

Giampaolo Bovenzi

Tutor: Prof. Antonio Pescapè

XXXIV Cycle - I year presentation

Learning Approaches for Improving  
Fine-Grain Knowledge of Internet Traffic



UNIVERSITÀ DEGLI STUDI DI NAPOLI  
FEDERICO II

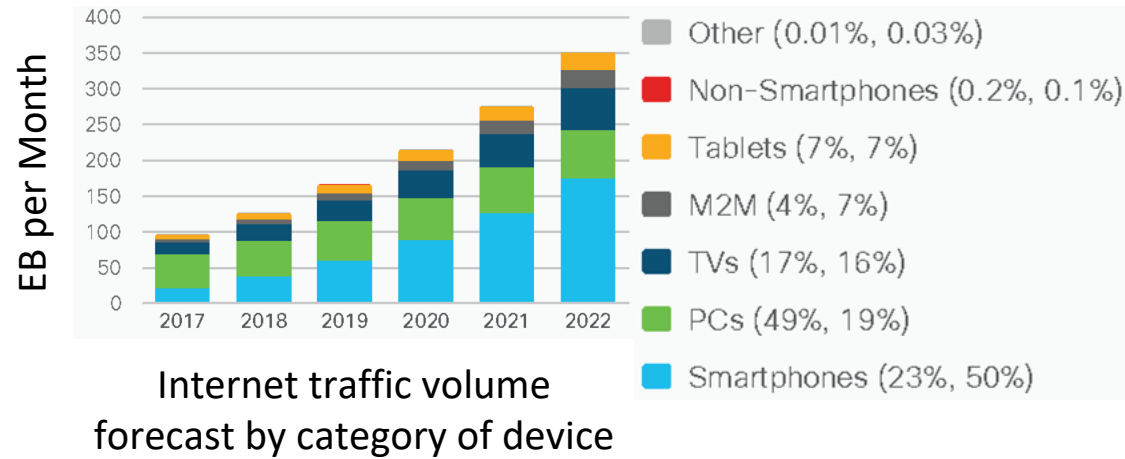
# Education and Cooperation Background

- **Graduation:** M.Sc. Degree in Computer Engineering, cum laude.
- **DIETI Group:** Computer Networks *Traffic* research.
- **Cooperation:** CINI consortium and University of Campania Luigi Vanvitelli
- **Fellowship:** CINI Ph.D. grant



# Motivations: growing Internet complexity (I)

Increasing Traffic  
Volume  
(30% CAGR 2017-22)

