

# Artificial Intelligence & Machine Learning for Molecular Biology Data

 ΤΜΗΜΑ ΠΛΗΡΟΦΟΡΙΚΗΣ  
ΙΟΝΙΟ ΠΑΝΕΠΙΣΤΗΜΙΟ



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Εργαστήριο BIHELAB, ΤΠΛΗ, ΙΠ

# Why AI/ML in Molecular biology?



## Big Data

Omics data explosion requires scalable computational approaches



## Complex Patterns

ML can uncover non-linear relationships in biological systems

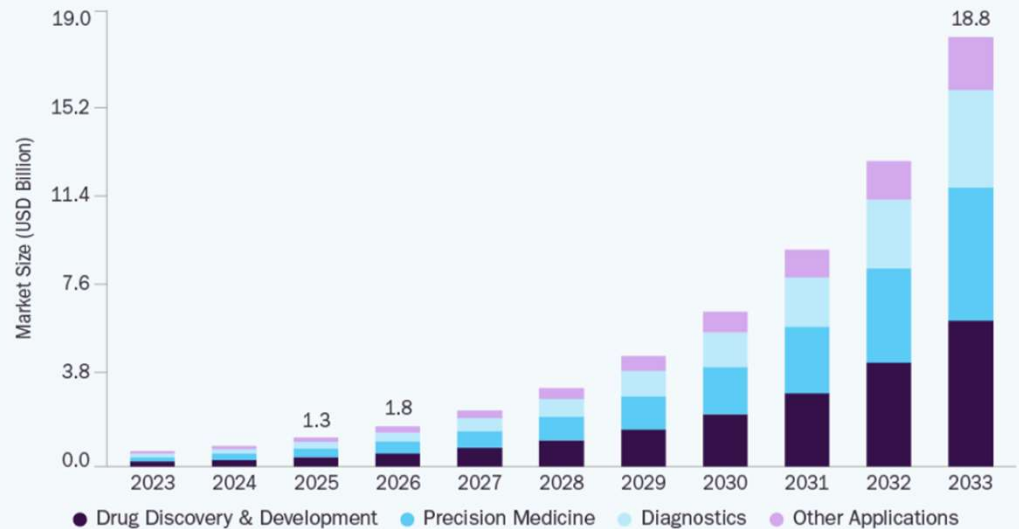


## Precision Medicine

From population-level to individualized diagnostics & treatment

## AI in Genomics Market

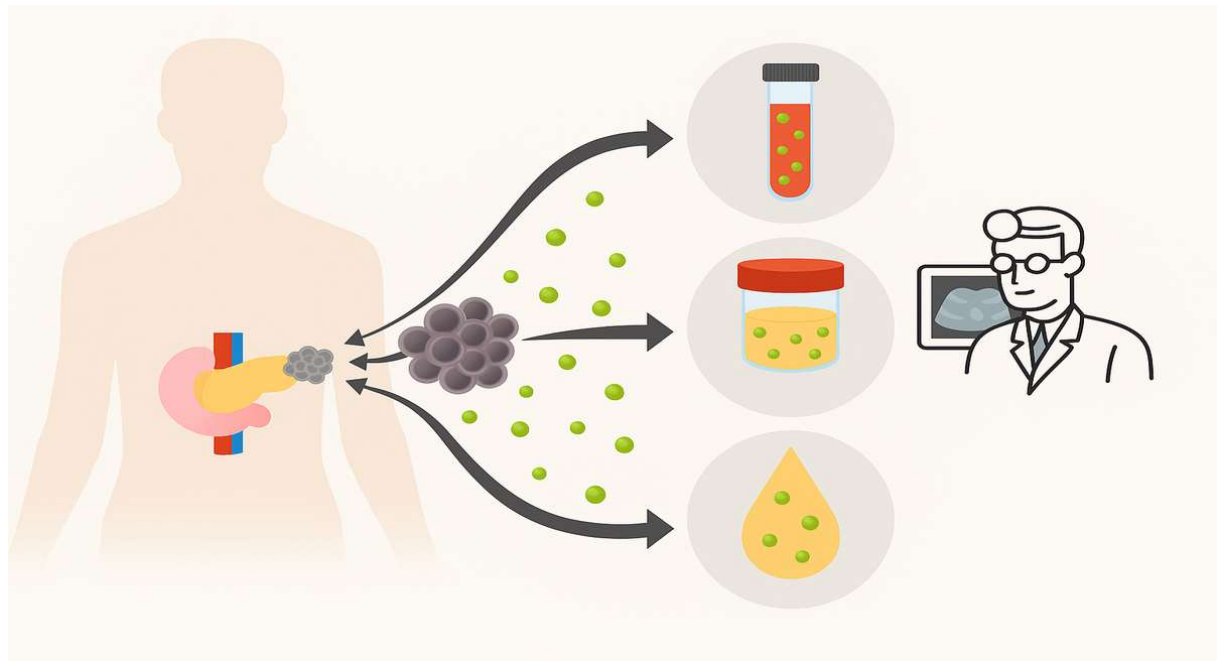
Size, by Application, 2023 - 2033 (USD Billion)



