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Advanced Genomics, GWAS & Machine Learning Program

Program Overview	Advanced training in population genomics, genome-wide association studies (GWAS), machine learning in genomics, high-performance computing (HPC), and scalable reproducible bioinformatics pipeline engineering.

TARGET AUDIENCE

Researchers, PhD students, postdoctoral fellows, and computational biology professionals pursuing advanced expertise in population genomics, statistical genetics, and machine-learning-driven biological discovery. Requires experience equivalent to the Intermediate program.

LEARNING OUTCOMES

- Design and execute genome-wide association studies (GWAS)
- Analyze population genomic structure (PCA, FST, LD)
- Apply supervised and unsupervised machine learning to genomic datasets
- Use HPC clusters with SLURM for large-scale analyses
- Engineer scalable workflows with Nextflow and Snakemake
- Containerize pipelines with Docker for reproducibility
- Interpret and communicate findings from complex genomic analyses

MONTHLY CURRICULUM (6 MONTHS)

Period	Topic	Key Content
Months 1-2	**Population Genomics & GWAS**	SNP analysis. Population structure. PCA. FST. Linkage disequilibrium. GWAS design & execution.
Months 3-4	**Machine Learning in Genomics**	Supervised learning. Unsupervised clustering. Classification models. Biomarker prediction. scikit-learn workflows.
Month 5	**Advanced Linux & HPC**	SLURM job scheduling. Parallel computing. Cluster workflows. Advanced shell scripting. Resource optimization.
Month 6	**Scalable Pipeline Engineering**	Snakemake. Nextflow. Docker containers. Reproducibility standards. Workflow documentation.

TOOLS & TECHNOLOGIES

PLINK	bcftools	VCFtools
GATK	Python 3	R / RStudio

scikit-learn	Pandas / NumPy	Nextflow
Snakemake	Docker	SLURM
ADMIXTURE	EIGENSOFT	Git / GitHub

FINAL RESEARCH PROJECT

Capstone Project	An end-to-end population genomics or GWAS research project covering data acquisition, quality control, population structure analysis, GWAS execution, machine learning interpretation, and a reproducible Nextflow pipeline with a written scientific report.

CERTIFICATION

CERTIFICATION	An Advanced Certificate in Computational Genomics is awarded upon successful completion of the program and capstone project. Recognizes expertise in population genomics, GWAS, machine learning in genomics, and scalable pipeline engineering.

CONTACT & ENROLLMENT

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