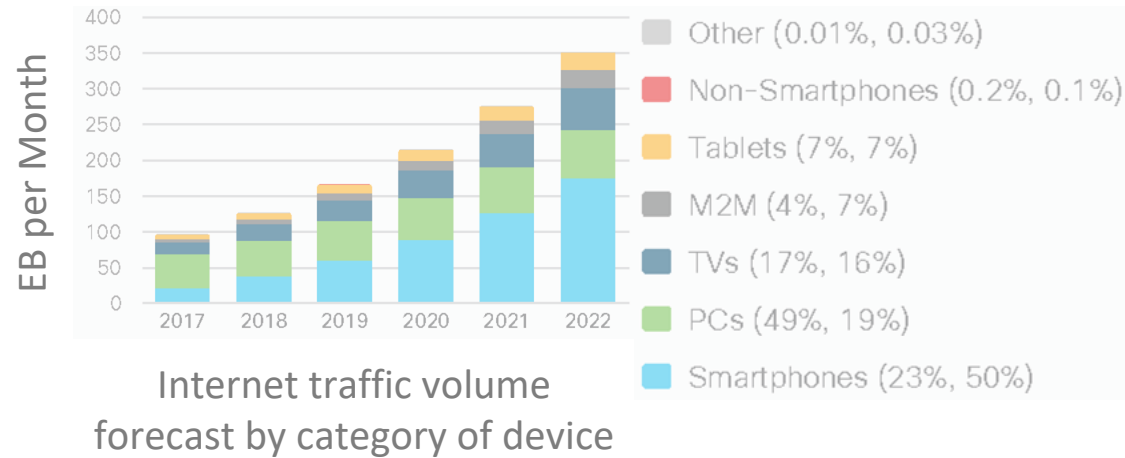


Source: Cisco VNI Global IP Traffic Forecast, 2017-2022

# Motivations: growing Internet complexity (II)

Increasing Traffic Volume

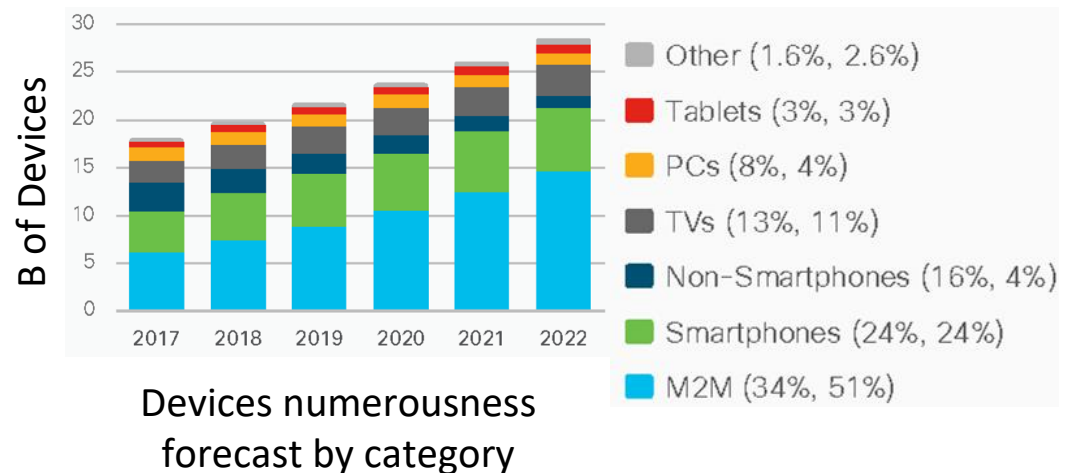
(30% CAGR 2017-22)



Heterogeneity of devices and growth of IoT category

(viz. M2M)

(20% CAGR 2017-22)



Source: Cisco VNI Global IP Traffic Forecast, 2017-2022



# Motivations: growing Internet complexity (III)



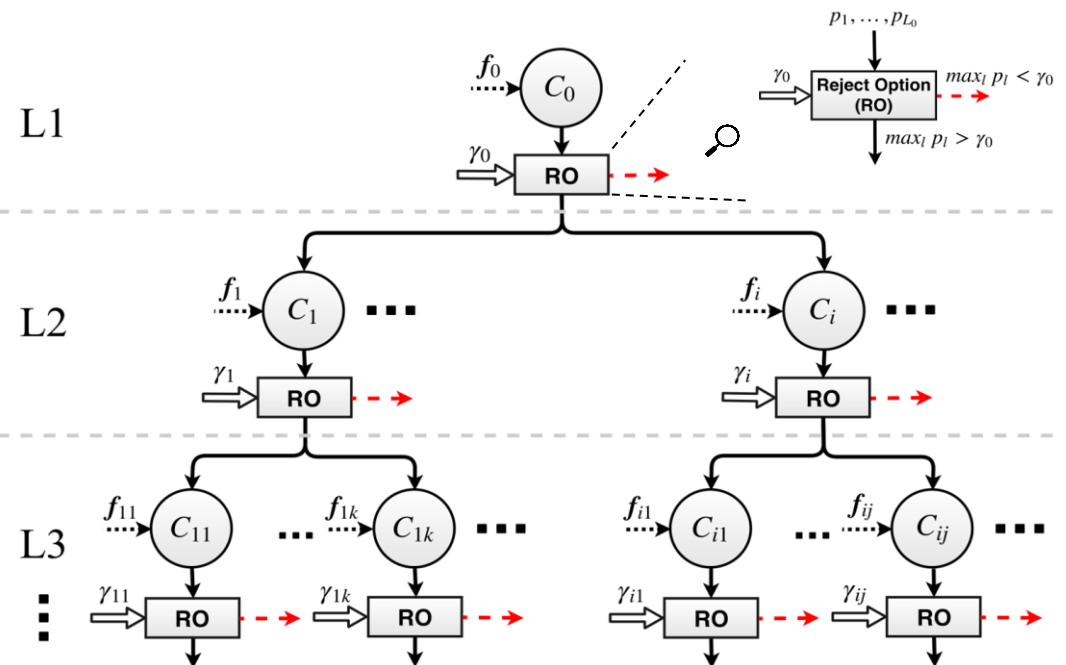
## More Complex Network Monitoring Systems



