

MOTIVATION FOR STNS

Few tools for studying/contrasting behaviour

Number of Iterations	Improved Genetic Algorithm (Fitness Value)	Traditional Genetic Algorithm (Fitness Value)
1	46,500	44,000
11	47,000	45,000
21	47,500	45,500
31	47,500	46,000
41	47,500	46,000
51	47,500	46,000
61	47,500	46,000
71	47,500	46,000
81	47,500	46,000
91	47,500	46,000
101	47,500	46,000

Typical convergence plot – Only shows dynamics on the objective space

Generalise LONs

Algorithms with no Local Search

Population-based Algorithms

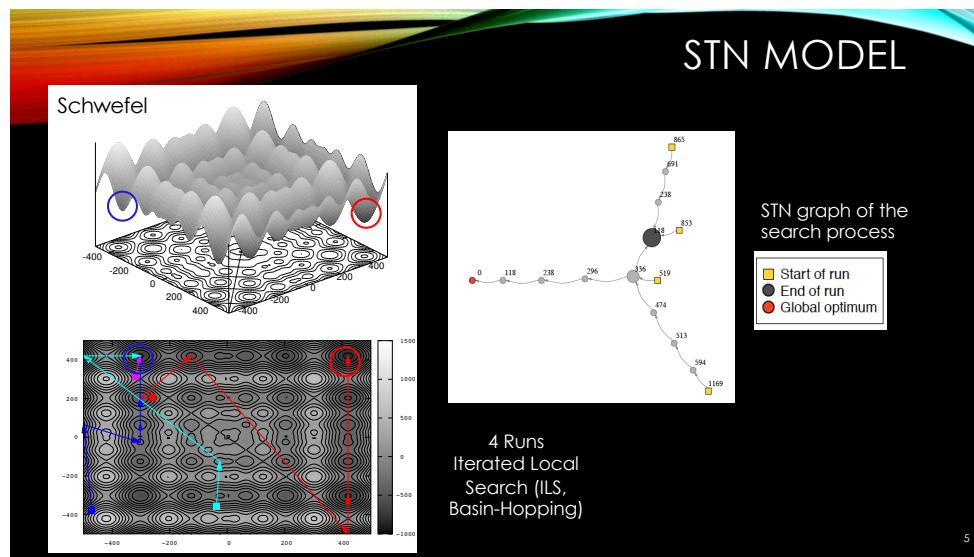
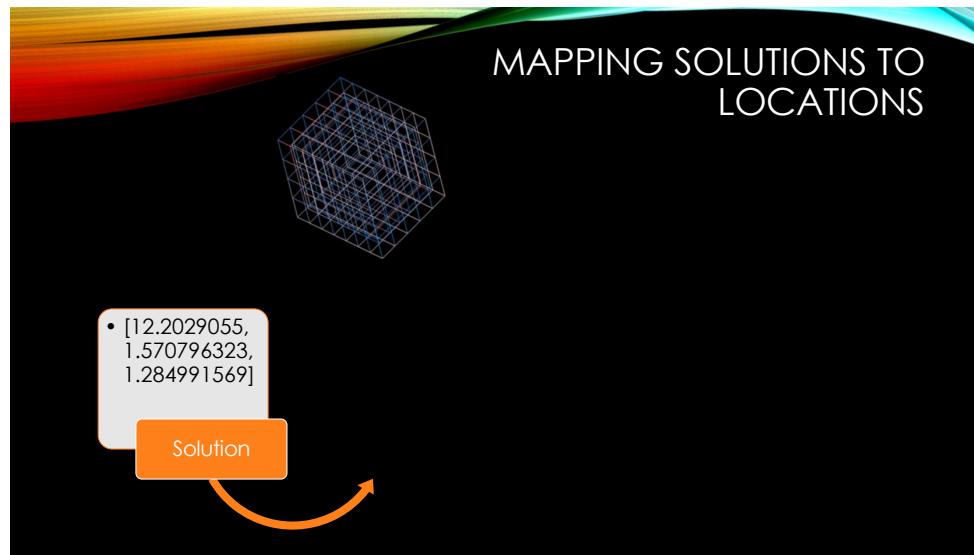
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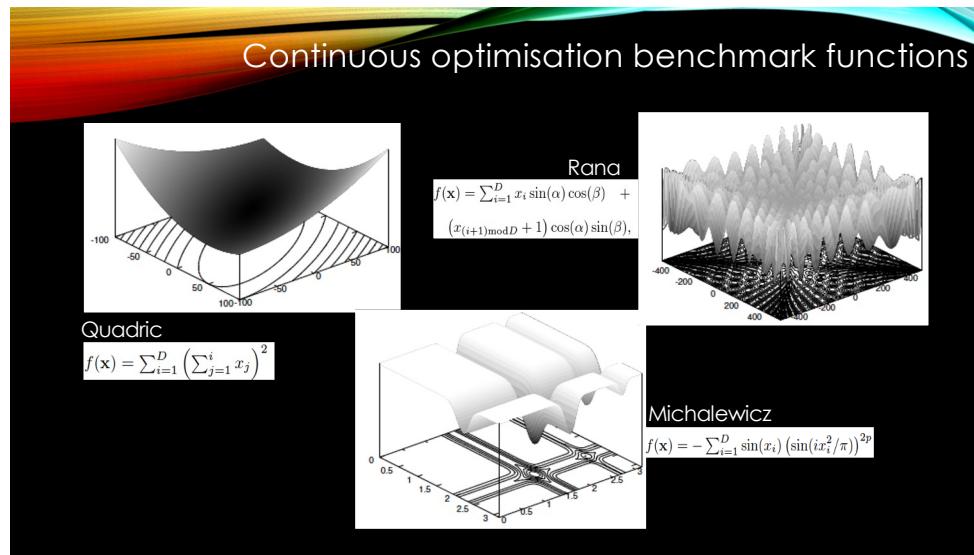
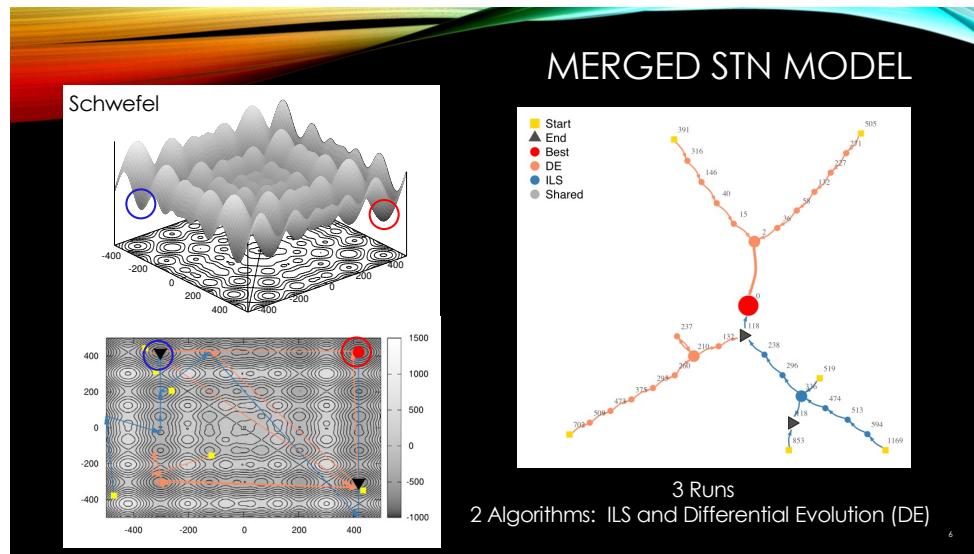
STN DEFINITIONS

