INVESTIGACIÓN EN REDES ÓPTICAS

UNIVERSIDAD TECNICA FEDERICO SANTA MARIA

UNIVERSIDAD ADOLFO IBÁÑEZ

DREAM-ON-GYM

Deep **RE**inforcement learning fre**AM**work for **O**ptical **N**etworks

Hack Your Research! Tools and Tricks for Today's Telecommunications Techies

OFC March 5 to 9, 2023 – San Diego, USA

Presented by:
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OFC

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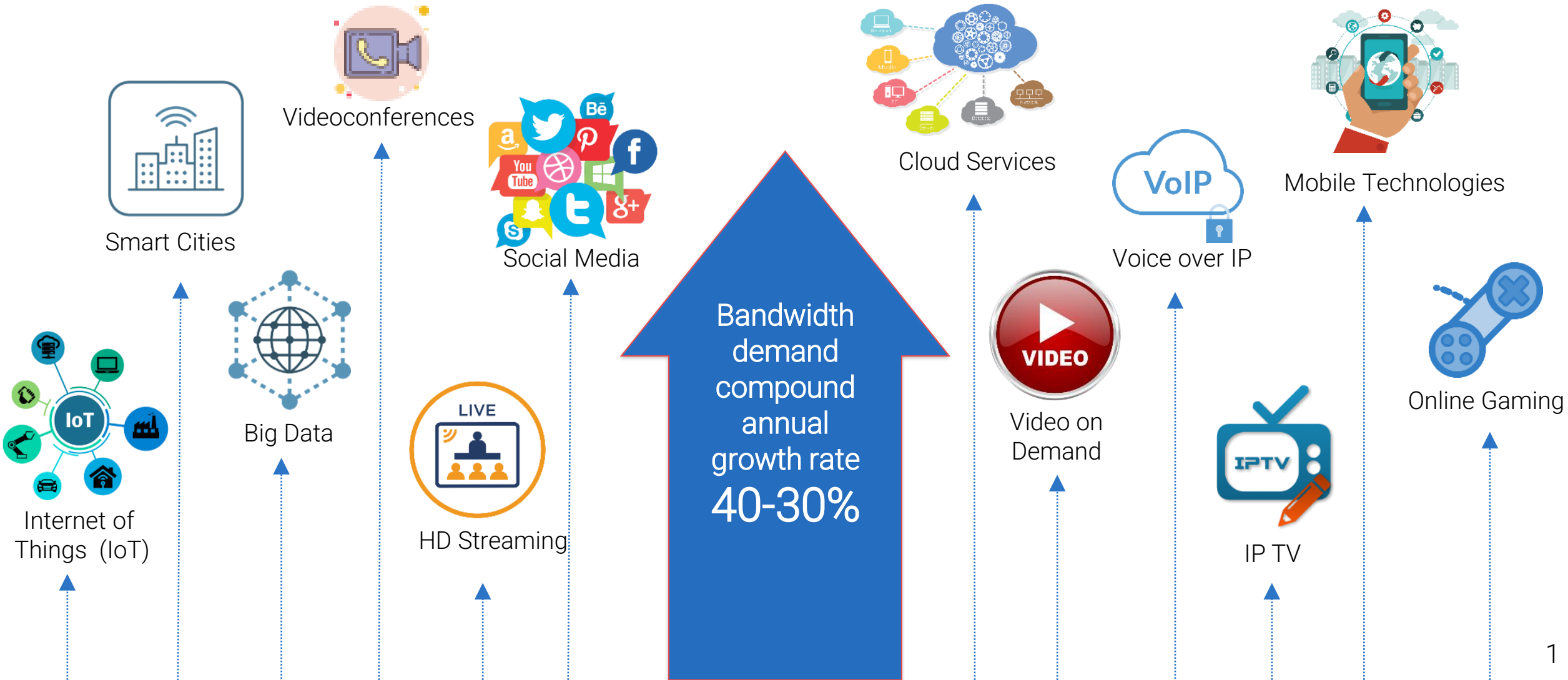
Bandwidth Demands



