ScuDo

Scuola di Dottorato ~ Doctoral School

WHAT YOU ARE, TAKES YOU FAR

35th Cycle

Machine learning for QoE of real-time applications

Dena Markudova

Supervisor: prof. Michela Meo

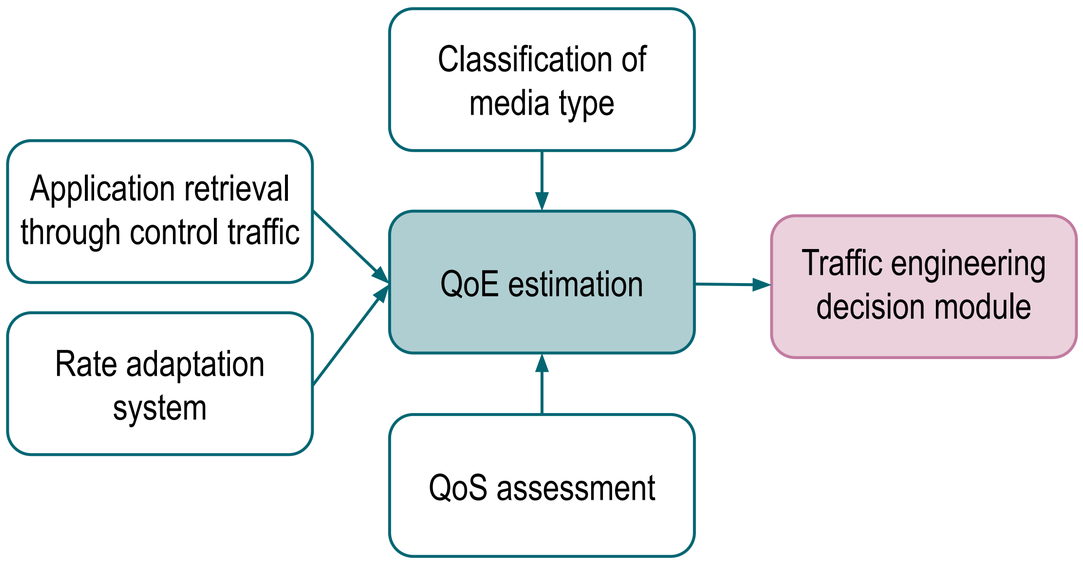
Research context and motivation

Real-time applications:

- video conferencing apps
- cloud gaming

Goal: improve the Quality of Experience while talking or playing, through network management policies that favour QoE of real-time applications.

Addressed research problems



Novel contributions

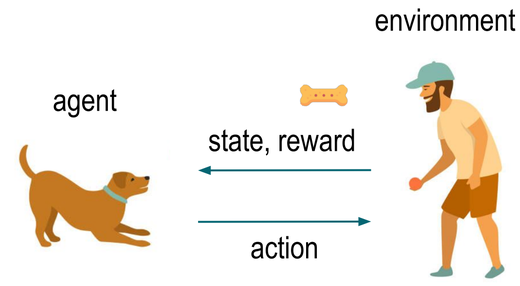
Machine learning (ML) applied to networking:

- We use ML classification and regression algorithms to differentiate media types and various QoS indicators in video call traffic
- We use Natural Language Processing techniques to classify applications based on domain names
- We use Reinforcement Learning (RL) for Rate adaptation on the application layer

