A line of research on vehicle routing problems supported by simulation and logistic projects.

AUTHORS

Diego Crespo Pereira

Alejandro García del Valle

David del Río Vilas

Rosa Ríos Prado

Arturo Nieto de Almeida

UNIVERSIDADE DA CORUÑA

grupo integrado de ingeniería

Summary

1. Group for Engineering Research
2. Lines of Research
3. Recent Research Projects
4. ELOCONS
5. Prioritization Rules Evolution
6. Conclusions
7. Future / Current Work

Introduction

Group for Engineering Research
University of A Coruña

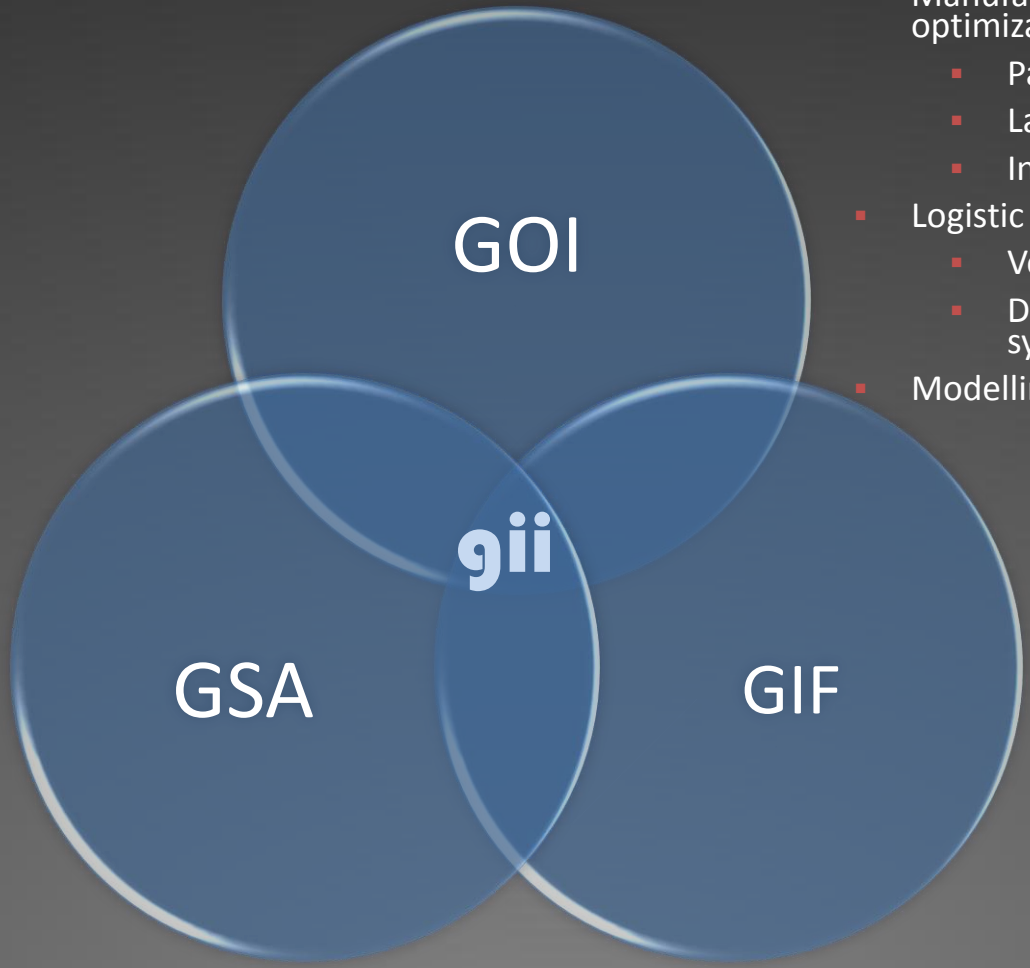
Group for Engineering Research

- Multidisciplinary group involved in research activities in a broad range of fields related to engineering and computing.
- Ferrol Campus of the University of Coruña.
- Departments: Computing, Naval Engineering and Management.

The Group Members

Industrial Engineering Group

- Manufacturing processes optimization
  - Parametric optimization
  - Layout design
  - Industrial ergonomics
- Logistic systems optimization
  - Vehicle routing problems
  - Dynamic transportation systems
- Modelling and Simulation



Autonomous Systems Group

- Signals processing
- Measurement systems and methods
- Artificial Intelligence
- Autonomous Robotics
- Environmental Intelligence
- High performance computing

Fluids Engineering Group

- Naval and oceanic technology
- Hydro and aerodynamics of vehicles and artifacts
- Numerical and experimental analysis of fluid flows

Group for Engineering Research

Activities

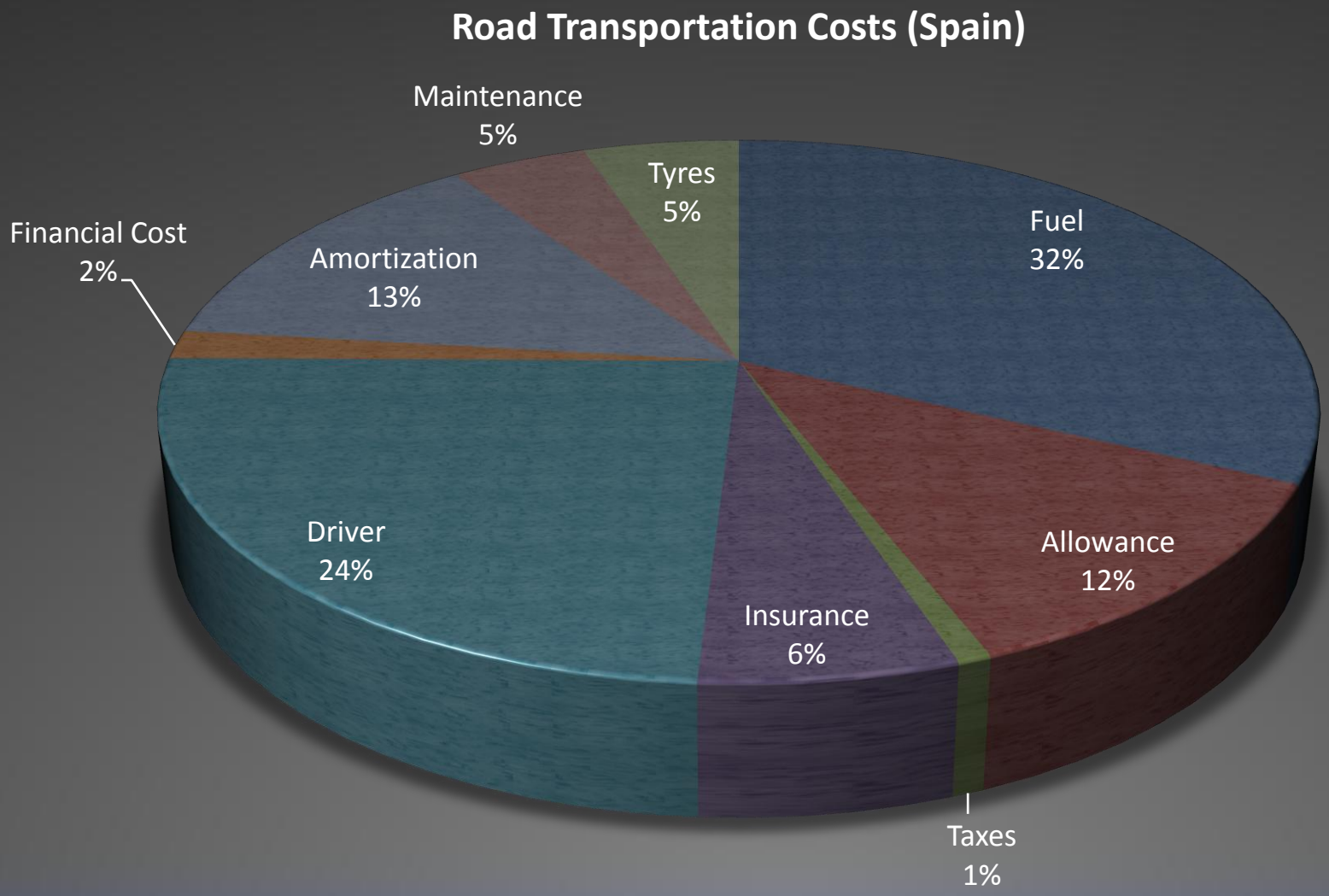
- Basic Research Lines
  - Basic Research Projects
  - PhD Thesis
  - Master Projects
  - Grants
- Applied Research Lines
  - Public funded projects (in collaboration with enterprises)
  - ***Projects for enterprises***