# 1st year research outline

- Network Monitoring techniques based on **Machine** and **Deep Learning**
- Design, implementation and evaluation of **Hierarchical Approaches** to **Traffic Classification** and **Intrusion Detection**

- scalability
- per-node optimization
- selective (re-)training

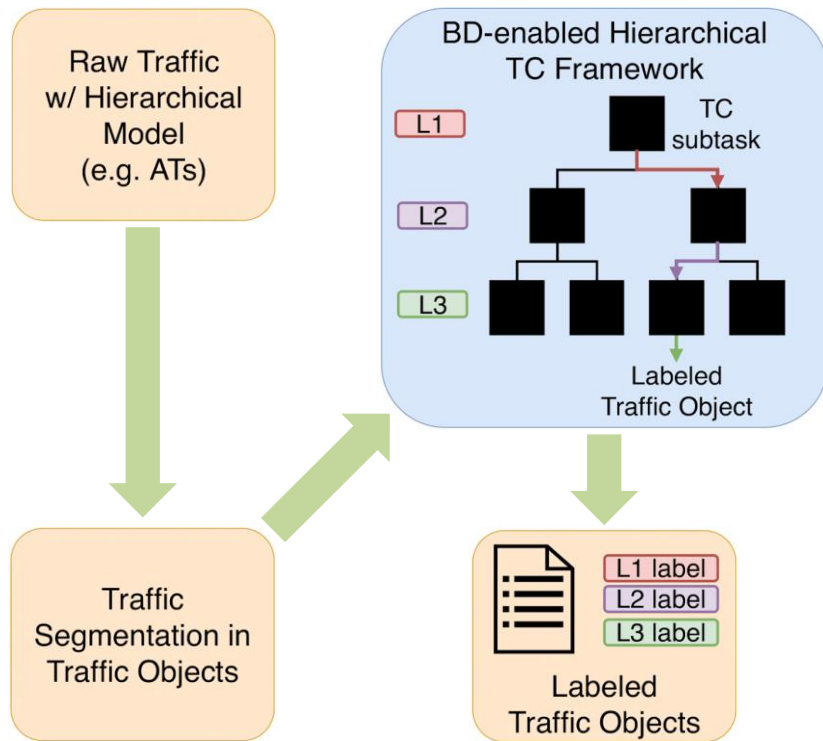


# Contributions (I)

- Fine-grain **Traffic Classification** of Anonymity Tools
  - Hierarchical dependencies among traffic classes to obtain potential **classification performance gain** at lower granularity

# Classification of Anonymity Tools \*

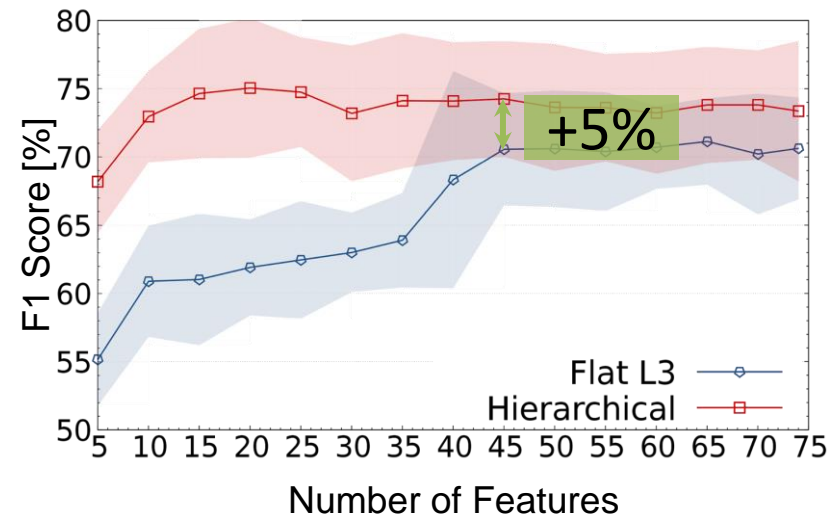
improving **classification performance** at finer granularity



