



UNIVERSITÀ DEGLI STUDI DI NAPOLI
FEDERICO II

itee^{PhD}
information technology
electrical engineering



Enea Vincenzo Napolitano

Artificial Intelligence techniques for Smart Environments

Tutor: Prof. Elio Masciari

Cycle: XXXVIII

co-Tutor: Prof. Nicola Mazzocca

Year: Second

My background

- MSc degree in Data Science @ Federico II
- DIETI Research group/laboratory: PICUSlab
- PhD start date: January 1, 2023
- Scholarship type: RESTART
- Period abroad: May 1, 2024 – October 31, 2024 @ BDS LAB - University of Houston, Houston (USA)

Summary of study activities

- 1 Ad hoc course:
 - Strategic Orientation for STEM Research & Writing
- 2 Seminars
- Conferences:
 - Medes 2024, *the 16th international conference on management of digital ecosystems* - Naples - November 18 - 20, 2024
 - Medi 2024, *13th International Conference on Model and Data Engineering* - Naples - November 18 - 20, 2024
 - DEMAI 2024, *2nd Workshop on Data Engineering and Modeling for AI @ IEEE BigData24*, Washington, USA, December 17, 2024 (online)
- Award:
 - Best Reviewer Award – MEDI 2024
- Period abroad:
 - May 1, 2024 – October 31, 2024 @ BDS LAB - University of Houston, Houston (USA)

Research area

Artificial Intelligence for Smart Environments

Objective: To apply AI techniques to optimize systems and processes in smart environments, ensuring sustainability and efficiency.

Key Areas of Focus:

- **Sustainability:** Developing metrics and tools to assess and reduce the environmental impact of AI applications.
- **Optimization:** Enhancing computational efficiency in data structures, sparse matrices, and graph-based algorithms.
- **Applications:** Leveraging AI in transportation, healthcare, and public administration for smarter resource utilization.

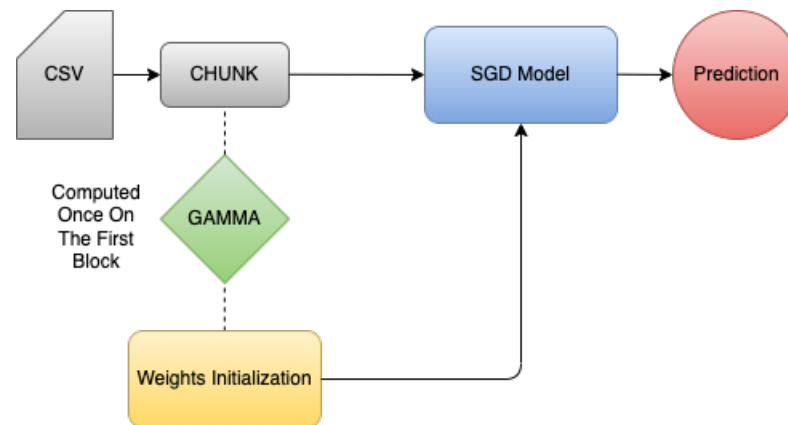
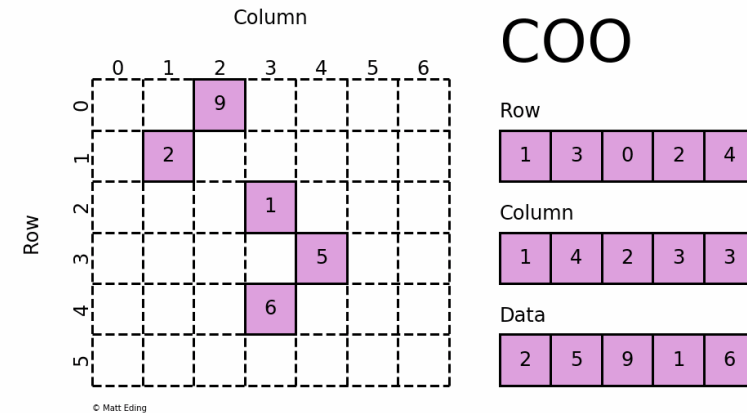
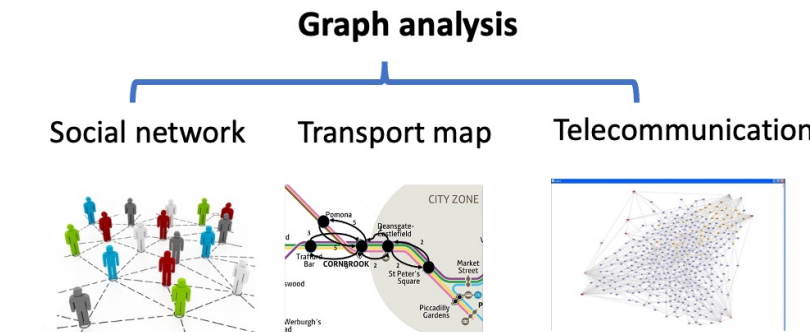


Research results: Green environments

- *Quantifying AI's Environmental Impact*
 - Developed a **metric** to estimate CO₂ emissions from AI tasks.
- Smart Mobility
 - Systematic Mapping Study on Load Passenger Prediction of Public Transportation