Lines of Research

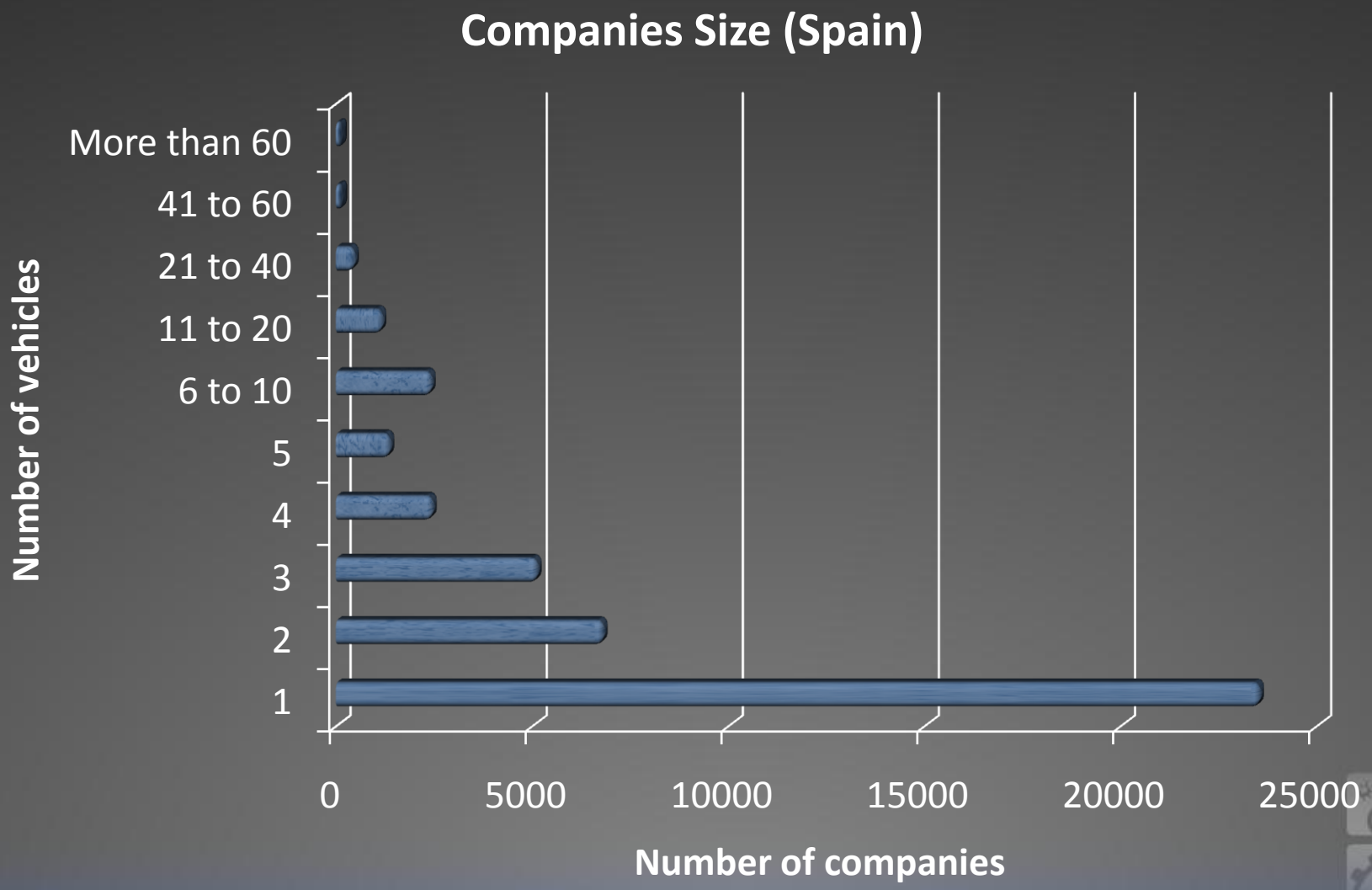
Transportation Enterprises in Spain

Line of research in routing problems

Enviroment: Spanish Carriers



Enviroment: Spanish Carriers



Enviroment: Spanish Carriers

- Small size bussineses
- Dependence on multinational corporations
- Null influence on transportation market prize
- Null influence on inputs prize
- Growing service level requirements

Need to increase productivity through managment->
ROUTES OPTIMIZATION

Enviroment: Spanish Carriers

Our goals

- Develop tools which to apply in research projects for enterprises
- Gain knowhow to undertake new and more complex projects
- Contribute to the research in these fields

