

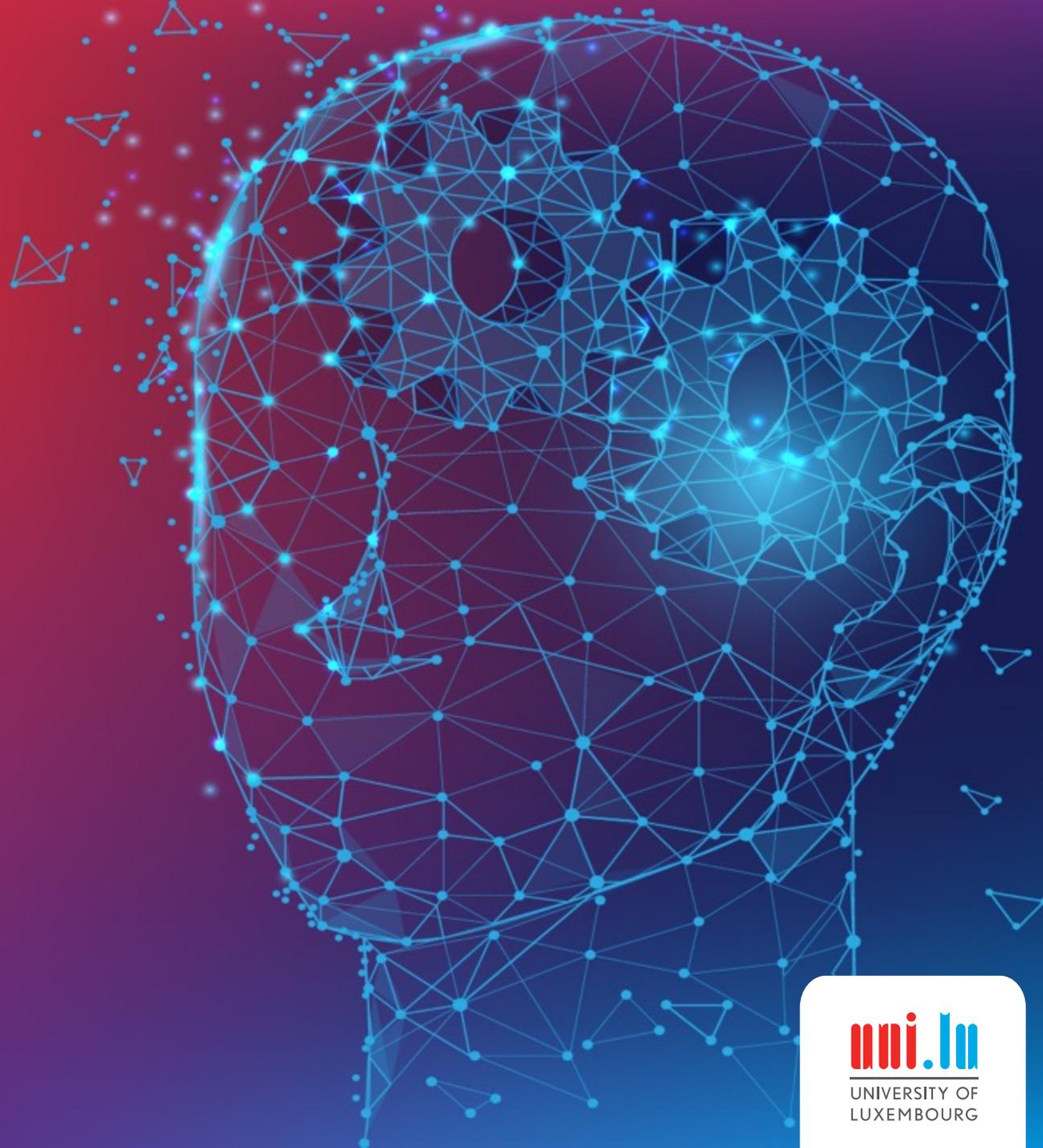
PCOG

Yearly Team Meeting

Dr. Grégoire Danoy

December 14, 2020

Research Projects



UNIVERSITY OF
LUXEMBOURG

On-going projects

- **ILNAS/ANEC** - Digital Trust / Standardization in Big Data & AI, Cloud Computing and Smart Cities (Drone swarms)
- **H2020** - PRACE-6IP
- **ONRG US Navy Award** - HUNTED project
- **FNR PoC** - Swarm Intelligent Missions systems
- **FNR PRIDE** - Doctoral Training Unit “Digital History & Hermeneutics”
- **ANR** - Energy efficient HPC – ENERGUMEN project

The logo for ILNAS, with 'IL' in orange and 'NAS' in blue.The logo for ANR, with 'ANR' in blue.