Submitted and published works

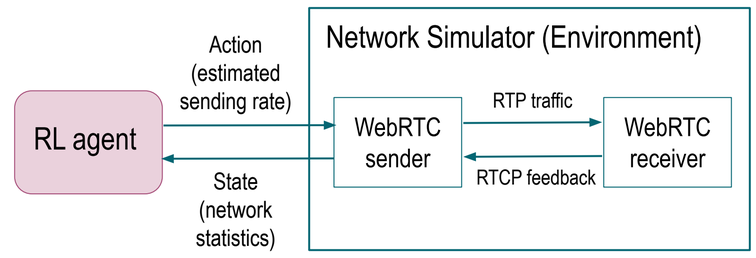
- Perna, G., Markudova, D., Trevisan, M., Garza, P., Meo, M., Munafò, M., & Carofiglio, G. "Real-Time Classification of Real-Time Communications." IEEE Transactions on Network and Service Management (2022).
- Perna, G., Markudova, D., Trevisan, M., Garza, P., Meo, M., & Munafò, M. M. "Retina: An open-source tool for flexible analysis of RTC traffic." Computer Networks 202 (2022).
- Markudova, D., Trevisan, M., Garza, P., Meo, M., Munafo, M. M., & Carofiglio, G. "What's my app? ML-based classification of RTC applications." ACM SIGMETRICS Performance Evaluation Review 48.4 (2021): 41-44.
- Markudova, D., Mishra, S., Cagliero, L., Vassio, L., Mellia, M., Baralis, E., ... & Loti, R. "Preventive maintenance for heterogeneous industrial vehicles with incomplete usage data." Computers in Industry 130 (2021).
- Perna, G., Markudova, D., Trevisan, M., Garza, P., Meo, M., Munafò, M., & Carofiglio, G., "Online classification of RTC traffic." IEEE 18th Annual Consumer Communications & Networking Conference (CCNC). 2021.
- Nistico, A., Markudova, D., Trevisan, M., Meo, M., & Carofiglio, G. "A comparative study of RTC applications." 2020 IEEE International Symposium on Multimedia (ISM). 2020.
- Ciociola, A., Markudova, D., Vassio, L., Giordano, D., Mellia, M., & Meo, M. "Impact of charging infrastructure and policies on electric car sharing systems." IEEE 23rd International Conference on Intelligent Transportation Systems (ITSC). 2020.
- Markudova, D., Baralis, E., Cagliero, L., Mellia, M., Vassio, L., ... & Lucia, S. "Heterogeneous industrial vehicle usage predictions: A real case." EDBT/ICDT. Vol. 2322. CEUR-WS. org, 2019.

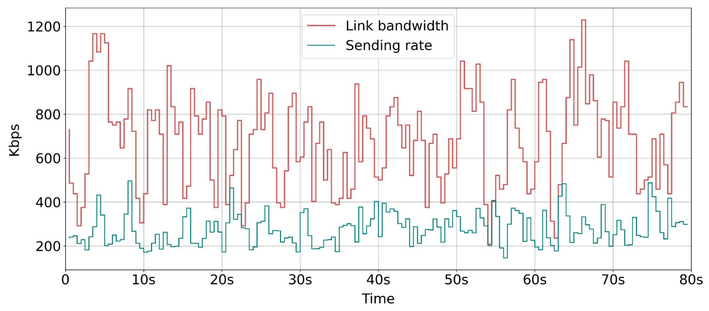
Adopted methodologies



Reinforcement learning is a type of ML where an agent learns how to solve tasks by trial and error, in a simulated environment.

We use a network simulator in ns-3 and interact with the simulation based on the decisions the RL algorithm makes.

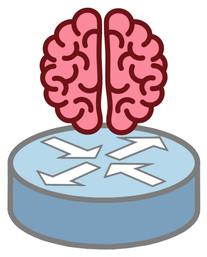




Preliminary results show that a Deep-RL approach using the Actor-critic algorithm is a promising technique for rate adaptation in RTC.

Future work

- A performance evaluation of different types of State-of-the-art RL algorithms for rate adaptation
- A prototype of the Traffic engineering decision module at an ingress router of a small network



Internship

NETFLIX

List of attended classes

Type	Code	Course name	Date	Hours	Credits
Hard	01SCTIU	Text mining and analysis	30/09/2021	15	3
	01UJARV	Data science for networks	28/01/2021	20	4
	01UJBRV	Adversarial training of neural networks	01/07/2020	15	3
	01UKBRV	Space Networking	01/04/2020	20	4
	01QTEIU	Data mining concepts and algorithms	20/01/2020	20	4
	01ULSRS	Psycology of urban life	07/01/2020	10	2
	External	TOP data analysis	23/09/2020	20	4
	External	Computing@PoliTO workshop	17/1/2020	4	1
Soft	01UNRRV	Entrepreneurship and start-up creation	31/05/2021	40	8
	01SWPRV	Time management	19/09/2020	2	1
		Total hours / points hard skills		**127**	**206.41**
		Total hours / points soft skills		**43**	**69.33**

PhD program in

Electrical, Electronics and Communications Engineering