Lines of research

Previous projects on routes optimization

Project for VRP aplication development

ElOCONS & Prioritization Rules Modelling

GIS Integration

ROUTES OPTIMIZATION PROBLEMS

Dynamic Problems Library

Aplication of Algorithms

DYNAMIC ROUTING PROBLEMS

Previous projects on processes optimization

S&M Projects in logistics systems

Statistical Analysis Modules

DEVS libraries and model components

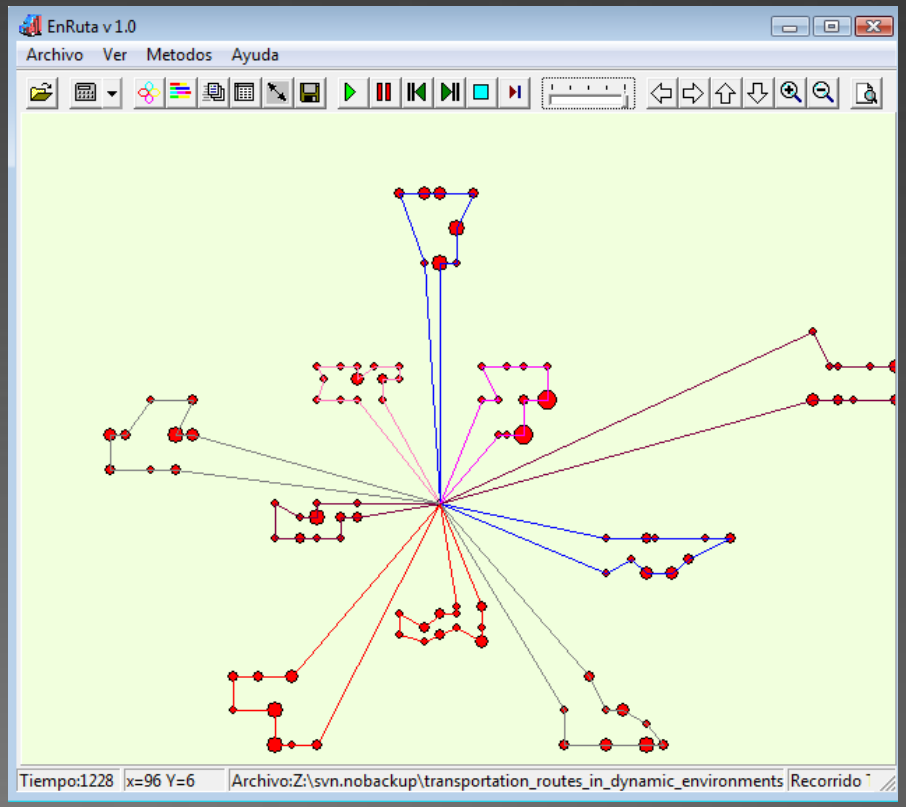
MODELLING AND SIMULATION

Recent Research Projects

Developments of an aplication for routes optimization

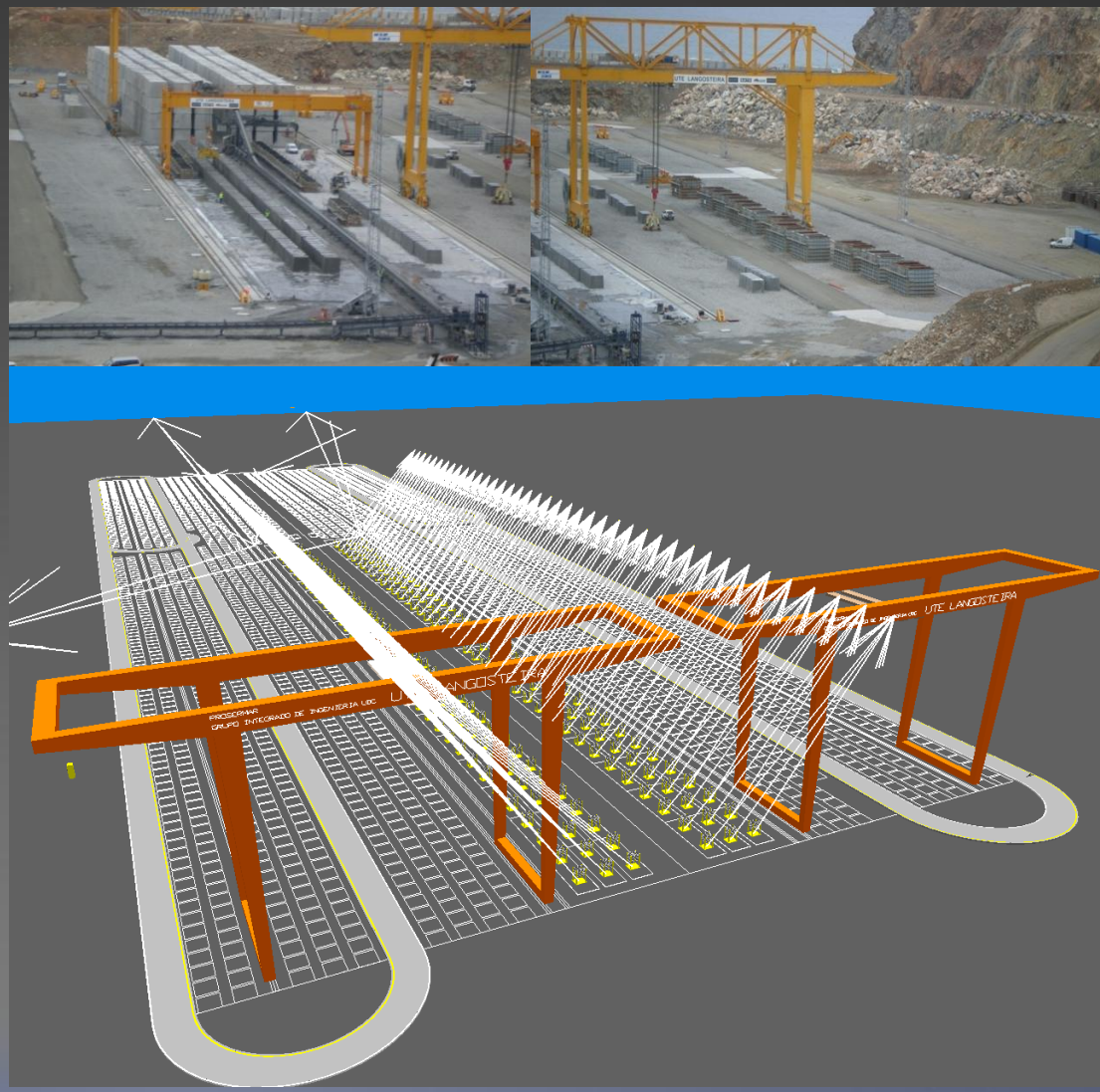
Recent Research Projects

- Development of an application for routes optimization in dynamic enviroments
- Basic research project that has supported research of algorithms in routing problems
- Development of a GUI aplication and JAVA library

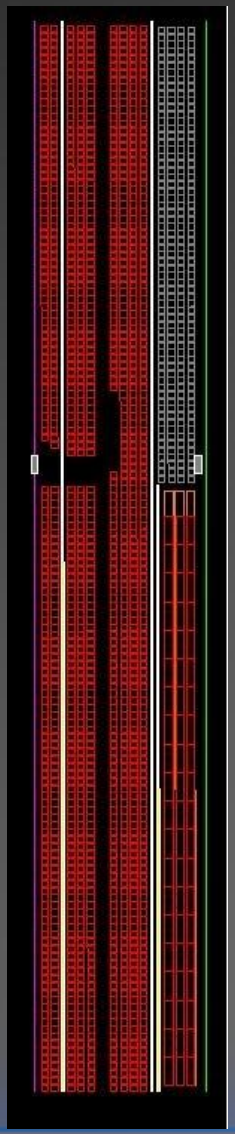


Recent Research Projects

- New port facilities at Punta Langosteira involve the construction of a large rubble mound breakwater that requires thousands of concrete armour units.
- Operational analysis of concrete units production plant.