L1) Anonymity Tool

L2) Traffic Type

L3) **Application**



\* The outcomes of this activity were published in IEEE Trans. on Network Science and Engineering (2019)

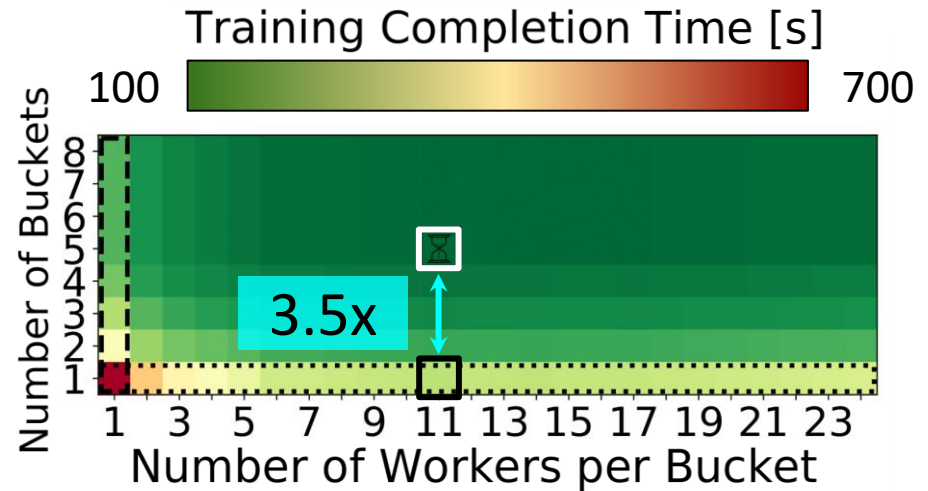
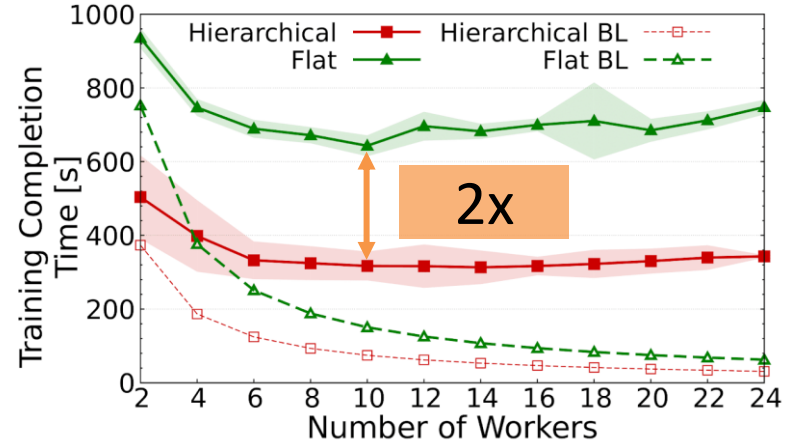
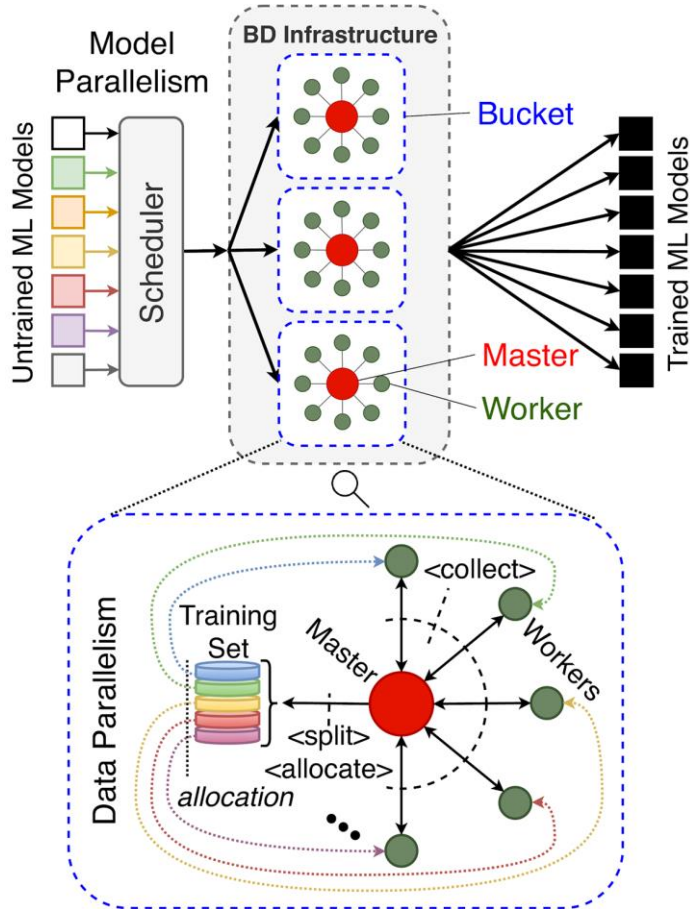