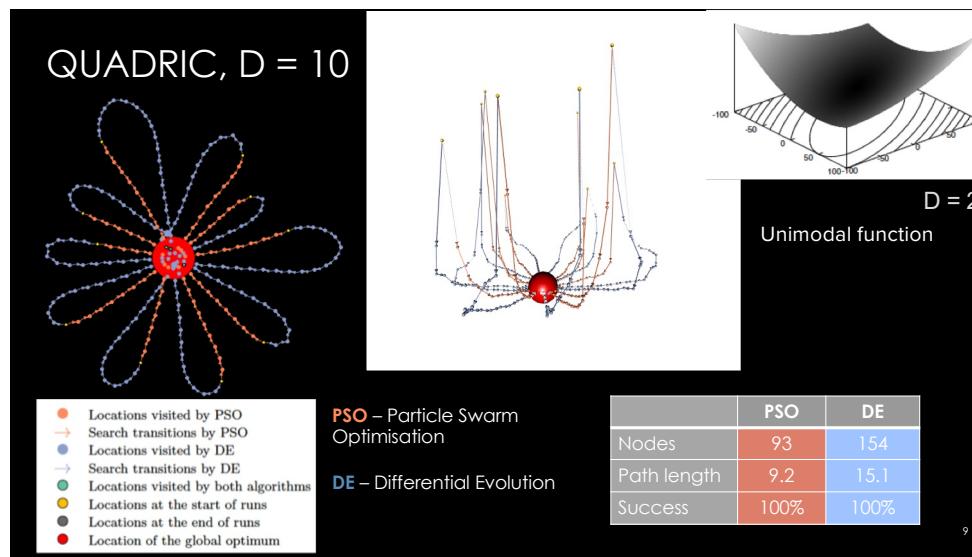
- Representative Solution** • Solution that represents status of the search process
- Location** • Subset of solutions, partition of the search space
- Nodes** • Locations of representative solutions
- Edges** • Directed, connect two consecutive locations
- STN** • Directed graph $STN = (N, E)$

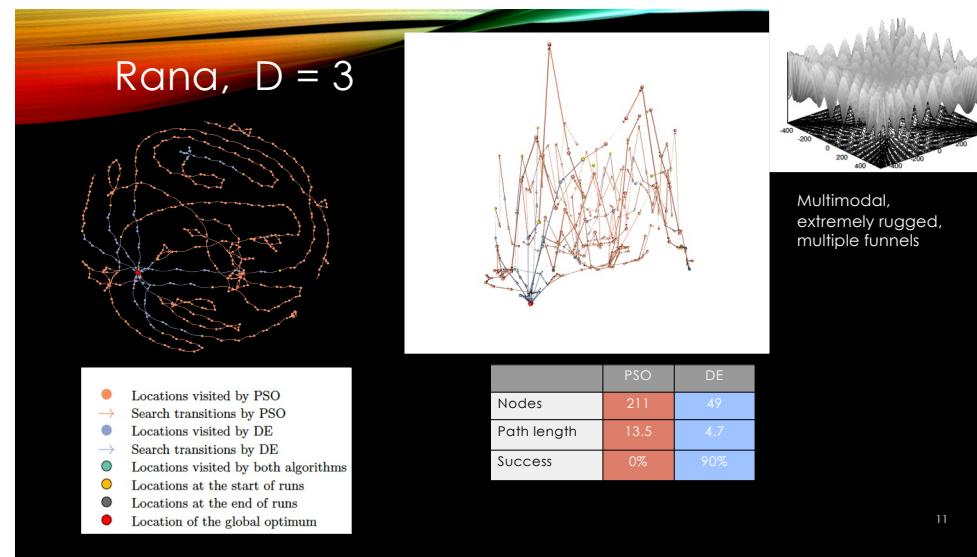
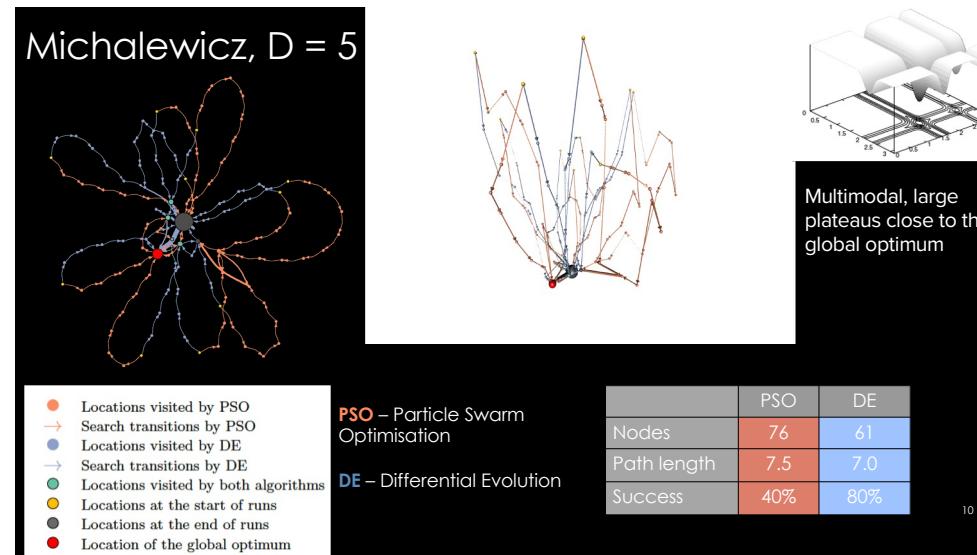
(Ochoa, Malan, Blum, EvoApps 2020, Appl. Soft Comput. 2021)