Recent Research Projects

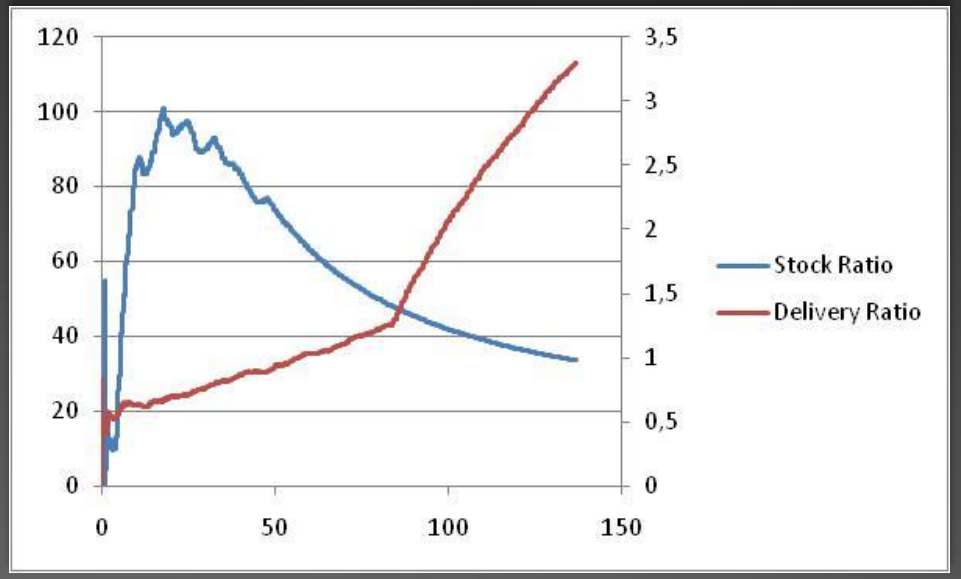


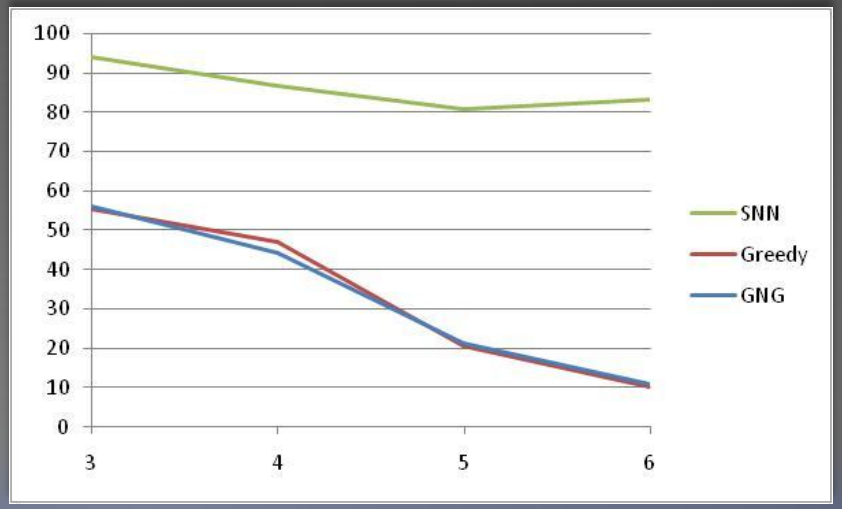
- Analysis of stacking phase (winter)
- It was found the optimal policy
- Comparison among stacking policies:
  - Traditional
  - Randomized
  - Optimal

Policy	Mean(m/block)
Optimal	86.80
Traditional	110.54
Random	112.80

Recent Research Projects

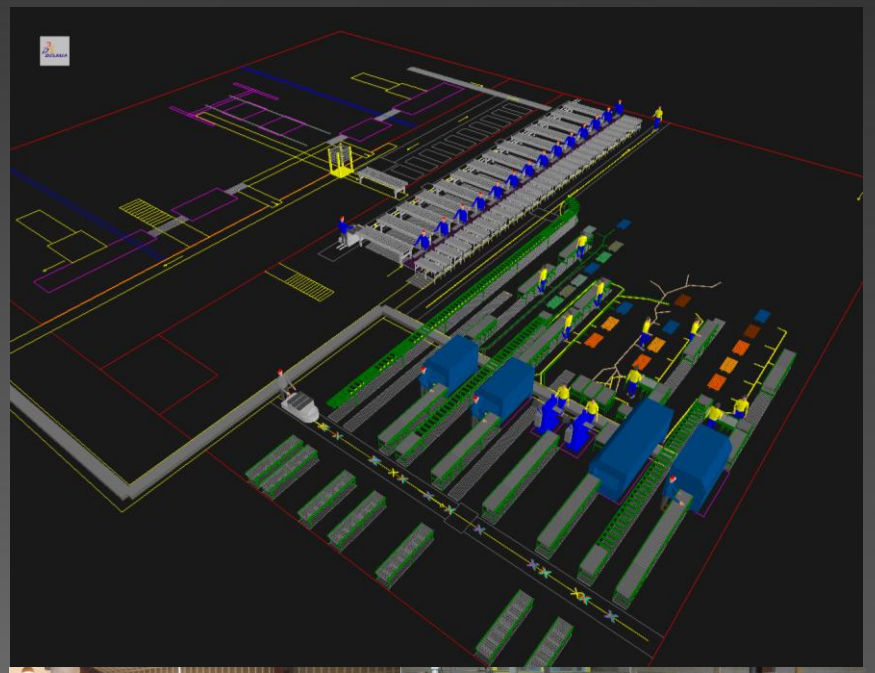
- Analysis of the input/output phase (summer)
- Comparison among policies:
  - Spread Nearest Neighbor (SNN)
  - Greedy
  - Greedy No Green (GNG)