Accepted projects

ILNAS



Fonds National de la
Recherche Luxembourg



ILNAS/ANEC Research Programme (2021-2024)

- PI: Prof. Pascal Bouvry
- Budget: 1.4M€ (720k€ ILNAS funding)

FNR CORE ADARS (2021-2024)

- PI: Dr. Grégoire Danoy
- Budget: 950k€ (690k€ FNR funding)

EIB STAREBEI STAIRS (2021)

- PI: Prof. Pascal Bouvry
- Budget: 55k€



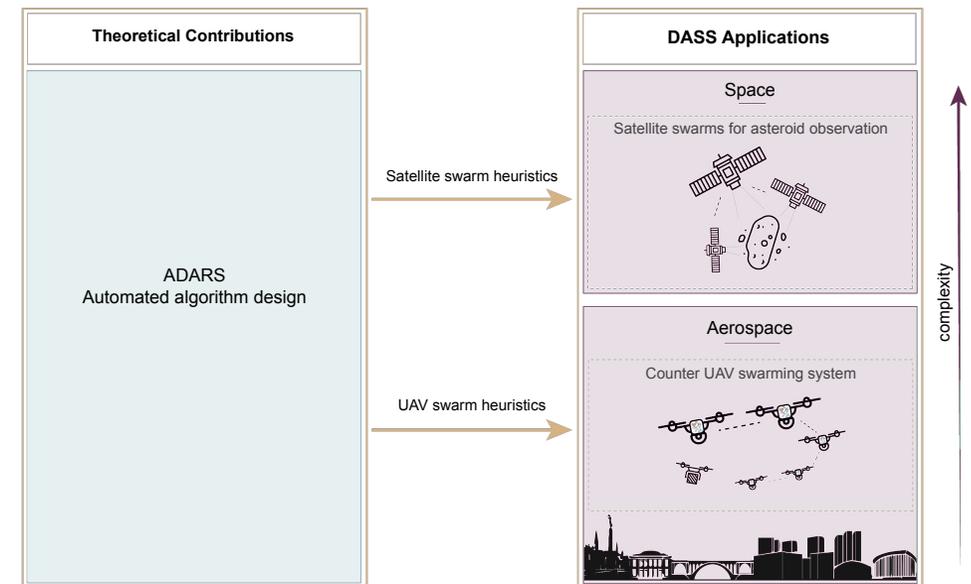
Construction



ICT



Aerospace



Projects under evaluation

H2020 - SUSPECT

- Swarms of Unmanned Surveillance Platforms Extended to Collaborative Teaming
- PI: Dr. Grégoire Danoy
- Budget: 7M€ (UL-SnT: 700k€)
- Consortium: 18 members - Thales, Fraunhofer IOSB, Univ. Bordeaux, Polish Naval Academy, Hellenic Police, etc.

FNR/ANR INTER – AutoDNN

- Automated design of deep neural networks
- PI: Prof. Pascal Bouvry
- Budget: 580k€ (280k€ FNR)