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MULTI-OBJECTIVE STNs

- A set of uniformly-generated weight vectors $(\lambda^1, \lambda^2, \dots, \lambda^p)$, scalar sub-problems
- Nodes:** representative solutions (ρ each iter.)
- Edges:** follow trajectories for each vector λ^i
- STNs for all vectors are aggregated in a single STN model
- ρ parameter related to granularity

$$\text{STN}_{\text{MO}} = G(N_{\lambda_1} \cup N_{\lambda_2} \cup \dots \cup N_{\lambda_p}, E_{\lambda_1} \cup E_{\lambda_2} \cup \dots \cup E_{\lambda_p})$$

(Lavinas, Aranha, Ochoa, EvoApps 2022)
(Ochoa, Liefoghe, Lavinas, Aranha EvoApps 2023)

Decomposition
Decompose into a number of scalar subproblems and optimise them simultaneously.
Chebyshev scalarising function

STN METHODOLOGY

Network Metrics

Metric	Description
nodes	No. unique solutions visited
pareto	No. solutions in the Pareto set
mean pareto in	Avg. incoming degree Pareto nodes
pareto num path	No. paths to Pareto nodes
pareto mean path	Mean shortest path to Pareto nodes

Visualisation

Two Layouts

- Force-directed
- Objective-space

Position

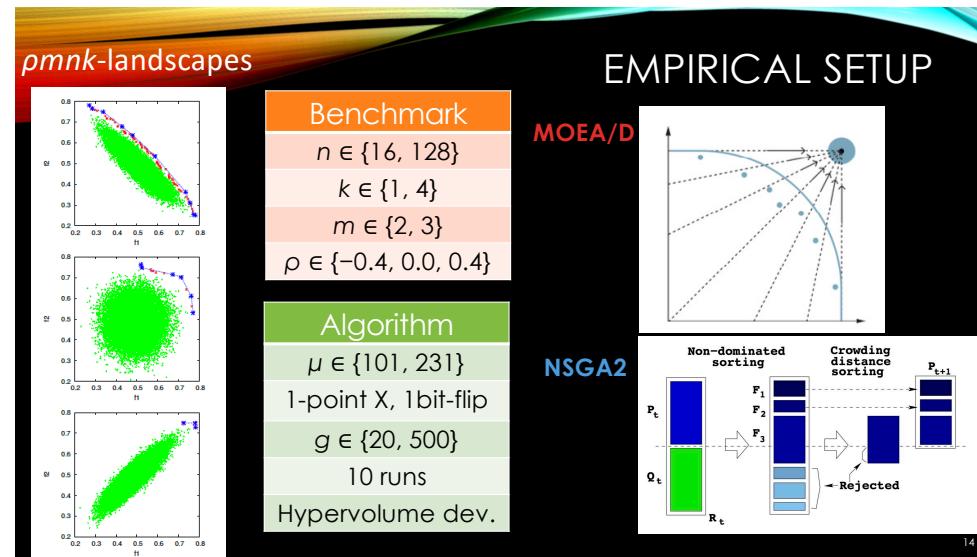
- Begin
- ▲ End
- Medium
- Pareto

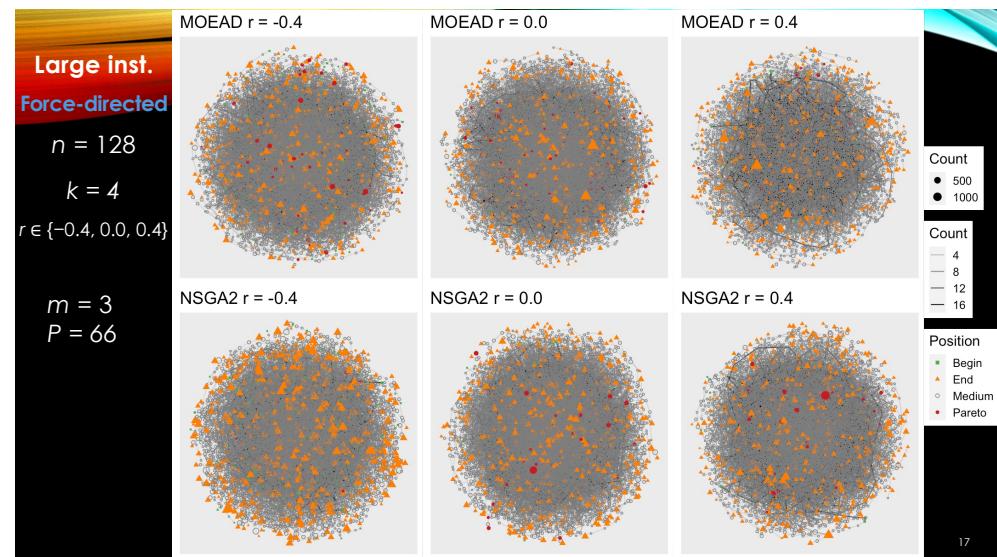
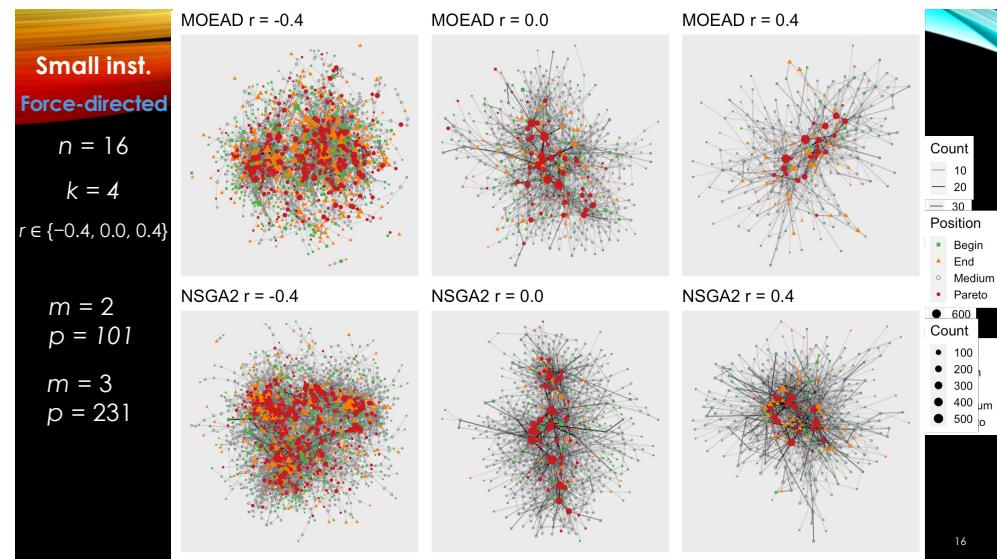
Count