M&S of a Natural Roofing Slates Manufacturing Plant

- M&S approach for:
  - Processes analysis
  - Logical model
- Input data phase:
  - Evaluation of available data
  - Definition on new data acquisition system
- Preliminary results:
  - Process analysis
  - Classification operation configuration



Recent Research Projects

- GLOBALOG project.
- 27 participants: research centers, universities, enterprises, port authorities.
- Improve competitiveness through logistics
- GII takes part in subproject 5: intermodal freight transportation planning.
  - Development of a model for mode choice analysis
  - Tool: TRANSCAD
  - Scenarios of analysis: Strengthen of maritime transportation

Algorithms

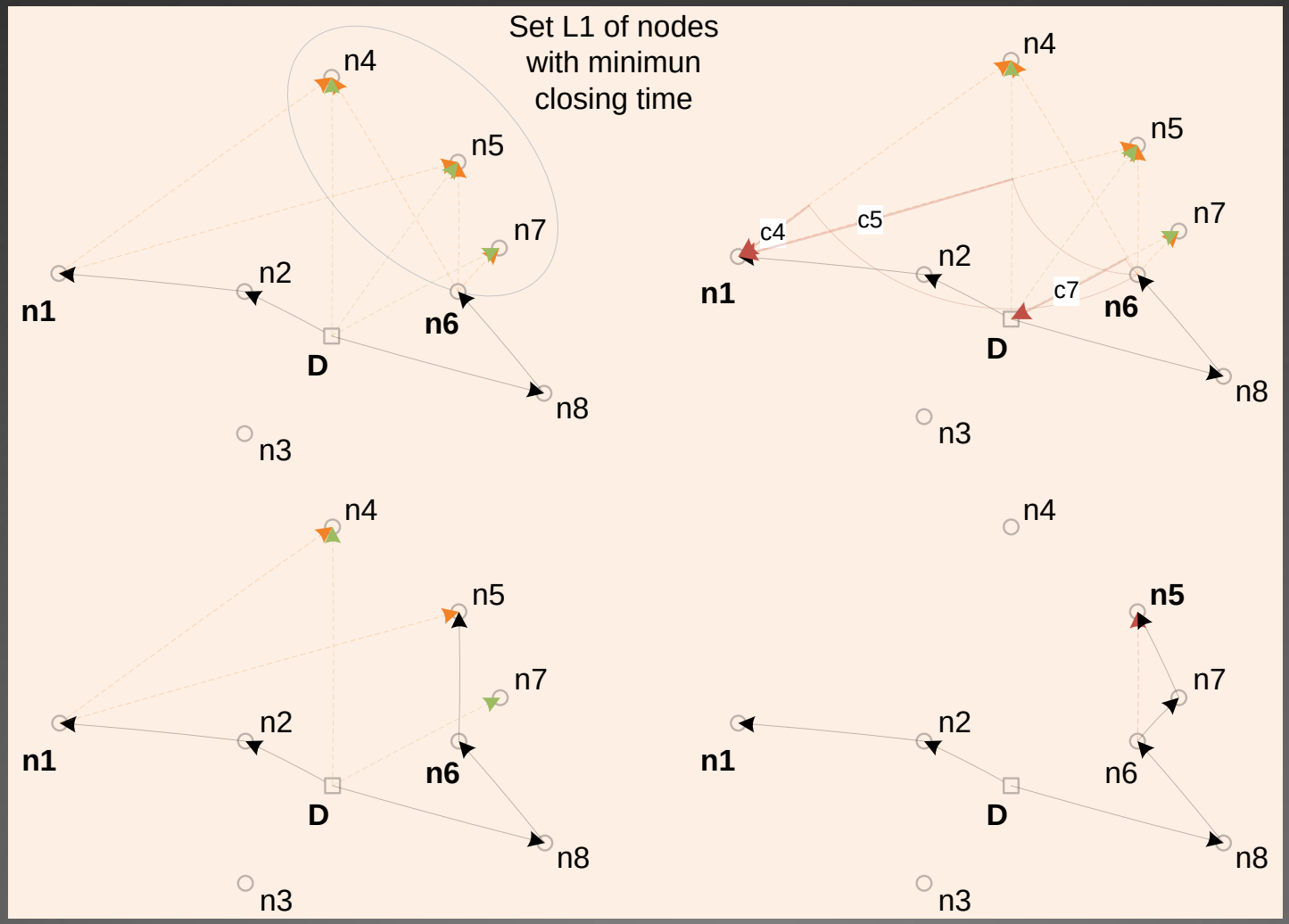
ELOCONS

Prioritization Rules Modelling

ELOCONS

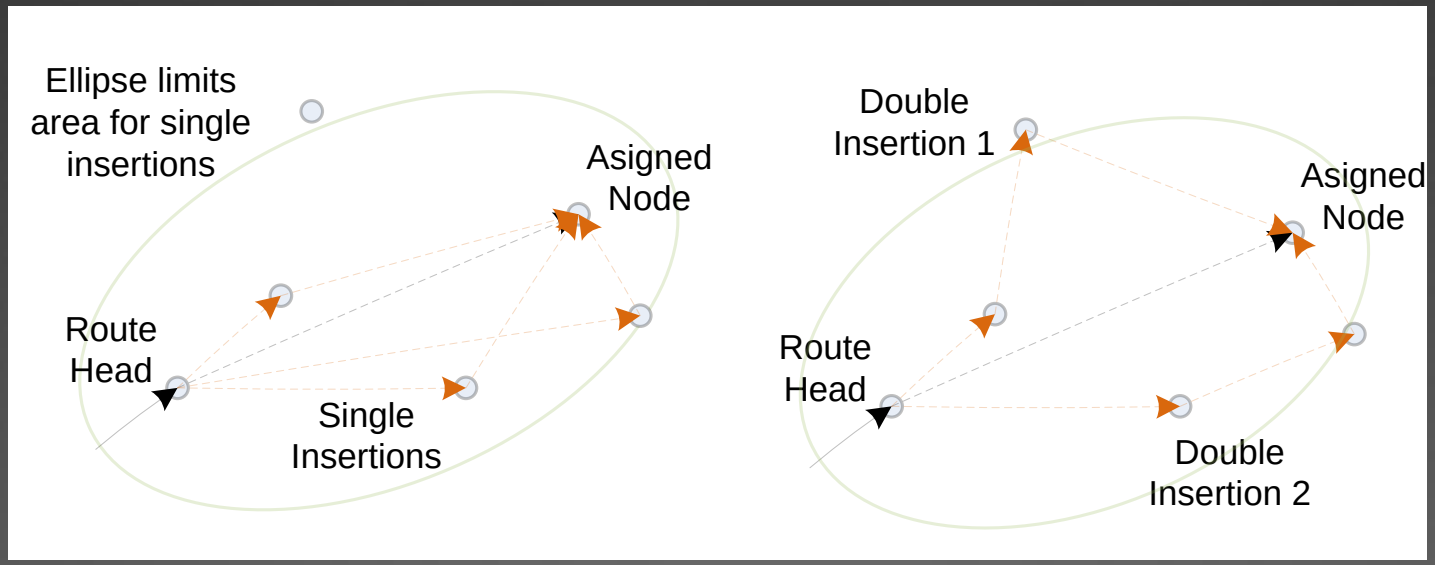
- ***ELOCONS: Efficient Low Cost Route Construction.***
- Constructive heuristic for the VRPTW.
- Each iteration consists of two phases:
  - Node assignment to existing routes.
  - Insertion of nodes between the assigned node and the route head.
- 4 parameters define its behavior.