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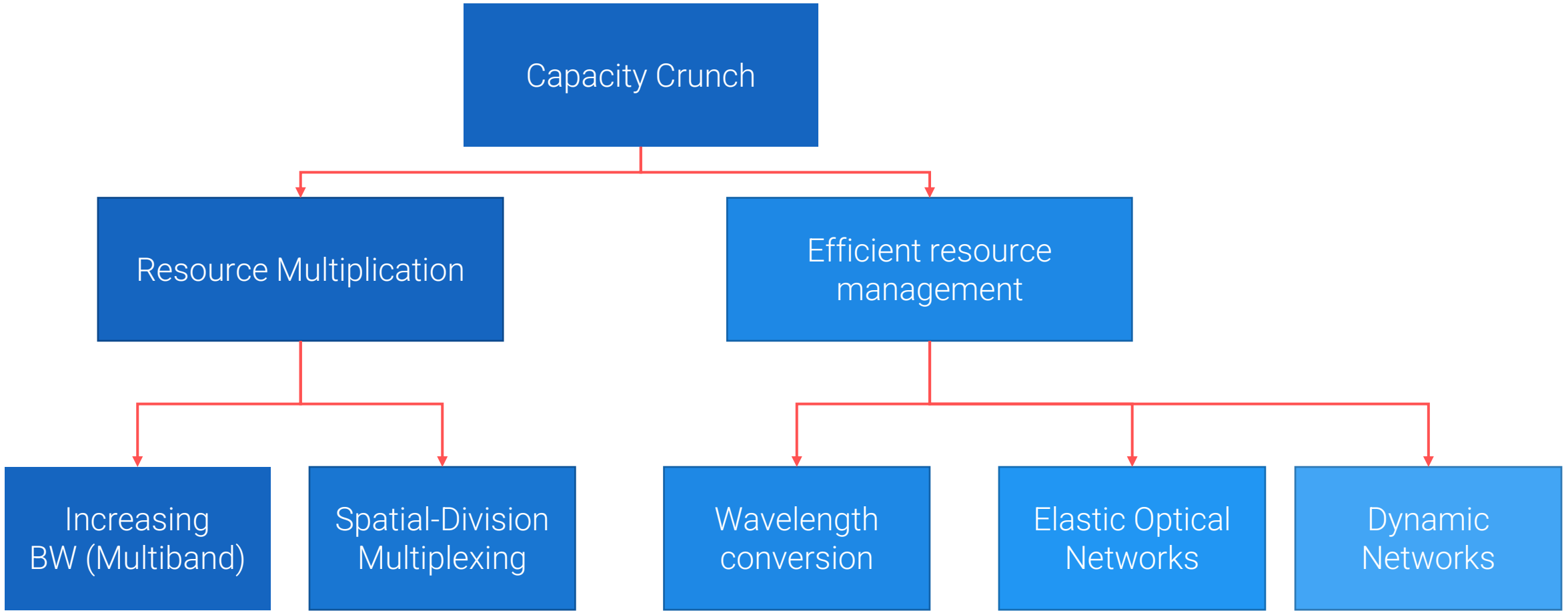
Facing impending capacity crunch