FNR/ANR INTER – UltraBO

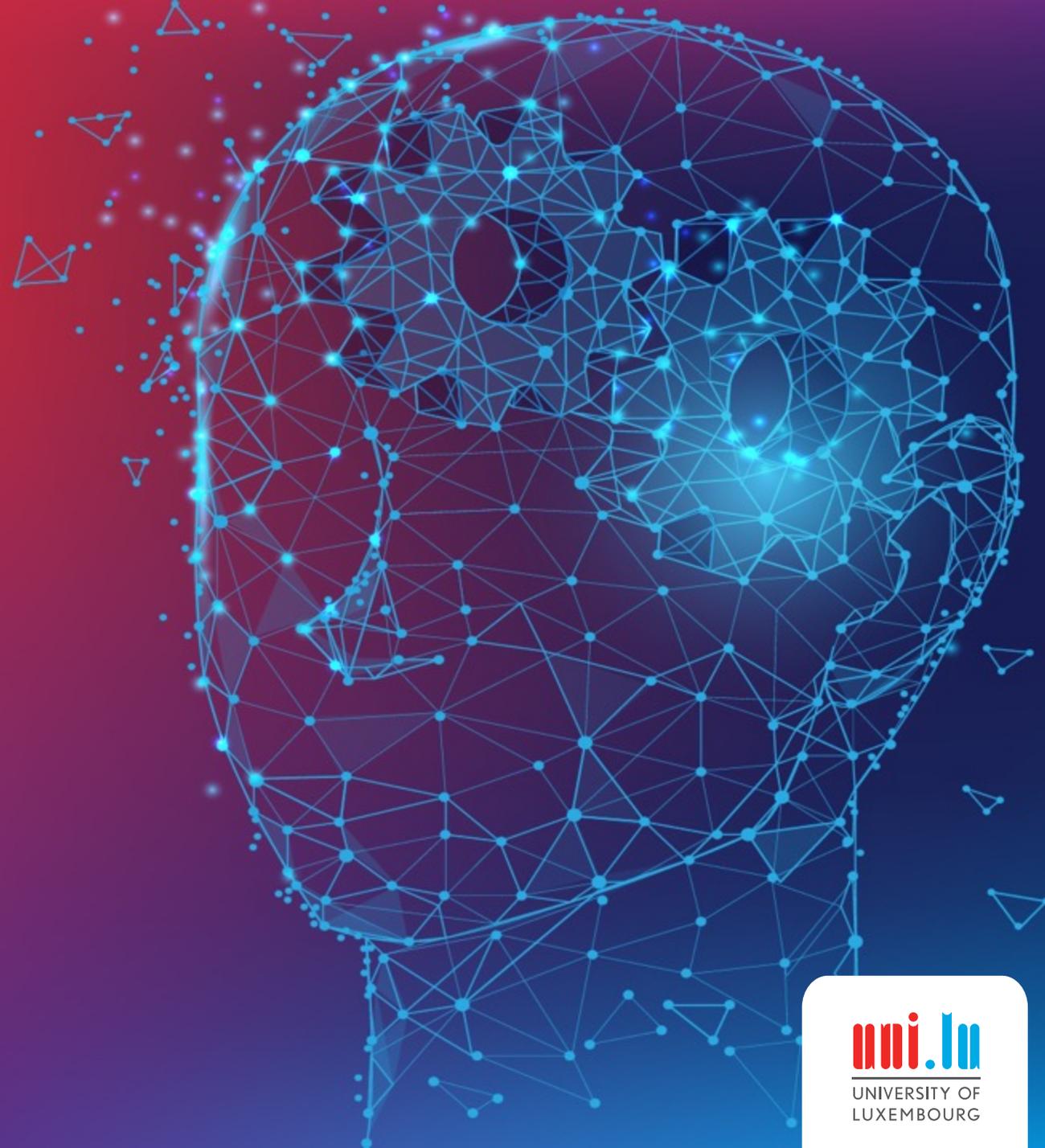
- Ultra-scale Computing for solving Big Optimization Problems
- PI: Dr. Grégoire Danoy
- Budget: 500k€ (280k€ FNR)

UL AUDACITY – HPSEEK

- High Performance Knowledge Graph Exploration in Biomedicine
- PI: Prof. Pascal Bouvry, co-PIs: Prof. Reinhard Schneider / Dr. Grégoire Danoy
- Budget 390k€



Research and Tech. Transfer Activities



Current Research

UAS swarms

- Embedding wireless communication interface
- Form Flying Ad Hoc Networks (FANETs)