ELOCONS



Parameter R (R0 in first iteration) defines the number of nodes in L1

ELOCONS



Parameter β defines the ellipse for single insertions

Parameter γ defines the extension for double insertions

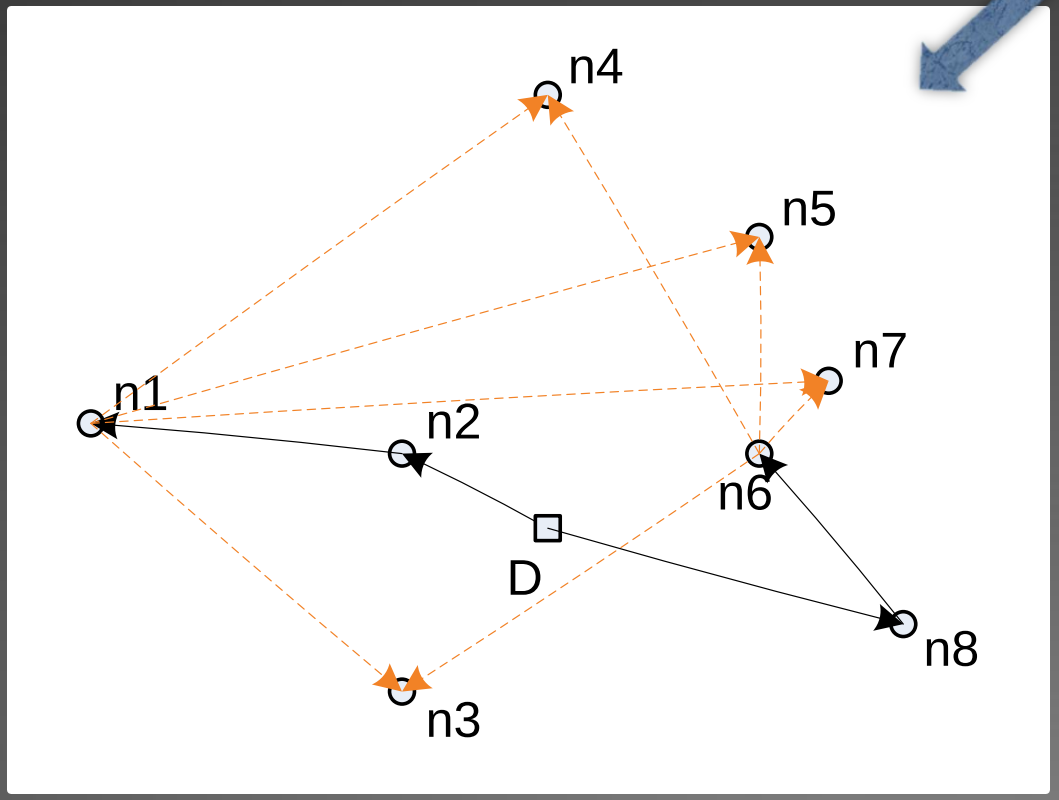
ELOCONS Results

	Best	ELOCONS		
Solomon Instance	Distance	Distance	Diference	Optimality Gap
R1	14.145,62	16.624,80	2.479,18	17,53%
R2	10.361,81	11.785,83	1.424,02	13,74%
C1	7.440,30	8.383,83	943,53	12,68%
C2	4.699,00	5.591,54	892,54	18,99%
RC1	10.731,11	12.982,67	2.251,56	20,98%
RC2	8.391,73	9.993,99	1.602,26	19,09%
TOTAL:	**55.769,57**	**65.362,65**	**9.593,08**	**17,20%**

Prioritization Rules Modelling

- Constructive heuristics performance mainly relies on the rules to prioritize the assignments of nodes to routes.
- Hyper heuristic approach: substitution of predefined prioritization rules by a parameterized model.
- For each feasible assignment are defined a set of parameters depending on the node and route characteristics.
- The model is optimized by means of an evolutionary algorithm.

Prioritization Rules Modelling



Step 1
Determine all the feasible assignments of nodes to routes.

Step 2
Select the N_K assignments with highest Selection Factor.

Step 3
Calculate the priority of an assignment with the Prioritization Rules Model.

Step 4
Perform the N_D compatible assignments with highest priority.

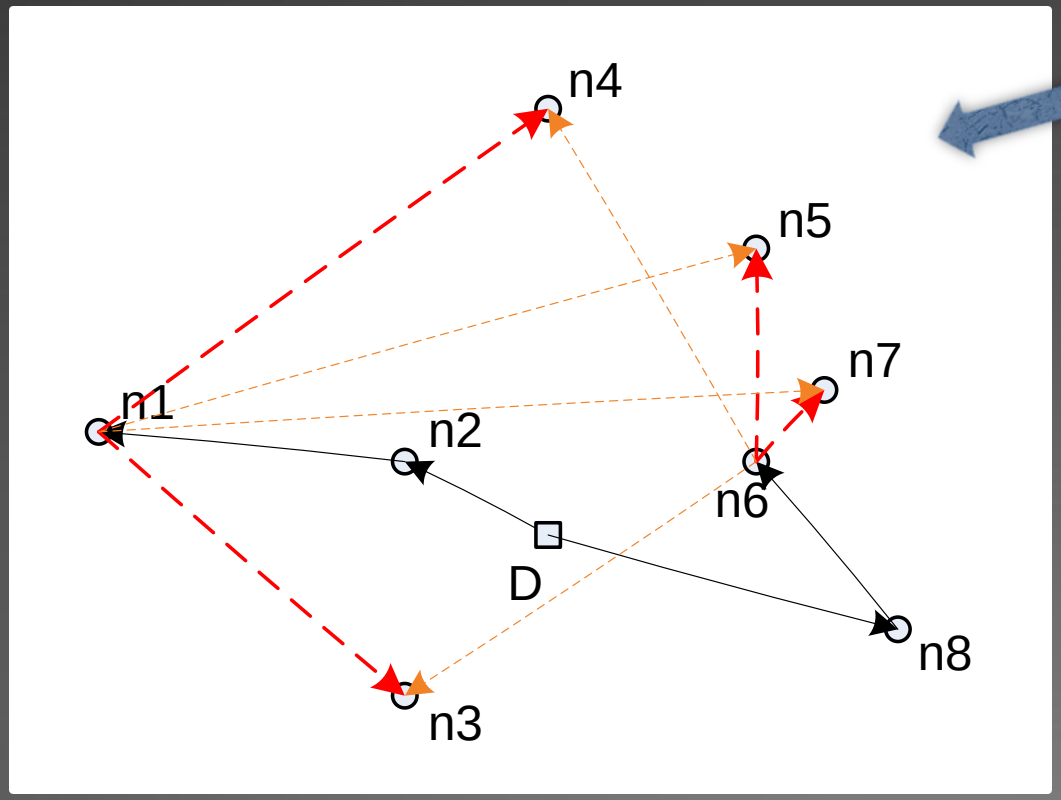
Are there non-assigned nodes yet?