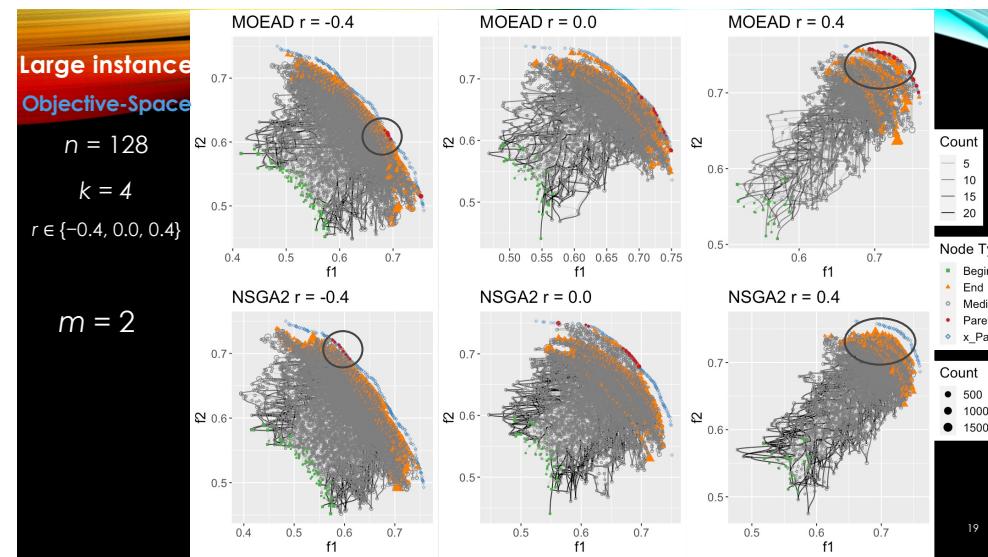
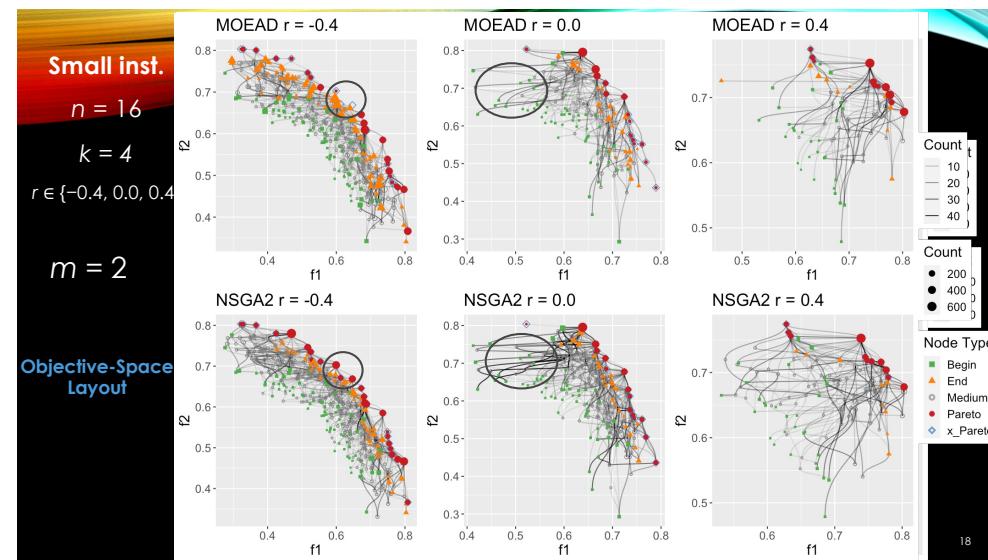
- 10
- 20
- 30
- 40