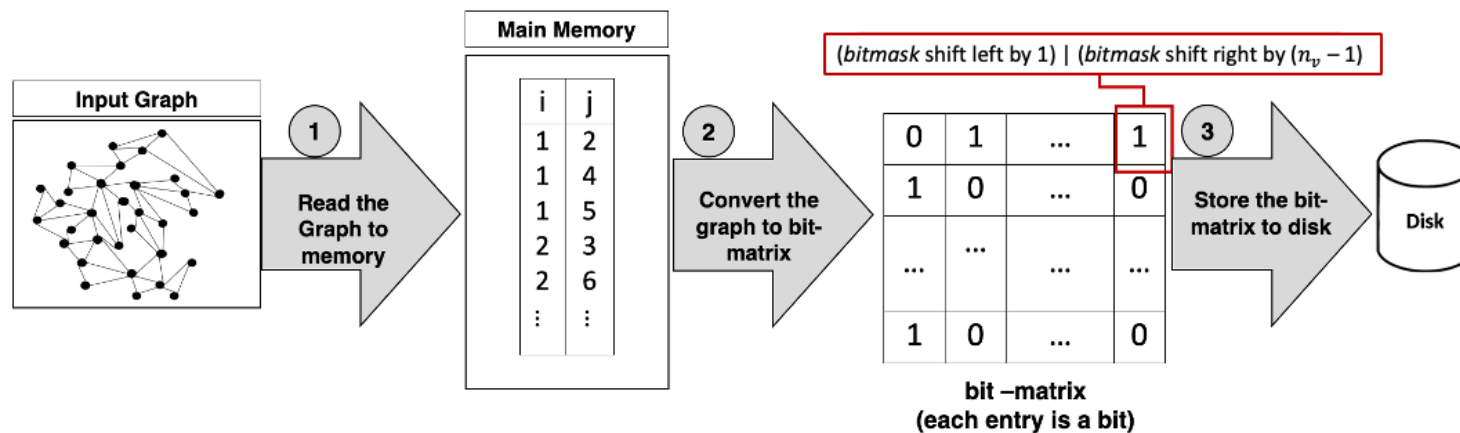
Research results: Computational Efficiency (I)

Sparse Matrix Multiplication



Research results: Computational Efficiency (II)

Adjacency Matrix Computation



```

Input:  $E$ 
Output:  $E^*$ 
1 for  $i \leftarrow 2$  to  $n$  do
2   for  $j \leftarrow 1$  to  $i - 1$  do
3     if  $E[i, j] = 1$  then
4       set  $E[i, *] = E[i, *] \vee E[j, *]$ 
5     end
6   end
7 end
8 for  $i \leftarrow 1$  to  $n - 1$  do
9   for  $j \leftarrow i + 1$  to  $n$  do
10    if  $E[i, j] = 1$  then
11      set  $E[i, *] = E[i, *] \vee E[j, *]$ 
12    end
13  end
14 end
  
```

Algorithm 1: Warren's Algorithm

Research products

[P1]	di Torrepadula, F. R., Napolitano, E. V. , Di Martino, S., & Mazzocca, N. (2024). Machine Learning for public transportation demand prediction: A Systematic Literature Review. <i>Engineering Applications of Artificial Intelligence</i> , 137, 109166
[P2]	Masciari, Elio, and Enea Vincenzo Napolitano . "The Environmental Cost of High Performance Computing System Simulation." PDP 2024.
[P3]	Indrio, F., Masciari, E., Marchese, F., Rinaldi, M., Maffei, G., Napolitano, E. V. , ... & Aceti, A. (2024). "Infantile Predictors of Functional Gastrointestinal Disorders: A Machine Learning Approach to Risk Assessment". SEBD 2024.
[P4]	Fioretto, S., Masciari, E., & Napolitano, E. V. «Machine Learning for KPI Development in Public Administration». DATA 2024.
[P5]	Bassi, N., & Napolitano, E. V. "Drive BELT: A Strategic Decision-Making Tool for Optimizing Naval and Rail Freight Logistics". <i>NFMCP</i> 2024.
[P6]	Benfenati, D., Capuozzo, S., De Filippis, G. M., De Simone, A., Gravina, M., Marassi, L., Napolitano, E.V. , ... & Sansone, C. (2024). "AI in Medicine: Activities of the CINI-AIIS Lab at University of Naples Federico II".

Research products (II)

[A1]	Napolitano, E. V., Masciari, E., Ordonez, C. (2024) Integrating Flow and Structure in Diagrams for Data Science, DEMAI 2024, <i>2nd Workshop on Data Engineering and Modeling for AI @ IEEE BigData24</i>
[A2]	Masciari, Elio, and Enea Vincenzo Napolitano . “Environmental Sustainability of AI: Estimating CO2e Emissions Across Cloud, Edge, and Fog Paradigms”, WISE 2024
[A3]	Masciari, Elio, and Enea Vincenzo Napolitano . “Sustainability and High Performance Computing”, IIWAS 2024
[S1]	Masciari, Elio, and Enea Vincenzo Napolitano . “An Effective Measure for Evaluating the Environmental Impact of AI Tasks”, <i>Information Sciences</i>
[S2]	Masciari, Elio, and Enea Vincenzo Napolitano . " Optimizing Transitive Closure Computation for High Performance Computing." <i>PDP 2025</i>
[S3]	Conza, Maria Luisa, Fioretto, Simona, Masciari, Elio and Enea Vincenzo Napolitano “Enhancing Employee Health Through an Experimental Diet: Insights from Machine Learning Analysis” <i>PDP 2025</i>

Future Work

Deepening Computational Sustainability:

- Refine the CO₂ emission estimation metric to include additional factors, such as Lifecycle HW impact.
- Explore real-world case studies to validate and expand the metric's applicability.

Algorithm Development:

- Investigate further optimizations for sparse matrix operations and graph-based algorithms
- Apply these optimizations to specific use cases in smart environments, such as urban planning and energy management.
- Collaborate with interdisciplinary teams to integrate AI solutions into diverse sectors.

THANK YOU.