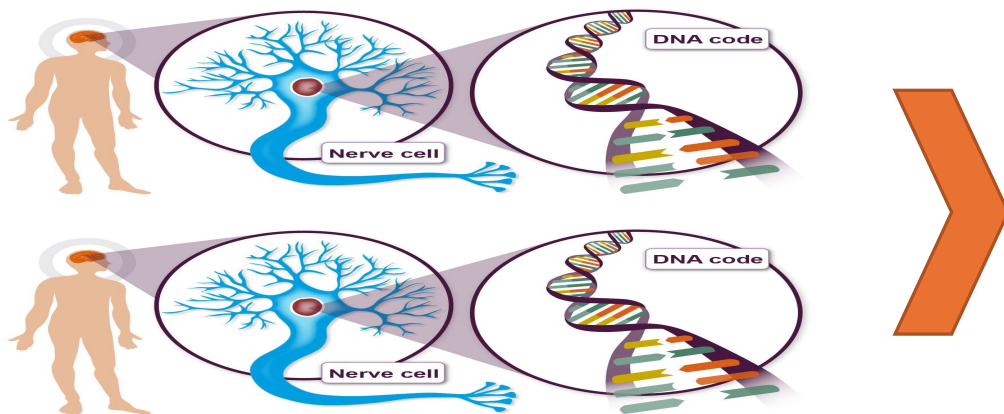
# Non-invasive Biomarkers: A new Era

## Related Publications

- Lazaros, K., Adam, S., Krokidis, M. G., Exarchos, T., Vlamos, P., & Vrahatis, A. G. (2025). Non-invasive biomarkers in the era of big data and machine learning. *Sensors*, 25(5), 1396.
- Vrahatis, A. G., Skolariki, K., Krokidis, M. G., Lazaros, K., Exarchos, T. P., & Vlamos, P. (2023). Revolutionizing the early detection of Alzheimer's disease through non-invasive biomarkers: the role of artificial intelligence and deep learning. *Sensors*, 23(9), 4184.
- Lazaros, K., Gonidi, M., Kontara, N., Krokidis, M. G., Vrahatis, A. G., Exarchos, T., & Vlamos, P. (2024). Exploring the Association between Pro-Inflammation and the Early Diagnosis of Alzheimer's Disease in Buccal Cells Using Immunocytochemistry and Machine Learning Techniques. *Applied Sciences*, 14(18), 8372.
- Lazaros, K., Krokidis, M. G., Grammenos, G., Adam, S., Exarchos, T. P., Vlamos, P., & Vrahatis, A. G. (2025, November). Uncovering Molecular Insights into Blood-Brain Barrier Dysfunction in Alzheimer's Disease. In *2025 IEEE 25th International Conference on Bioinformatics and Bioengineering (BIBE)* (pp. 27-31). IEEE.
- Dimitrakopoulos, G. N., Lazaros, K., Vrahatis, A. G., & Krokidis, M. (2023). A machine learning approach combining omics data for Alzheimer's disease analysis. In *2nd International Conference on Chemo and Bioinformatics (ICCBIG 2023)*.