Research challenges

- New mobility models for UAS swarms

Applications

- Surveillance
- Tracking
- Escorting
- Traffic Management



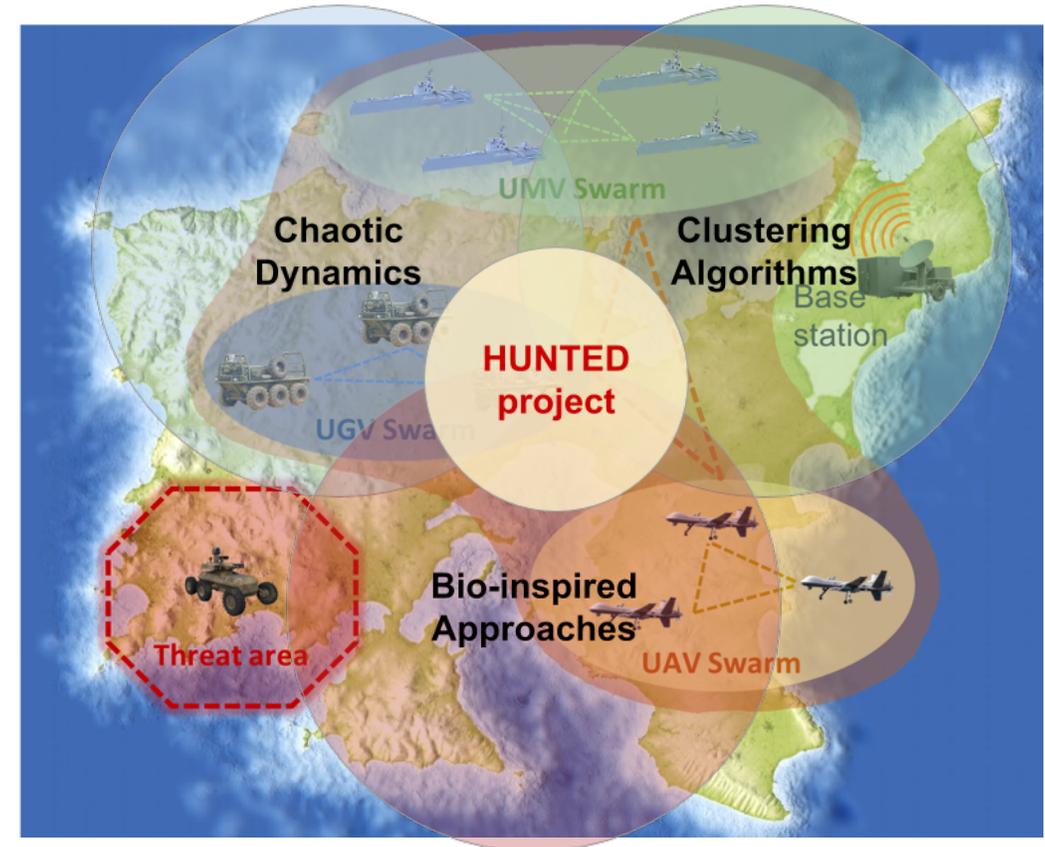
Multi-swarms for surveillance

<http://hunted.gforge.uni.lu>

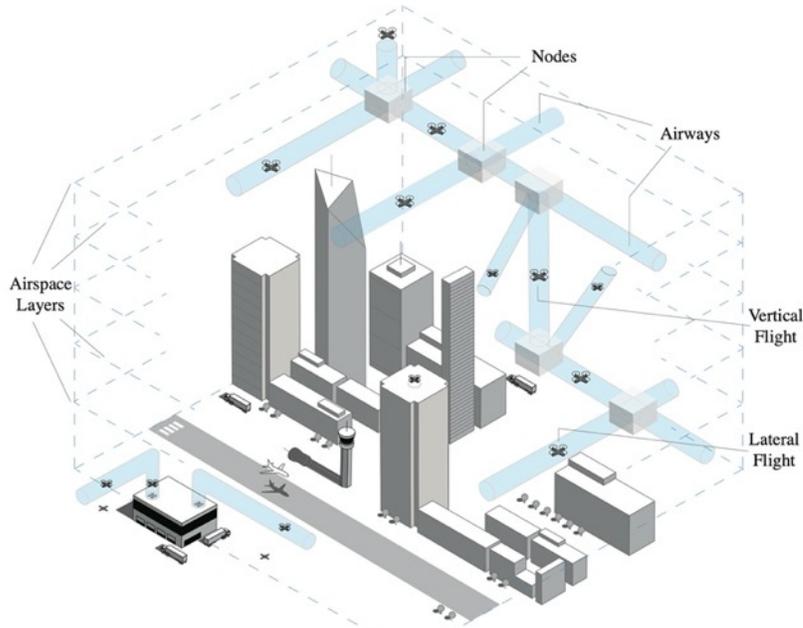
HUNTED - Heterogeneous multi-swarms of UNmanned auTonomous systEms for mission Deployment