# Contributions (II)

- Fine-grain **Traffic Classification** of Anonymity Tools
  - Hierarchical dependencies among traffic classes to obtain potential **classification performance gain** at lower granularity
- Hierarchical approach enabled by **Big Data (BD)**
  - Model and data parallelisms to **speedup training phase**

# Hierarchical BD-enabled Training

improving training time performance

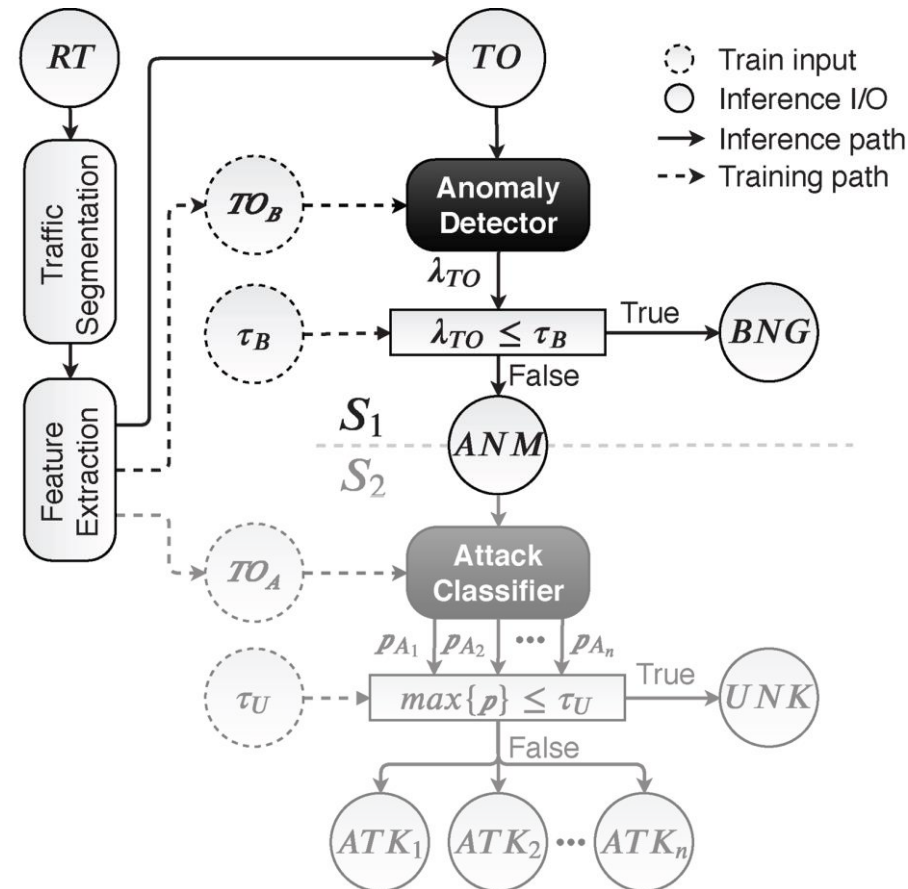


# Contributions (III)

- Fine-grain **Traffic Classification** of Anonymity Tools
  - Hierarchical dependencies among traffic classes to obtain potential **classification performance gain** at lower granularity