# Core Focus: Single Cell RNA sequencing Data (scRNA-seq)



		Features						
		Gene 1	Gene 2	Gene 3	Gene 4	.....	.....	Gene 10.000
Observations	Cell 1							
	Cell 2							
	Cell 3							
	.....							
	.....							
	.....							
	.....							
	.....							
	.....							
	Cell 1000							

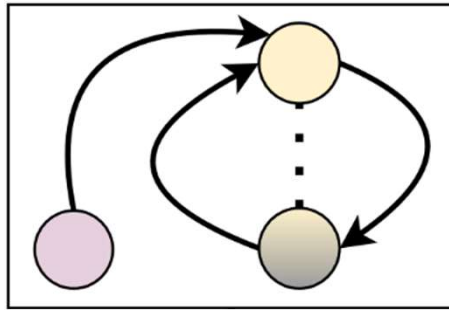
## Related Publications

- Kondaki, K., Lazaros, K., & Vrahatis, A. G. (2024). Unraveling Diabetes Mechanisms: A Computational scRNA-Seq Approach to Inflammation and Diabetes. *International Genomics, Neuroscience, Therapeutics and Data Innovation Summit*, 551-557.
- Krokidis, M. G., Vrahatis, A. G., Lazaros, K., & Vlamos, P. (2023). Exploring promising biomarkers for Alzheimer's disease through the computational analysis of peripheral blood single-cell RNA sequencing data. *Applied Sciences*, 13(9), 5553.
- Krokidis, M. G., Vrahatis, A. G., Lazaros, K., Skolariki, K., Exarchos, T. P., & Vlamos, P. (2023). Machine learning analysis of Alzheimer's disease single-cell RNA-sequencing data across cortex and hippocampus regions. *Current Issues in Molecular Biology*, 45(11), 8652-8669.

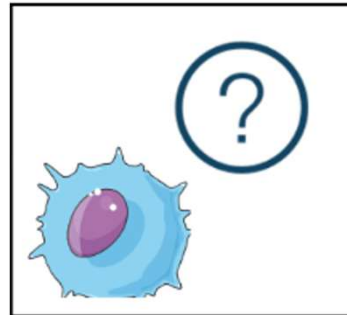
# Key Challenges in scRNA-seq Data Analysis



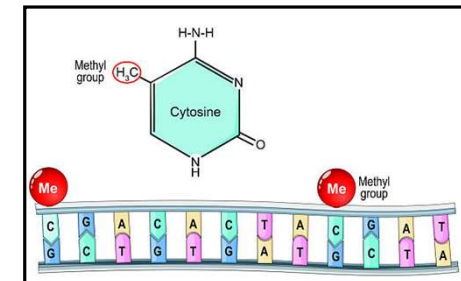
**Data Integration & Feature Selection**