New generation of swarming mobility model for heterogeneous multi-swarms

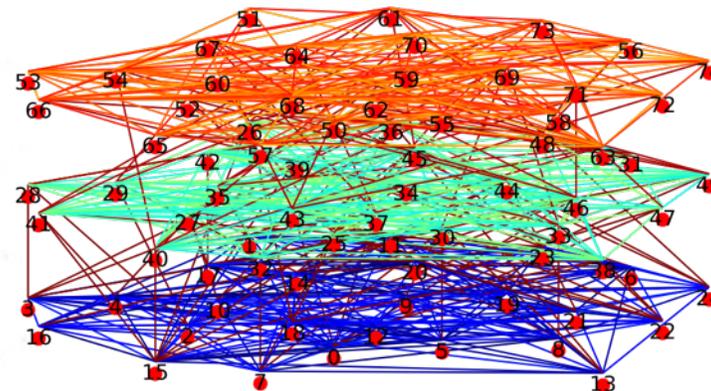
- Unmanned Aerial Vehicles
- Unmanned Ground Vehicles
- Unmanned Maritime Vehicles
- PI: Prof. Pascal Bouvry, co-PI: Dr. Grégoire Danoy
- Funding: ONRG (US Navy) – co-financing by US Air Force
- Budget: 275k\$ (238k€)



Multilayer Low-Altitude Airspace Model for Distributed UTM



New layered class G airspace model



Multi-level multi-weighted graph model

$$\min P = \sum_{i=1}^I \sum_{l=1}^L a_{il} * e_l \quad (1)$$

$$\min T = \sum_{i=1}^I \sum_{l=1}^L a_{il} * t_l \quad (2)$$

$$\text{s.t. } \sum_{i=1}^I a_{il} = c_l, l = 1, \dots, L, \quad (3)$$

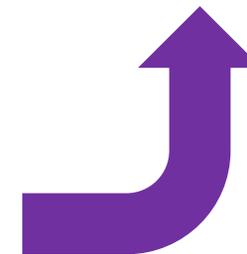
$$c_l \leq c_l^{max}, l = 1, \dots, L, \quad (4)$$

$$a_{il} \in \{0,1\}, i = 1, \dots, I, l = 1, \dots, L, \quad (5)$$

$$P, T \in \mathbb{N}, \quad (6)$$

$$e_l, t_l, c_l \in \mathbb{N}, l = 1, \dots, L, \quad (7)$$

Distributed UTM optimisation model



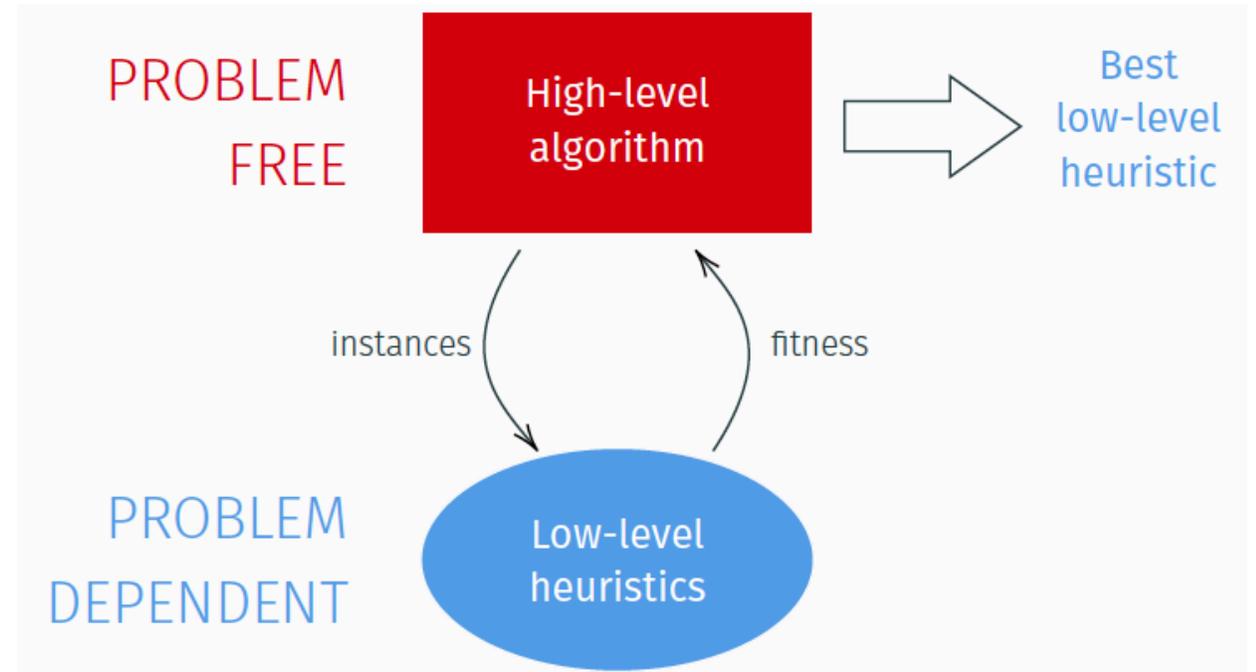
Automatic generation of swarming behaviours

