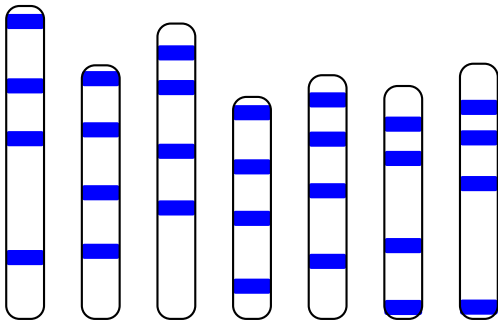
snp_id	funct	n_tissue
CAJNNU010000001.1:7825	Open_chromatin	10
CAJNNU010000001.1:7865	Open_chromatin	4
CAJNNU010000001.1:8046	Enhancer	21
CAJNNU010000001.1:8084	Open_chromatin	5
CAJNNU010000001.1:8116	Promoter	12
⋮	⋮	⋮



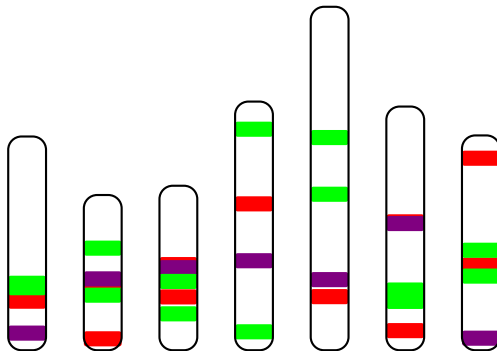
- Randomly sample a fixed proportion p of all SNPs.
- Simple but may cause imbalance across chromosomes.

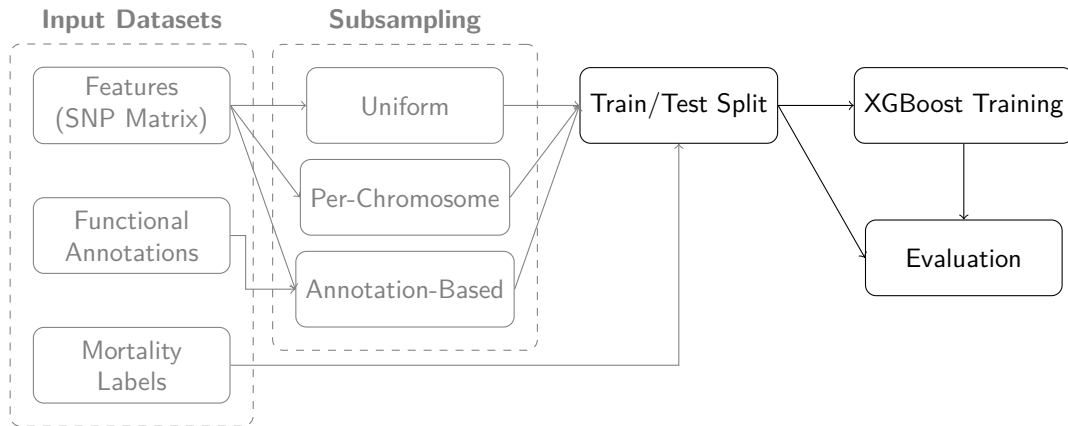


- Ensures balanced representation from each chromosome.
- Randomly sample same number of SNPs per chromosome.



- Filter SNPs by biological annotation.
- Then apply uniform subsampling to relevant regions.





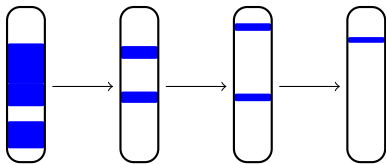
Let's get to the substance



UNIVERSITÀ
DEGLI STUDI
DI PADOVA



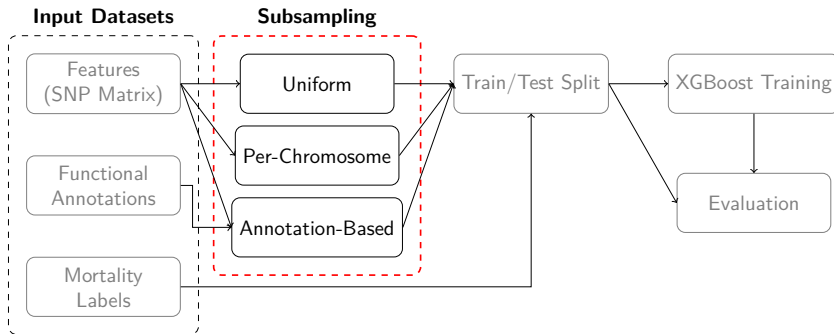
- Subsampled with multiple subsampling ratio values: log-spaced varying from the whole genome to few SNPs.