- Hierarchical approach enabled by **Big Data (BD)**
  - Model and data parallelisms to **speedup training phase**
- Hybrid **Intrusion Detection** for security of IoT devices
  - First stage of **lightweight** Anomaly Detection for resource-costrained devices (viz. IoT)
  - Second Stage of Open-set Attack Classification for **Unknown Attack Detection**

# Intrusion Detection for IoT devices (I)

lightweight and unknown attacks detection



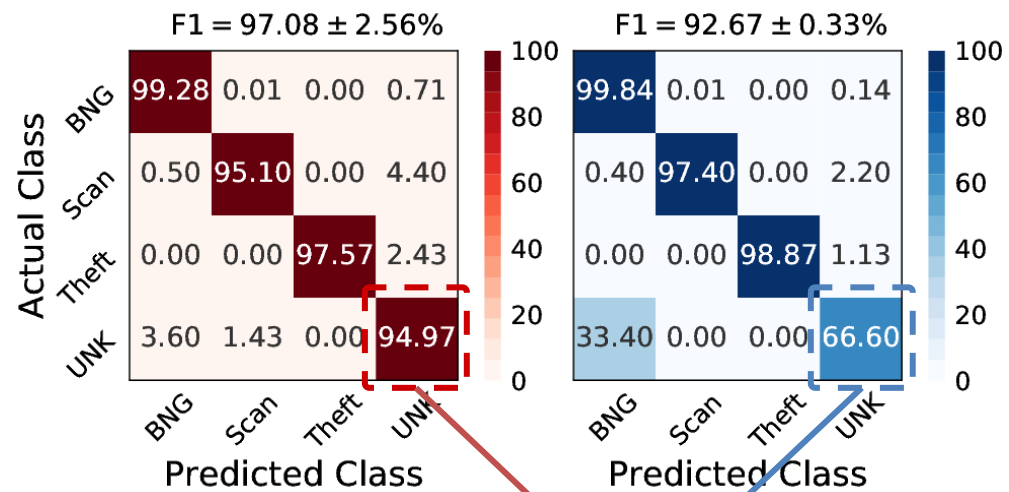
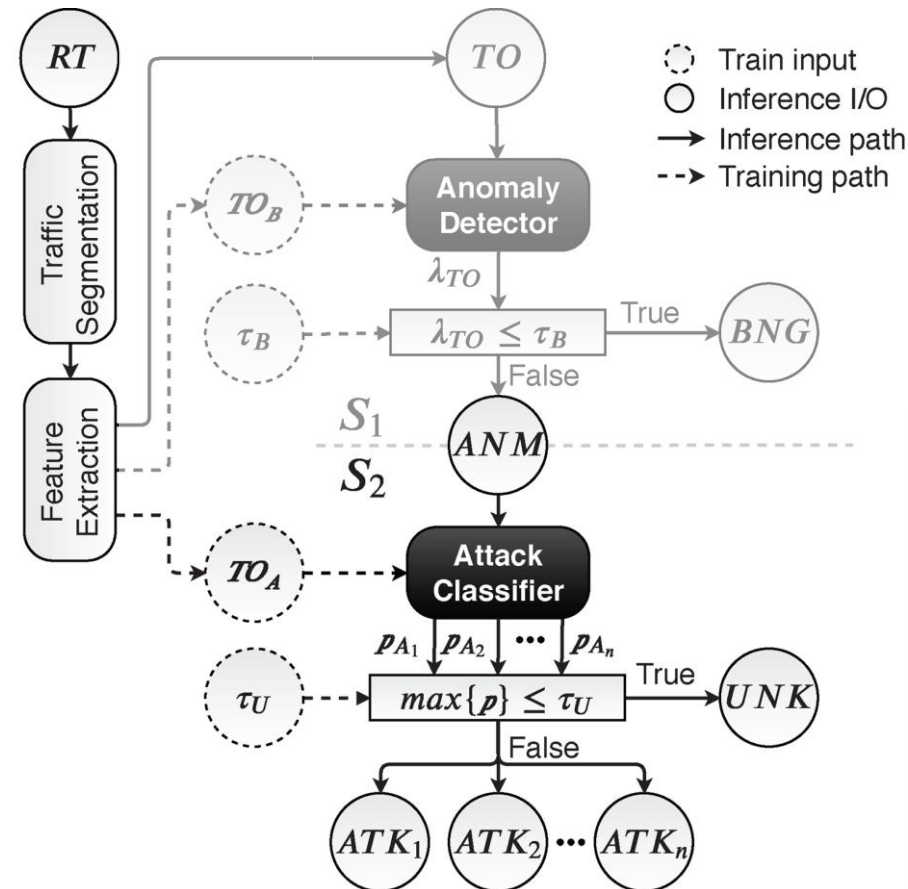
**S1) Multimodal Deep Autoencoder for Lightweight Anomaly Detection**