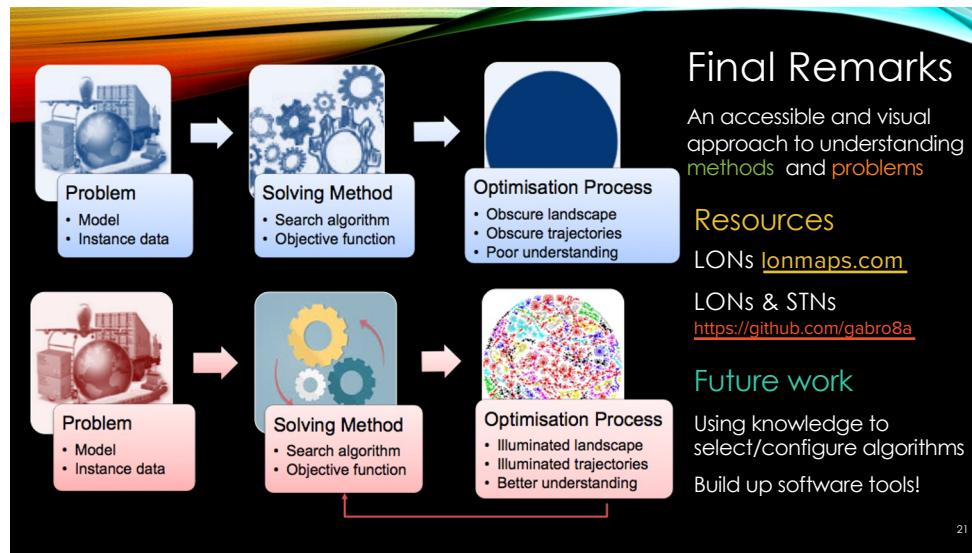
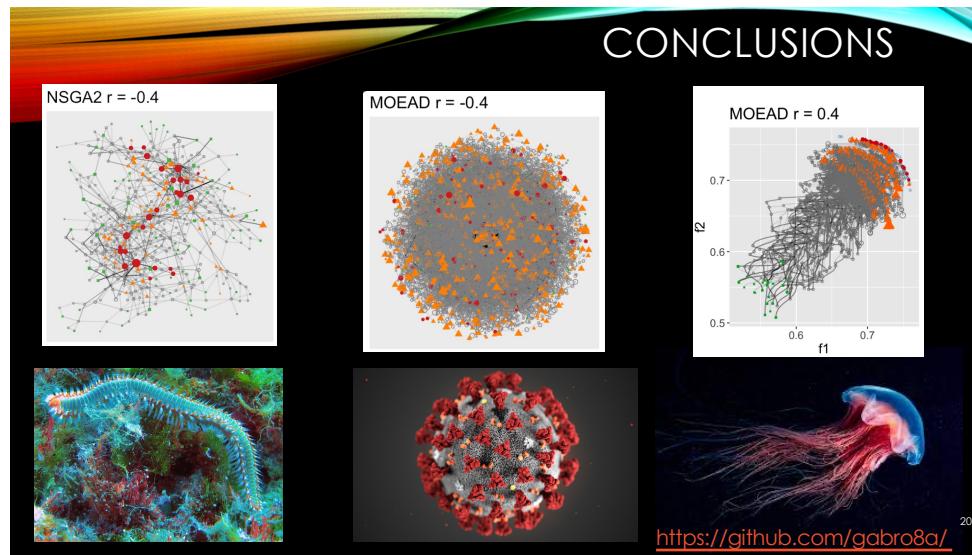
Count

- 400
- 800
- 1200











REFERENCES (STNS)

- G Ochoa, K M Malan, C Blum (2020) **Search Trajectory Networks of Population-Based Algorithms in Continuous Spaces**. *EvoApplications 2020*: 70-85
- G Ochoa, K M Malan, C Blum (2021) **Search trajectory networks: A tool for analysing and visualising the behaviour of metaheuristics**. *Appl. Soft Comput.* 109: 107492
- Y Lavinhas, C Aranha, G Ochoa (2022) **Search Trajectories Networks of Multiobjective Evolutionary Algorithms**. *EvoApplications 2022*: 223-238
- G Ochoa, A Liefooghe, Y Lavinhas, C Aranha (2023) **Decision/Objective Space Trajectory Networks for Multi-objective Combinatorial Optimisation**. *EvoCOP 2023*: 211-226

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