Yes

No

Solution obtained

Prioritization Rules Modelling



Step 1
Determine all the feasible assignments of nodes to routes.

Step 2
Select the N_K assignments with highest Selection Factor.

Step 3
Calculate the priority of an assignment with the Prioritization Rules Model.

Step 4
Perform the N_D compatible assignments with highest priority.

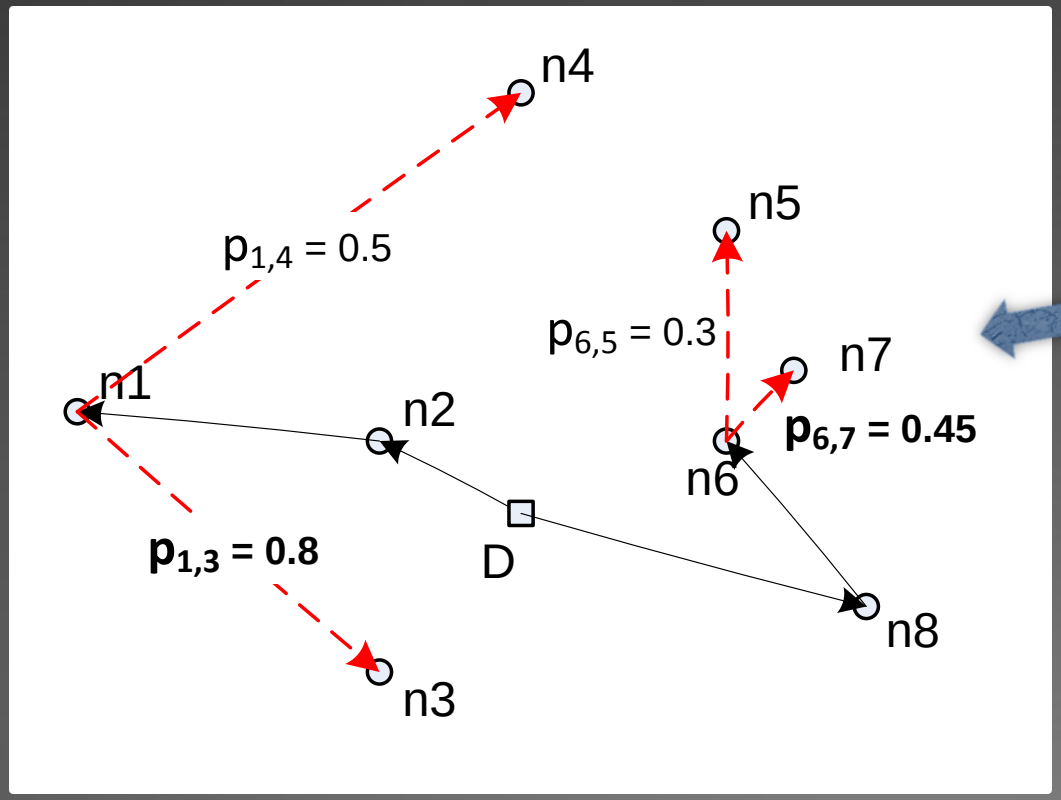
Are there non-assigned nodes yet?

Yes

No

Solution obtained

Prioritization Rules Modelling



Step 1
Determine all the feasible assignments of nodes to routes.

Step 2
Select the N_K assignments with highest Selection Factor.

Step 3
Calculate the priority of an assignment with the Prioritization Rules Model.

Step 4
Perform the N_D compatible assignments with highest priority.

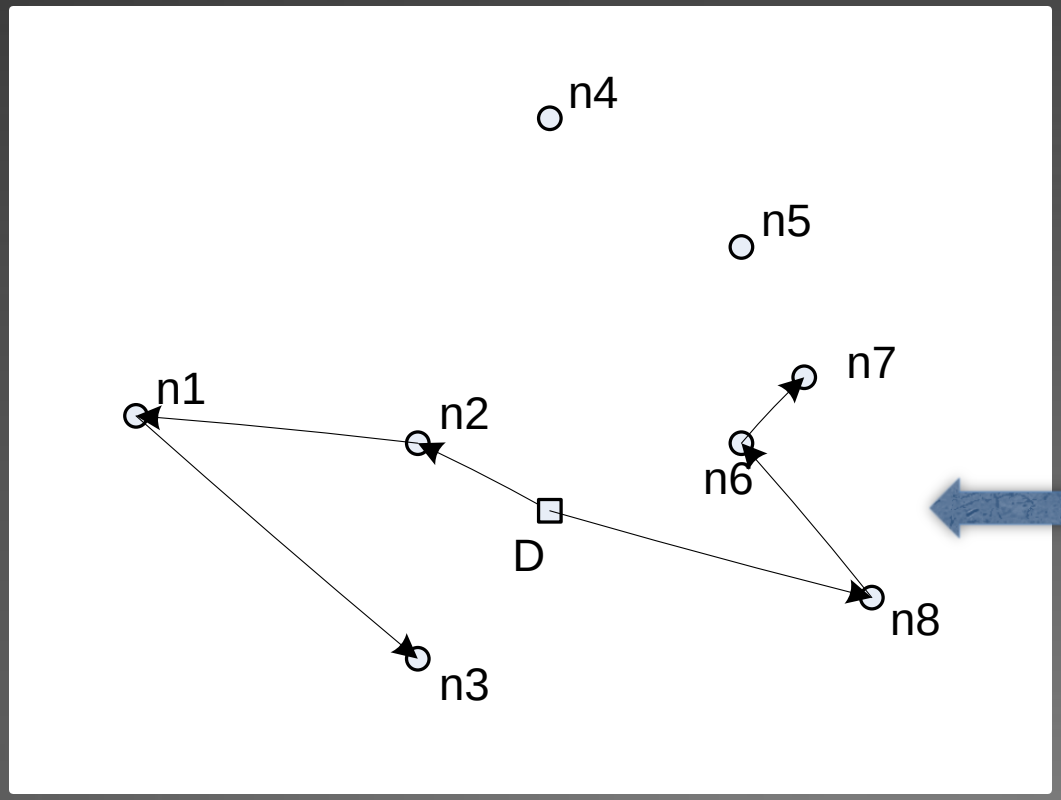
Are there non-assigned nodes yet?