**4x reduction factor** (w.r.t. DAE) of neural network size keeping a low (<1%) False Positive Rate

# Intrusion Detection for IoT devices (II)

lightweight and unknown attacks detection

## S2) Open-set Attack Classification for Unknown Attack Detection



# Products

## Publications

[J1] Montieri, A., D. Ciunzo, **G. Bovenzi**, V. Persico, and A. Pescapè. "A Dive into the Dark Web: Hierarchical Traffic Classification of Anonymity Tools." IEEE Transactions on Network Science and Engineering (2019).

[C1] Piantadosi, G., **G. Bovenzi**, G. Argenziano, E. Moscarella, D. Parmeggiani, L. Docimo, and C. Sansone. "Skin Lesions Classification: A Radiomics Approach with Deep CNN." In International Conference on Image Analysis and Processing, pp. 252-259. Springer, Cham, 2019.

[R1] **Bovenzi, G.**, G. Aceto, D. Ciunzo, V. Persico, and A. Pescapè. "Double Parallelism in Traffic Classification: Big Data-enabled Hierarchical (BDeH) Framework." under revision at IEEE Network (2019).

[R2] **Bovenzi, G.**, G. Aceto, D. Ciunzo, V. Persico, and A. Pescapè. " H2ID: Hierarchical Hybrid Intrusion Detection for Security of IoT Devices." under revision at IEEE International Conference on Communications (2020).



# Next years

- Credit summary and next years' estimates

	Credits year 1							Credits year 2							Credits year 3							Total	Check			
	Estimated	1 bimonth	2 bimonth	3 bimonth	4 bimonth	5 bimonth	6 bimonth	Summary	Estimated	1 bimonth	2 bimonth	3 bimonth	4 bimonth	5 bimonth	6 bimonth	Summary	Estimated	1 bimonth	2 bimonth	3 bimonth	4 bimonth			5 bimonth	6 bimonth	Summary
Modules	20	1.2	4.2	9	4.2	0	5	23.6	10							0	0							0	23.6	30-70
Seminars	5	0.8	0.6	0.9	2.4	0.2	0.2	5.1	5							0	0							0	5.1	10-30
Research	35	8	5.2	0.1	3.4	9.8	4.8	31.3	45							0	60							0	31.3	80-140
	60	10	10	10	10	10	10	60	60	0	0	0	0	0	0	0	60	0	0	0	0	0	0	0	60	180

- Research directions for next year

- IoT device traffic modeling, prediction, and generation for feasible Network Monitoring

# Thanks for your attention



It is Q&A time!

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# Skin Lesion Classification through CNN



## Ensemble Deep Learning with Image Patching