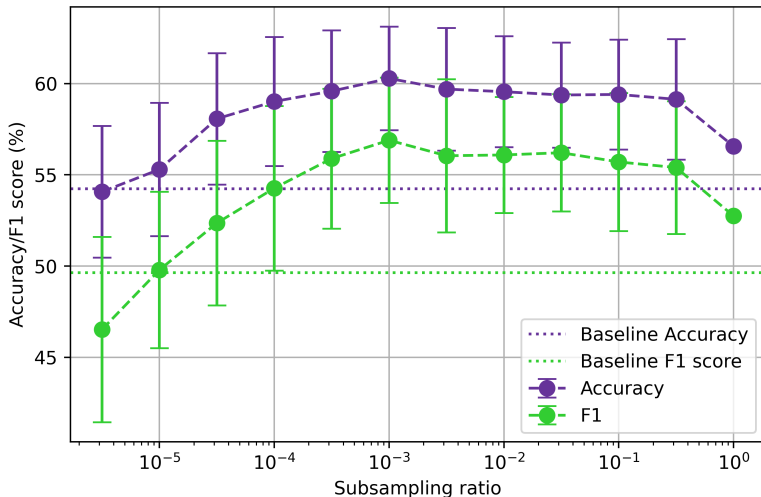
- Trained model for each combination of model and subsample rate.
- Multiple runs for each pair of parameters.
- Comparison with **baseline results** from a "dumb" classifier, always guessing the most common class.

In order to limit the variance of results we impose:

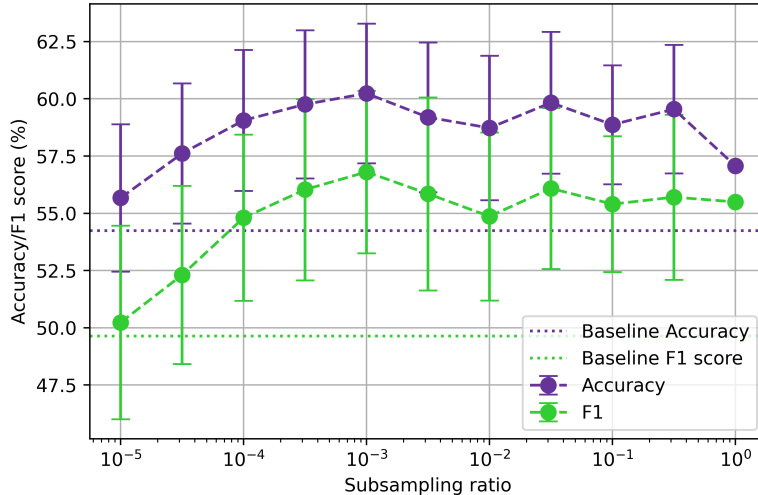
- XGBoost random seed and train-test split are fixed.
- Subsampling is the only random component varying between experiments.



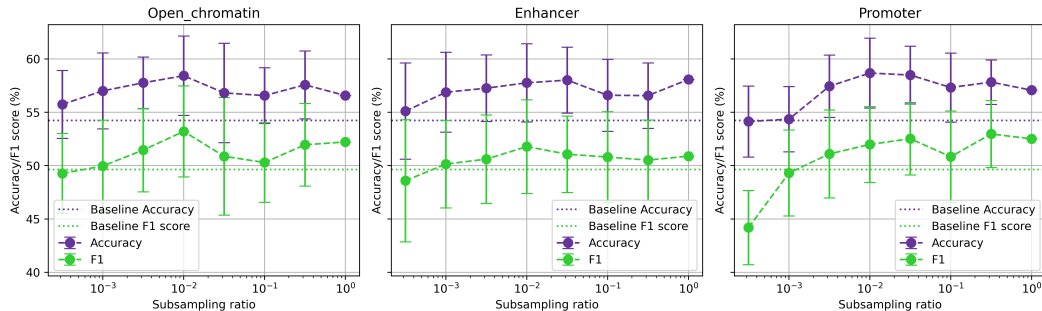
Results: uniform subsampling



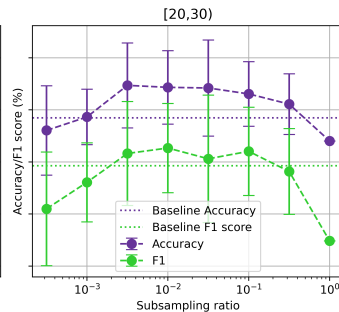
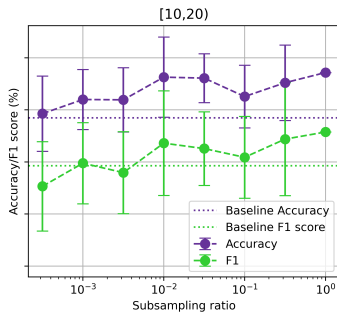
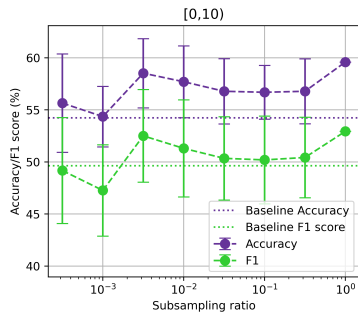
Results: subsampling uniformly on chromosomes



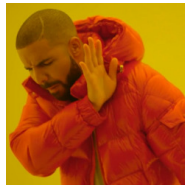
Results: annotated subsampling (function)



Results: annotated subsampling (tissue number)



- Random SNP subsampling retains model effectiveness.
- No strong trend between rate and accuracy (outside extremes): this may be good.
- There doesn't seem to be specific regions of the genome containing the information determining the disease effects.



The results don't show any meaningful trend



We showed that subsampling allows the use of more complex models

Thank You!