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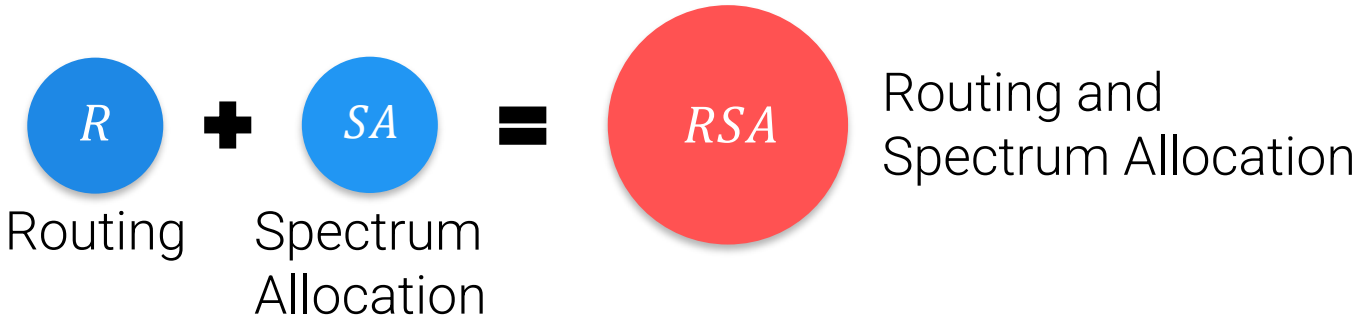
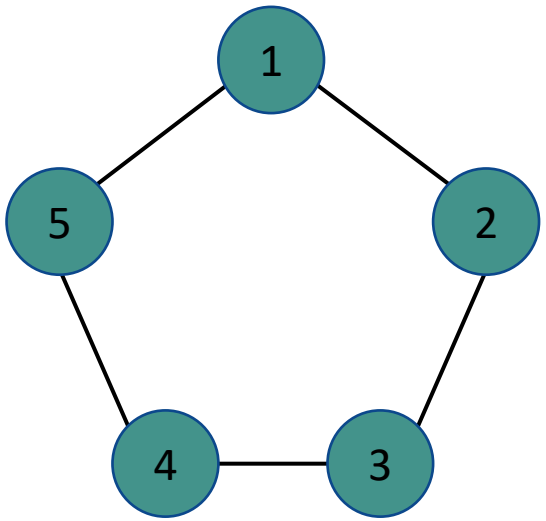
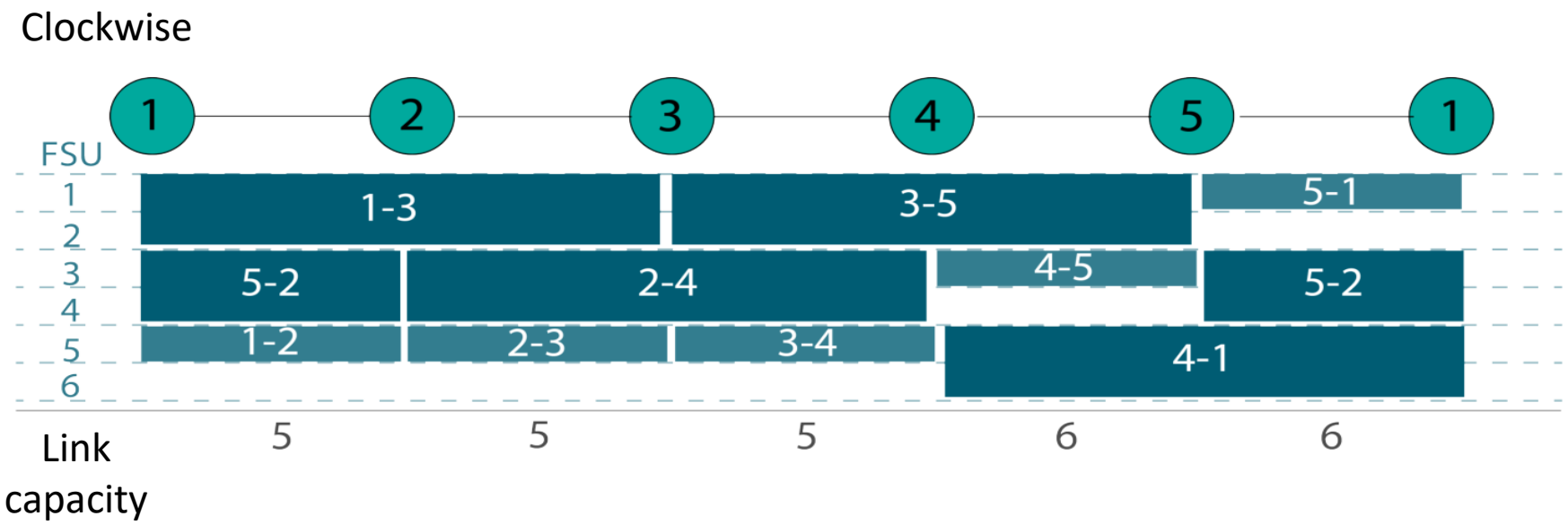
Resource Allocation







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Techniques to solve resource allocation problems

Optimization Techniques

Integer Lineal Programming (ILP)
Mixed Integer Lineal Programming (MILP)

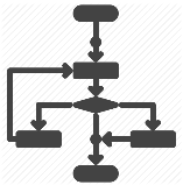
min (*Cap*)
min (Frag)

- RMSA
- RBMSA

NP-complete

Heuristics Meta-Heuristics

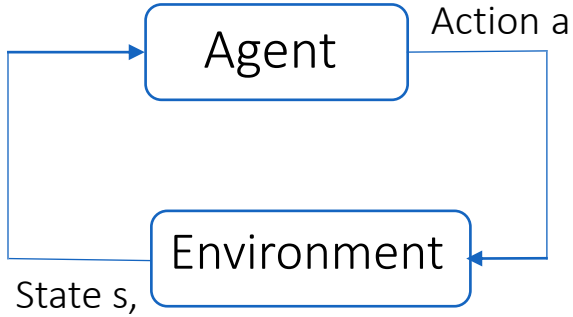
Problem can be divided in multiple sub-problems