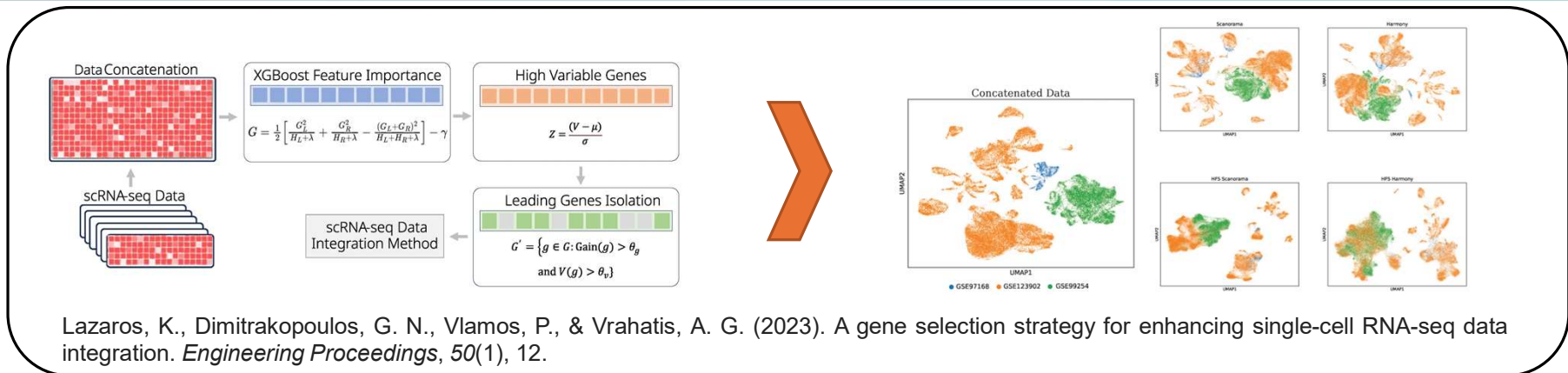
**Cell-type Annotation**



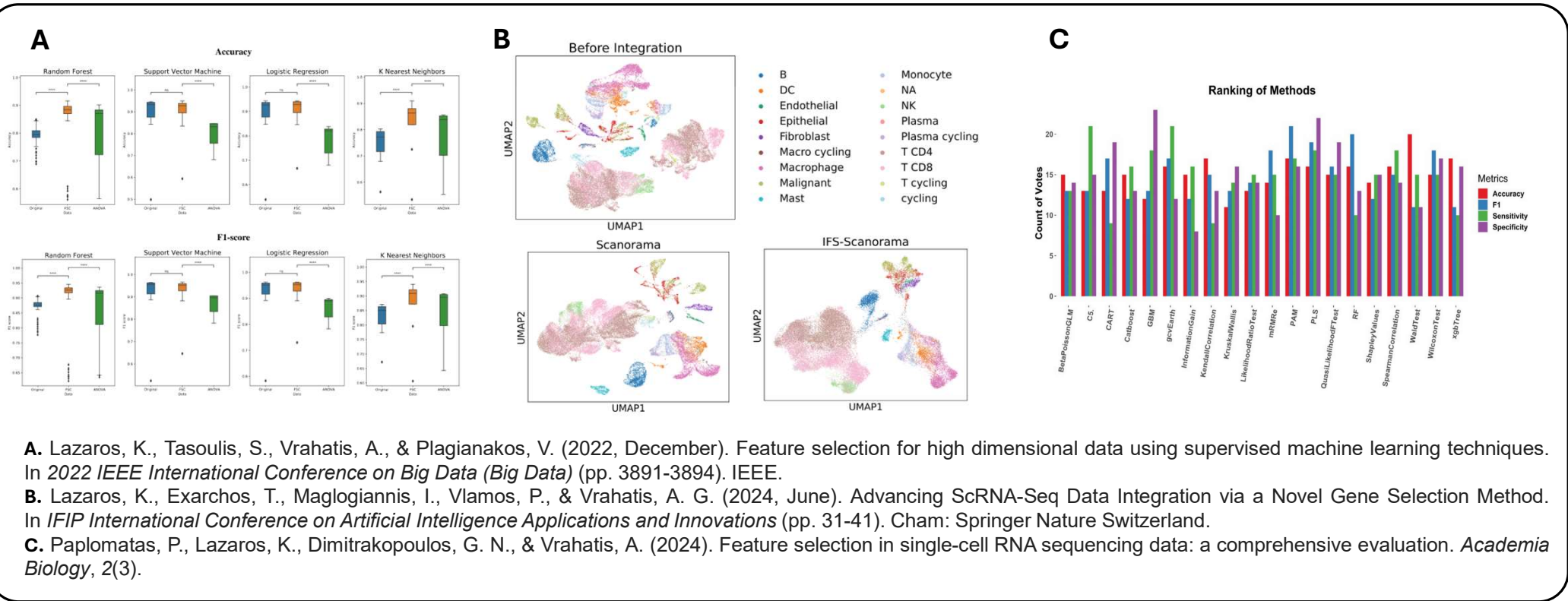
**Epigenetic Analysis**



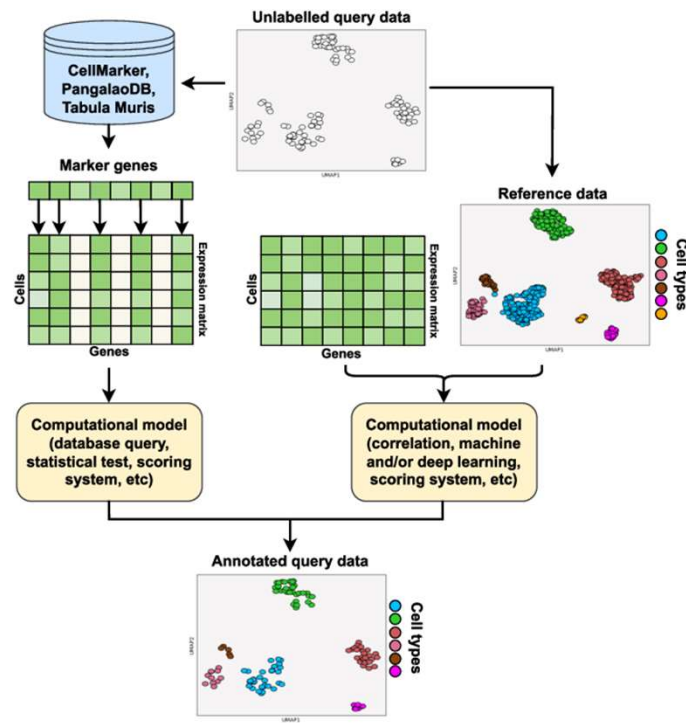