Yes

No

Solution obtained

Prioritization Rules Modelling



Step 1
Determine all the feasible assignments of nodes to routes.

Step 2
Select the N_K assignments with highest Selection Factor.

Step 3
Calculate the priority of an assignment with the Prioritization Rules Model.

Step 4
Perform the N_D compatible assignments with highest priority.

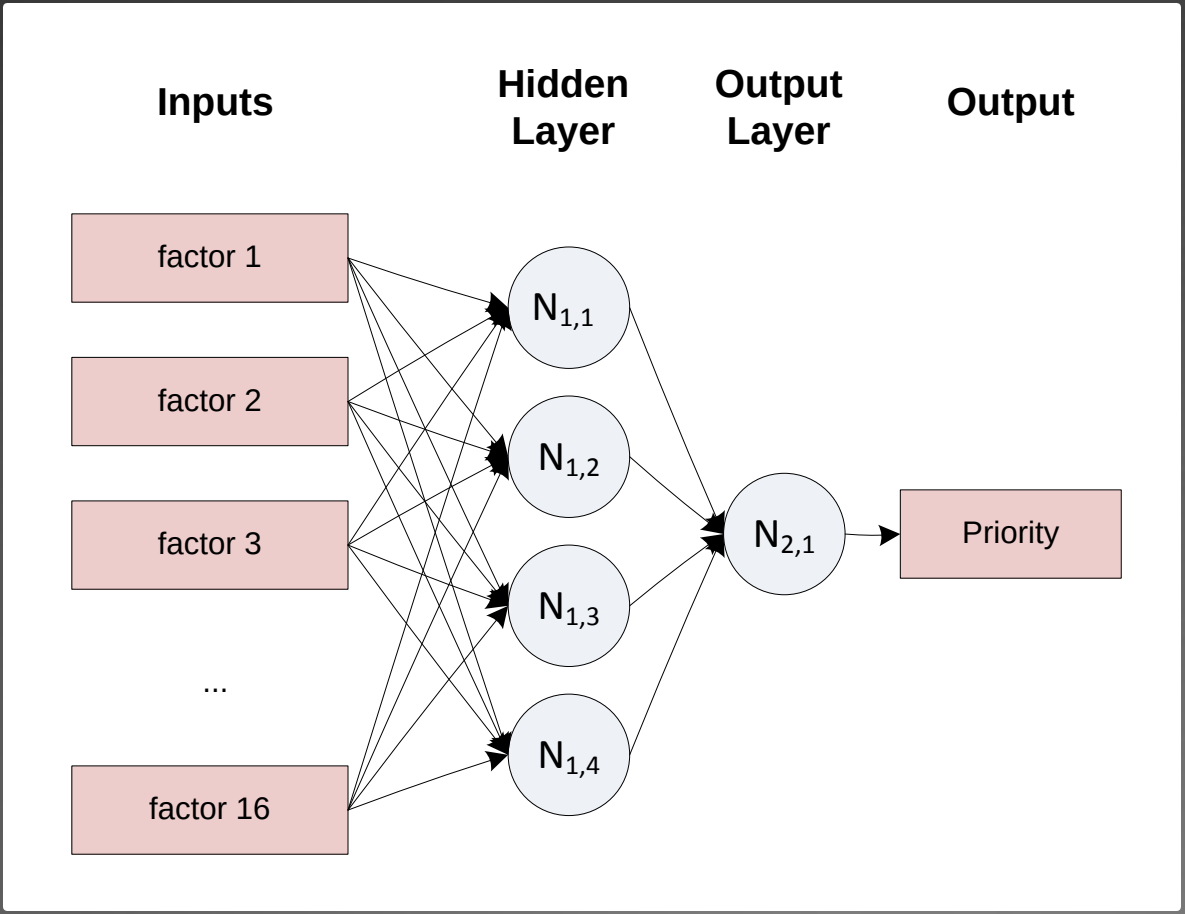
Are there non-assigned nodes yet?

Yes

No

Solution obtained

Prioritization Rules Modelling



- Prioritization Rules are modeled by a Neural Network
- The Neural Network is evolved using an evolutionary algorithm

Best results

26 Nodes Solomon's Instances					101 Nodes Generalization
Problem	**Optimal Distance**	**Distance**	**Avg. optimality gap**	**Max. optimality gap**	**Avg. optimality gap**
R1	5,560	5,788	4.09%	8.75%	40.34%
R2	4,204	4,439	5.60%	11.52%	31.72%
C1	1,716	1,733	0.99%	4.84%	56.18%
C2	1,716	1,733	1.00%	4.30%	53.75%
RC1	2,802	2,872	2.51%	3.86%	57.08%
RC2	2,554	2,690	5.33%	10.54%	46.87%
Total	***18,552***	***19,256***	***3.79%***	***11.52%***	***46.19%***

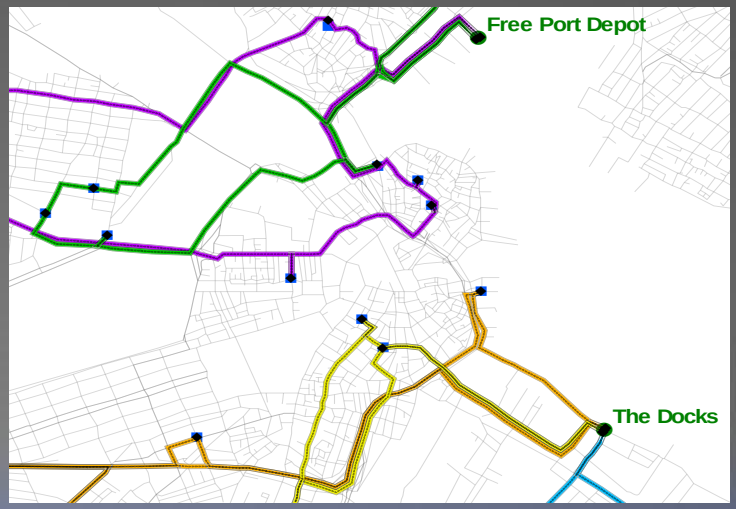
Conclusions and Future Work

Conclusions

- A line of research in routing problems and modelling and simulation has been presented.
- ELOCONS is a

Future / Current Work

- Development of a JAVA library for dynamic transportation systems modelling.
- Connection of the algorithms with GIS (TRANSCAD).
- Algorithms improving.
- Extension to new problems.



Thanks for your attention!

Diego Crespo Pereira

dcrespo@udc.es