Genetic Algorithms
Simulated Annealing
Ant Colonies

Do not guarantee optimal solutions

Deep Reinforcement Learning Techniques



Deep Reinforcement Learning Gym

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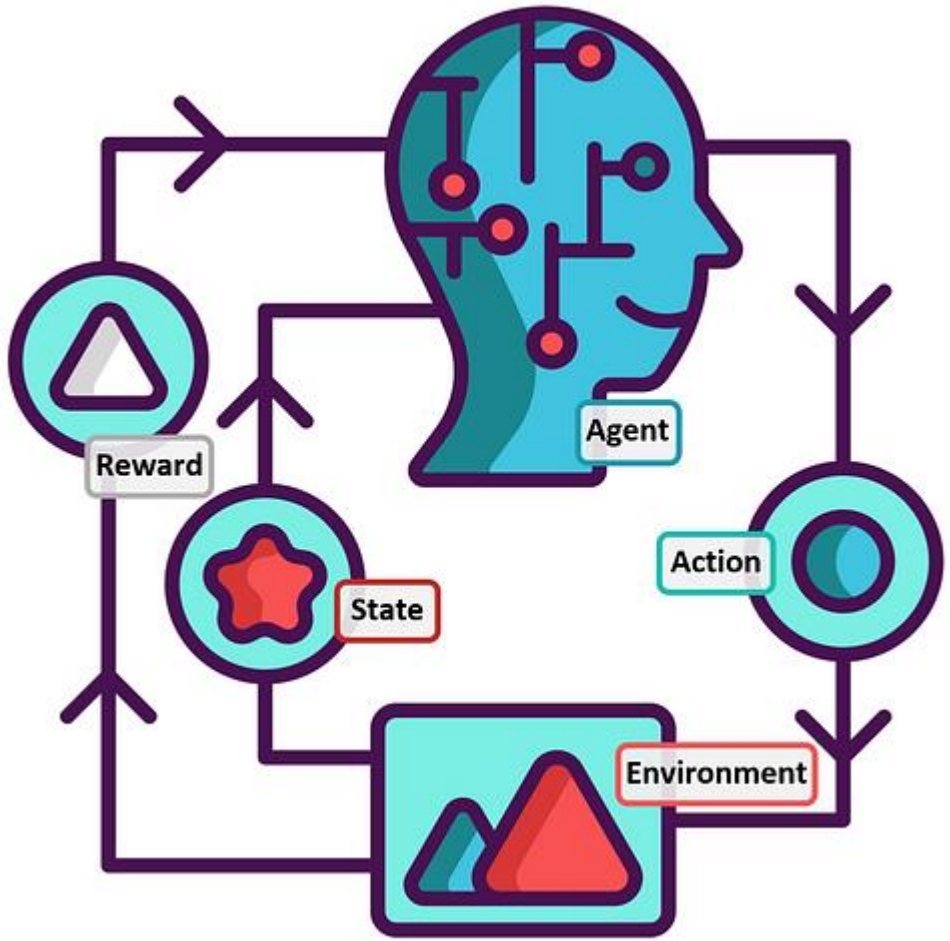
Deep Reinforcement Learning

Promising approach for various industries.

In optical networks, I/O constraints may be difficult to optimize standard optimization algorithms. DRL can help in building solutions for:

- Design new routing strategies for better use of the link resources (e.g., wavelengths, frequency spectrum, cores, bands), ensuring quality level or enabling capacity for network scalability.

- To develop and implement a dynamic resource allocation scheme that can respond to real-time changes in the network environment to maximize network performance.



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//www.freepik.com/free-photo/tired-young-student-boy-sitting-desk-with-school-tools-putting-head-books-isolated-yellow-wall_13740141.htm

Challenges

Main disadvantages of using DRL in ON is the cost associated with implementing and maintaining such systems.

Implementing these models is considered time-consuming, with a complex learning curve for development and application, which commonly includes creating them from scratch.

There are many parameters to be set for the training and evaluation, which in turn vary with the context of the problem

Our proposal

DREAM-ON GYM, a Deep REinforcement learning freAMwork for Optical Networks*.