Problem

- Developing and fine tuning efficient collective behaviours can be a challenging and time-consuming task

Proposed approach

- Generative hyper-heuristics

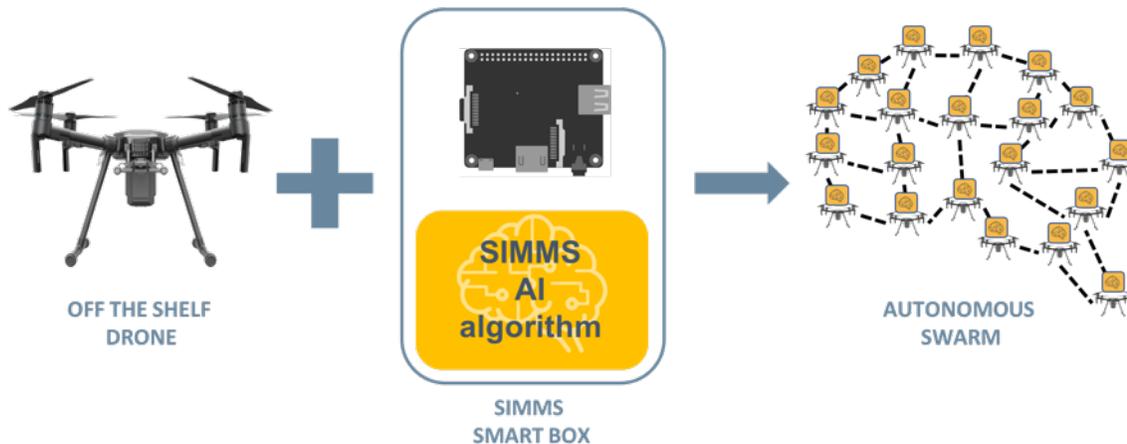


SIMMS

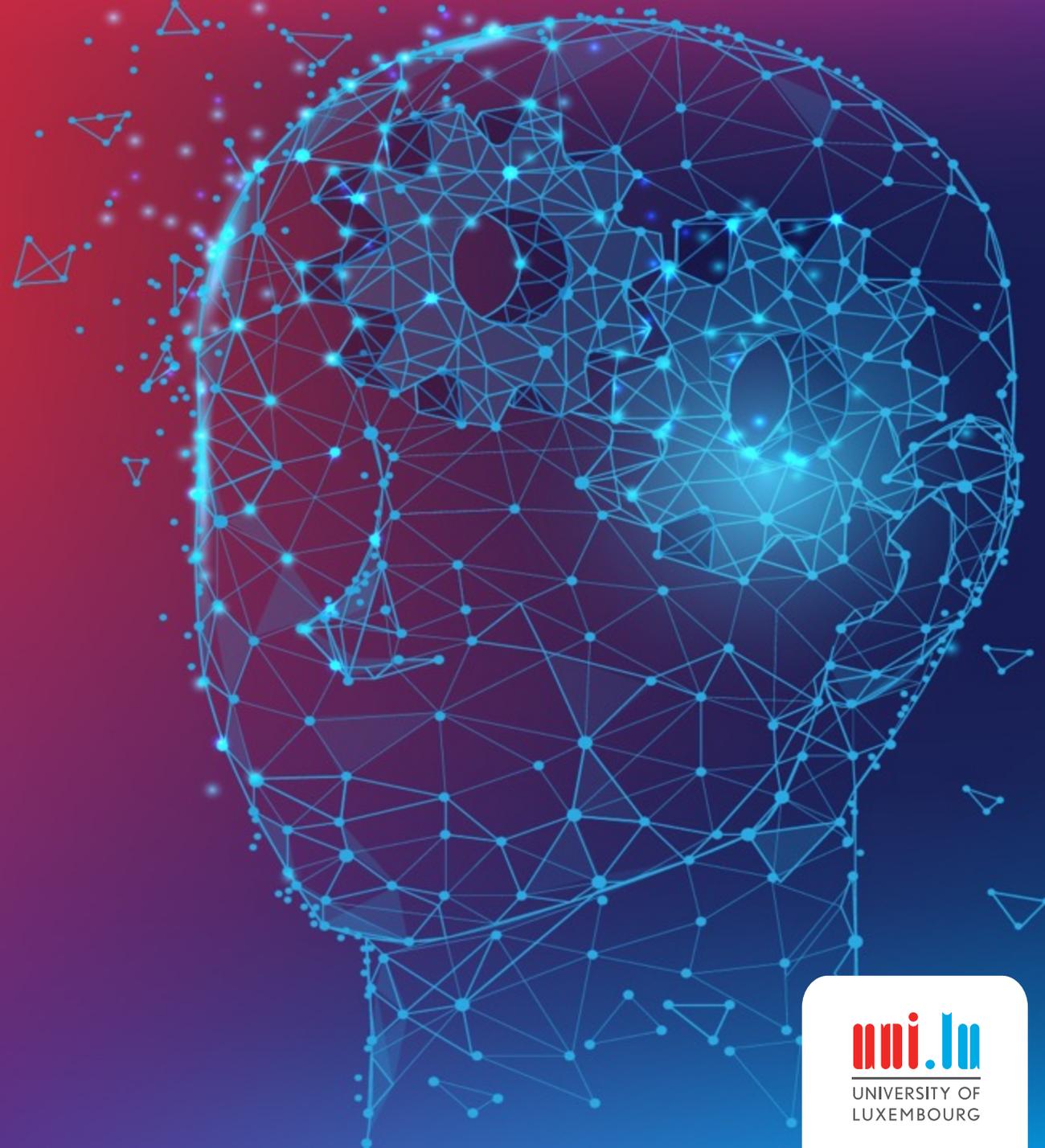
www.simms.lu

Swarm Intelligent Mission systemS

- PI: Dr. Grégoire Danoy
- Funding: FNR PoC
- Budget: 200k€
- Duration: 27 months
- A.I. powered box bringing swarming capabilities to off the shelf systems



Dissemination Activities



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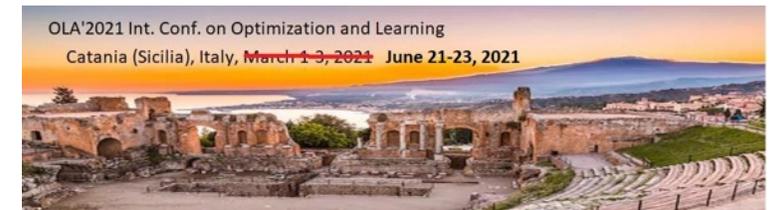
Scientific events organisation

Past

- OLA 2020 (Cadiz, Spain), IEEE PDCO 2020 (online), GCAI 2020 (online), PSTrustAI 2020

Upcoming

- PaCOS 2020 (online) – January 25-29 2021 - <http://conf.cisedu.info/rp/hpcs20>
 - Workshop on Synergy of Parallel Computing, Optimization and Simulation
- CoSenseAI 2021 (Phuket, Thailand) – April 7-10 2021 - <https://aciids.pwr.edu.pl/2021/>
 - Special Session on Commonsense Knowledge, Reasoning and Programming in Artificial Intelligence
- OLA 2021 (Catania, Italy) - June 21-23 2021 - <https://ola2021.sciencesconf.org>
 - International Conference on Optimization and Learning
 - Deadline: December 18, 2020
- PDCO 2021 (Portland, USA) - May 17 2021 - <https://pdco2021.sciencesconf.org>
 - IEEE Workshop on Parallel / Distributed Combinatorics and Optimization
 - Deadline January 31, 2021



Publications

Journals:

- [1] A. M. Fiscarelli, M. R. Brust, G. Danoy, and P. Bouvry. A vertex-similarity clustering algorithm for community detection. *Journal of Information and Telecommunication*, 4(1):36–50, 2020.
- [2] E. Kieffer, G. Danoy, M. R. Brust, P. Bouvry, and A. Nagih. Tackling large-scale and combinatorial bi-level problems with a genetic programming hyper-heuristic. *IEEE Transactions on Evolutionary Computation*, 24(1):44–56, Feb 2020.
- [3] M. Rosalie, E. Kieffer, M. R. Brust, G. Danoy, and P. Bouvry. Bayesian optimisation to select rossler system parameters used in chaotic ant colony optimisation for coverage. *Journal of Computational Science*, 41:101047, 2020.
- [4] D. H. Stolfi, M. R. Brust, G. Danoy, and P. Bouvry. Emerging inter-swarm collaboration for surveillance using pheromones and evolutionary techniques. *Sensors*, 20(9):2566, 2020.

Conferences:

- [1] M. R. Brust, P. Bouvry, G. Danoy, and E. Talbi. Design challenges of trustworthy artificial intelligence learning systems. In P. Sitek, M. Pietranik, M. Krótkiewicz, and C. Srinilta, editors, *Intelligent Information and Database Systems - 12th Asian Conference, ACIIDS 2020, Phuket, Thailand, March 23-26, 2020, Companion Proceedings*, volume 1178 of *Communications in Computer and Information Science*, pages 574–584. Springer, 2020.
- [2] B. Changaival, G. Danoy, D. Kliazovich, F. Guinand, M. R. Brust, J. Musial, K. Lavangnananda, and P. Bouvry. NGAP: a novel hybrid metaheuristic algorithm for round-trip carsharing fleet planning. In C. A. C. Coello, editor, *GECCO '20: Genetic and Evolutionary Computation Conference, Companion Volume, Cancun, Mexico, July 8-12, 2020*, pages 259–260. ACM, 2020.
- [3] G. Danoy, D. E. Baz, V. Boyer, B. Dorronsoro, L. T. Yang, and K. Li. Workshop 9: PDCO parallel / distributed combinatorics and optimization. In *2020 IEEE International Parallel and Distributed Processing Symposium Workshops, IPDPSW 2020, New Orleans, LA, USA, May 18-22, 2020*, page 489. IEEE, 2020.
- [4] G. Duflo, G. Danoy, E. Talbi, and P. Bouvry. Automated design of efficient swarming behaviours: a q-learning hyper-heuristic approach. In C. A. C. Coello, editor, *GECCO '20: Genetic and Evolutionary Computation Conference, Companion Volume, Cancun, Mexico, July 8-12, 2020*, pages 227–228. ACM, 2020.
- [5] A. Gaudin, G. Madruga, C. Rodríguez, S. Iturriaga, S. Nasmachnow, C. Paz, G. Danoy, and P. Bouvry. Autonomous flight of unmanned aerial vehicles using evolutionary algorithms. In J. L. Crespo-Marinó and E. Meneses-Rojas, editors, *High Performance Computing*, pages 337–352. Cham, 2020. Springer International Publishing.
- [6] D. H. Stolfi, M. R. Brust, G. Danoy, and P. Bouvry. Competitive evolution of a UAV swarm for improving intruder detection rates. In *2020 IEEE International Parallel and Distributed Processing Symposium Workshops, IPDPSW 2020, New Orleans, LA, USA, May 18-22, 2020*, pages 528–535. IEEE, 2020.
- [7] D. H. Stolfi, M. R. Brust, G. Danoy, and P. Bouvry. Optimizing the performance of an unpredictable UAV swarm for intruder detection. In B. Dorronsoro, P. Ruiz, J. C. de la Torre, D. Urda, and E. Talbi, editors, *Optimization and Learning - Third International Conference, OLA 2020, Cadiz, Spain, February 17-19, 2020, Proceedings*, volume 1173 of *Communications in Computer and Information Science*, pages 37–48. Springer, 2020.
- [8] D. H. Stolfi, M. R. Brust, G. Danoy, and P. Bouvry. A cooperative coevolutionary approach to maximise surveillance coverage of UAV swarms. In *17th Annual Consumer Communications & Networking Conference (CCNC)*. IEEE, 2020.



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