# Data Integration



# Feature Selection

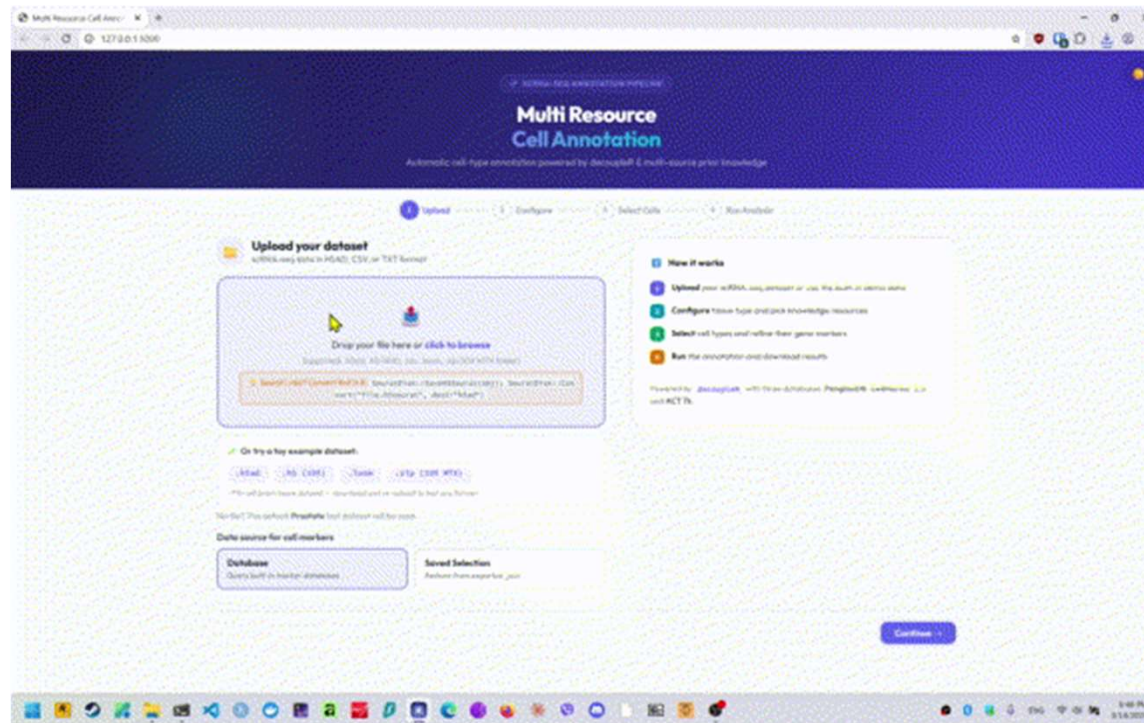


# Cell-type Annotation (1)



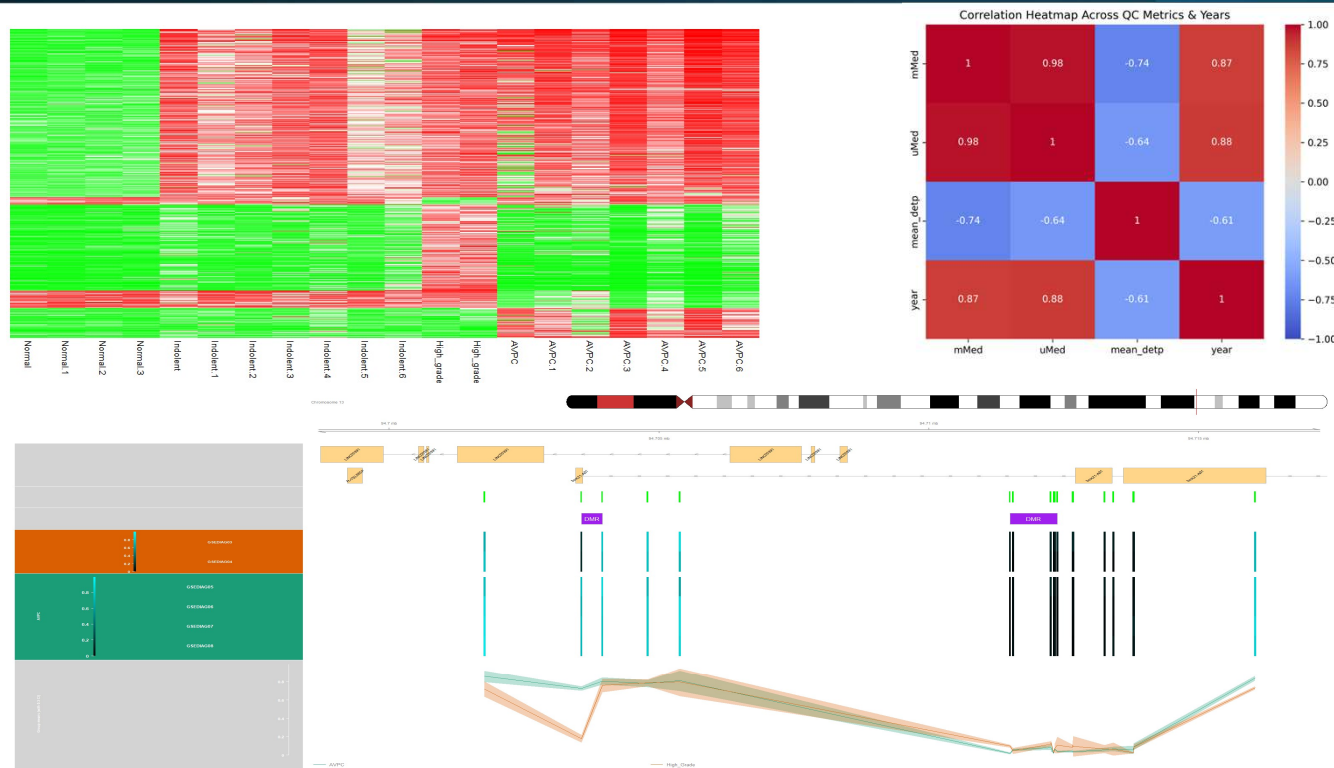
Lazaros, K., Vlamos, P., & Vrahatis, A. G. (2023). Methods for cell-type annotation on scRNA-seq data: A recent overview. *Journal of Bioinformatics and Computational Biology*, 21(05), 2340002.