- Follows the principles established by the OpenAI GYM.
- Straightforward implementation with easy-to-use functions and modules.
- Versatile framework for solving any resource allocation problem in many optical network architectures, such as routing, spectrum or wavelength allocation, band or core selection in multiband or multicore architectures.
- Compatible with the Stable Baselines library
- For the training and testing evaluations, we adapted the Flex-Net-Sim Simulator **

* Code available at: https://gitlab.com/IRO-Team/dream-on-gym
** F. Falcón, G. España, and D. Bórquez-Paredes, “Flex net sim: A lightly manual,” 2021

Application, Environment and Simulator Interaction

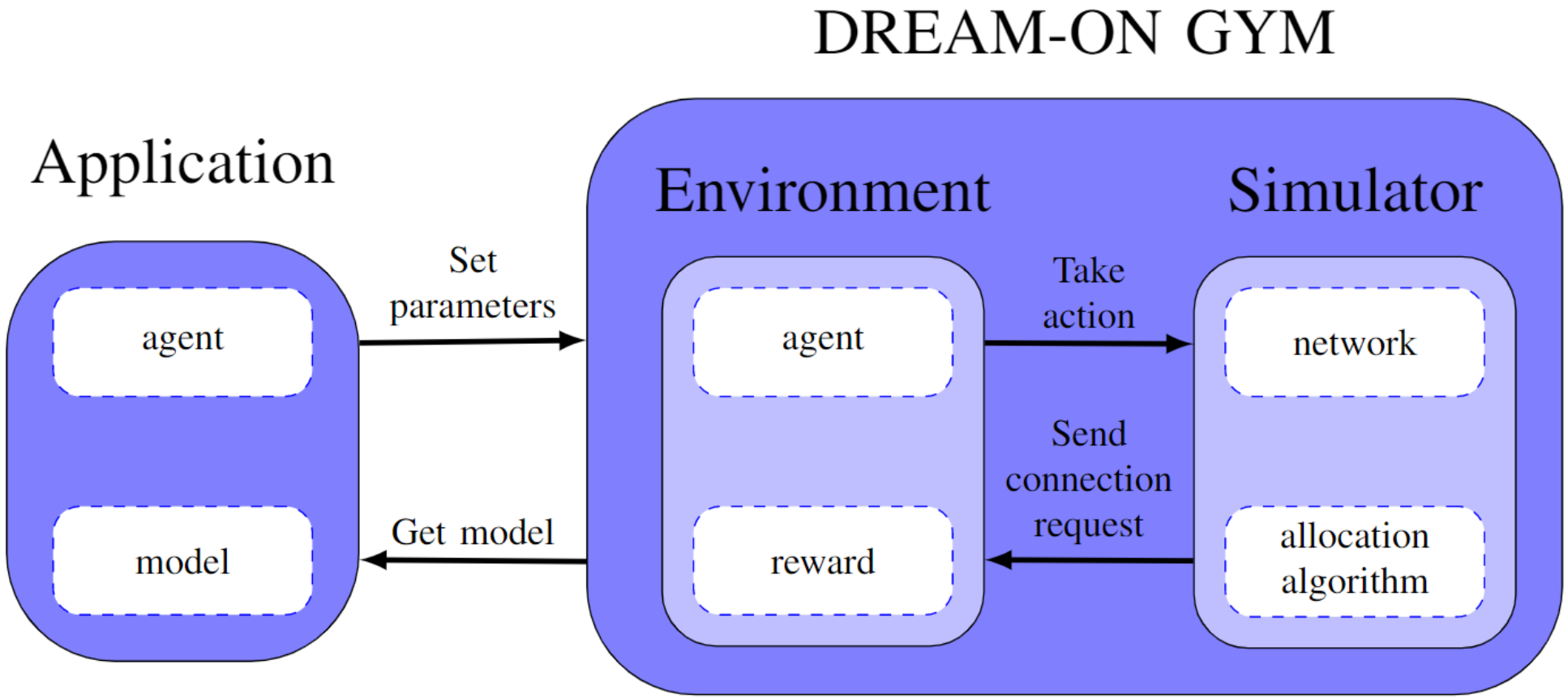
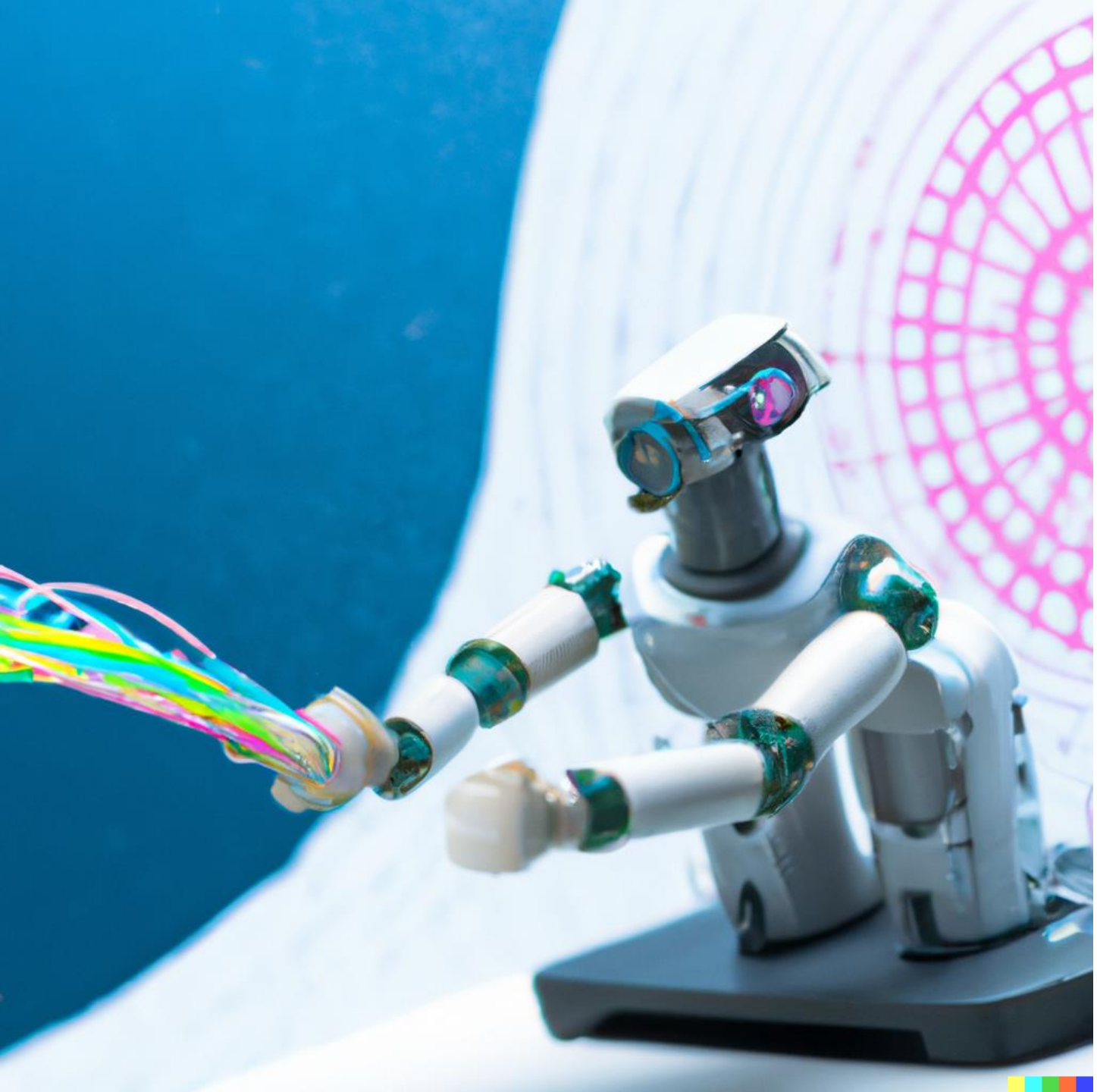


Figure: Schematic of the developed RL framework. Left: the application including the agent and model and their interactions. Right: a breakdown of the environment and simulator interaction.



DEMO

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Conclusions and Future Work

1. The framework allows the implementation of deep reinforcement learning in a straightforward and versatile manner to solve resource allocation problems in optical network architectures
2. This way, we reduce the time and complexity of implementing and evaluating DRL for Optical Network problems.
3. In future works, we will add new capabilities to the framework, such as compatibility for survivability problems.
4. We will use the framework to allow interpretability and generalization of the models while training and evaluating DRL in optical networks.

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Download our tool on pipy or
https://gitlab.com/IRO-Team/dream-on-gym
https://gitlab.com/IRO-Team/dream-on-gym-app

Please follow us at:
https://iro-team.gitlab.io/

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