# Cell-type Annotation (2)



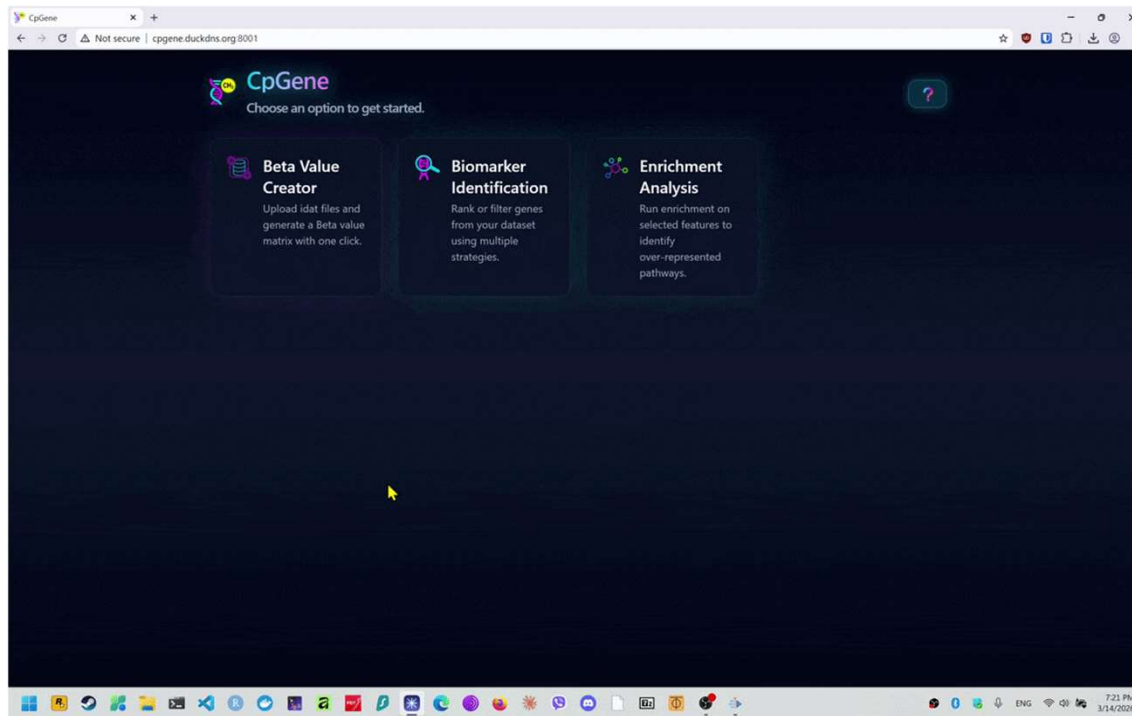
Lazaros, K., Souzana Logotheti, Vasiliki Tzelepi, Panagiotis Vlamos & Aristidis G. Vrahatis. (2026). scAnnot: A Web Application for Marker-based Cell-type Annotation in scRNA-seq Data. Oxford Bioinformatics, Application Note (Under Review).

# Epigenetic Analysis (1)



Logotheti, S., Mesiakaris, K., Lazaros, K., Kontogianni, E., Panopoulou, E., & et al. (2025). Epigenetic biomarker identification of each stage during the progression of prostate cancer. *Cancer Research*, 85(8\_Supplement\_1), 4122–4122.

# Epigenetic Analysis (2)



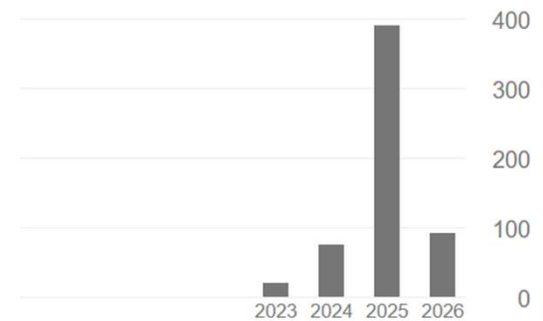
Lazaros, K., Souzana Logotheti, Christopher Logothetis, Vasiliki Tzelepi, Panagiotis Vlamos & Aristidis G. Vrahatis. (2026). CpGene: A Web Application for Epigenetic Signature Identification from DNA Methylation Arrays. Oxford Bioinformatics, Application Note (Accepted; In Press).

# Publication Statistics (Google Scholar)

Publication Type	Number of Publications
Journal	21
Conference	7
Abstract	2

Cited by

	All	Since 2021
Citations	590	589
h-index	9	9
i10-index	8	8



**Thank You!**

