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If you want to refer to this research, please refer to
Van Eynde, R., & Vanhoucke, M. (2020). Resource-constrained multi-project scheduling: benchmark datasets and decoupled scheduling. *Journal of Scheduling*, *23*(3), 301-325.
Van Eynde, R., & Vanhoucke, M. New summary measures and datasets for the multi-project scheduling problem. *Under revision*
The datasets can be found on: *https://projectmanagement.ugent.be/research/project_scheduling/RCMPSP*

FACULTY OF ECONOMICS AND BUSINESS ADMINISTRATION

DEPARTMENT OPERATIONS MANAGEMENT AND BUSINESS INFORMATICS
RESEARCH GROUP OR&S

NEW BENCHMARK DATASETS FOR THE RCMPSP

Rob Van Eynde and Mario Vanhoucke

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OUTLINE

- Previous research
- New summary measures
- Dataset generation and evaluation
- Impact on solution algorithms

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PREVIOUS RESEARCH

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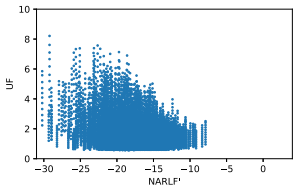
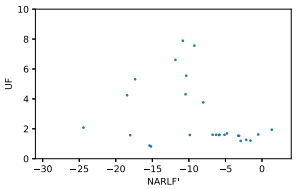
PREVIOUS RESEARCH [5]

- Reimplemented generation procedure of Browning and Yassine (2010)
- Compared all datasets for RCMPSP

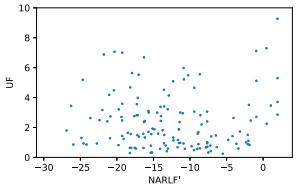
BY [1]



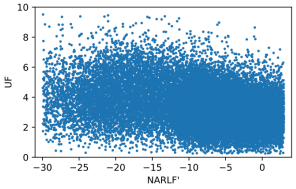
RCMPSPLIB [6]



MPSPLIB [2,3]



VV [5]



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PREVIOUS RESEARCH [5]

- Gaps in literature:
  - Feasible range of parameter values
  - Parameter interdependencies
  - Cannot describe all portfolio characteristics

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RESEARCH OBJECTIVES

- Develop new summary measures:
  - Describing a wider range of portfolio characteristics
  - Having clear ranges of feasible values
  - Having as few interdependencies as possible
- Generate new datasets using the measures
- Compare algorithm performance on new datasets

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NEW SUMMARY MEASURES

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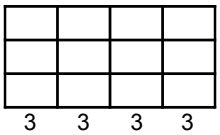
VARIATION MEASURE

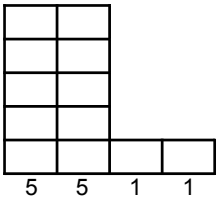
- Measure for variation (Labro and Vanhoucke, 2010):

$$\alpha \in [0,1]$$

$\alpha = 0$



$\alpha = 1$



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NEW SUMMARY MEASURES

- Basic characteristics
- Portfolio network characteristics
- Portfolio resource characteristics

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BASIC CHARACTERISTICS

- Number of activities per project $|\bar{I}|$
- Average SP-indicator $\bar{SP}$
- Independence strength IS

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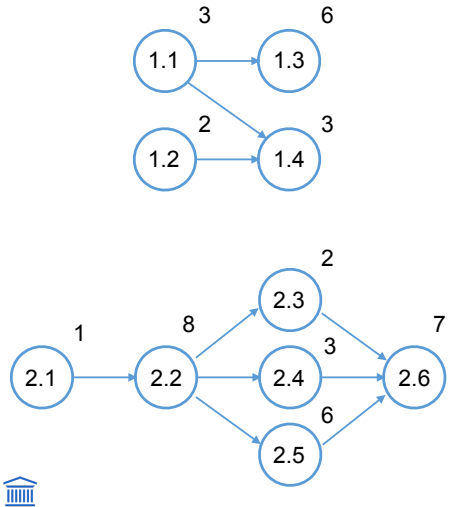
EXAMPLE

$$R = 10$$



	P1	P2	Avg	α
$\|I\|$	4	6	5	0.25
SP	0.33	0.6	0.47	0.37
IS	-	-	0.16	-

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PORTFOLIO NETWORK CHARACTERISTICS

- We allow interproject precedence constraints
  - Activity to dummy start / dummy end to activity

- Multiproject Parallelity: how serial/parallel is the portfolio?
- Multiproject Float: how tight are the interproject precedence constraints?

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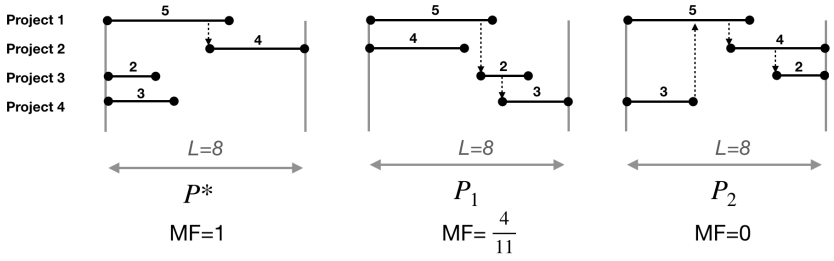
PORTFOLIO NETWORK CHARACTERISTICS



$$MP = \frac{L - L_{min}}{L_{max} - L_{min}} = \frac{8 - 5}{14 - 5} \qquad MF = \frac{F}{F_{max}}$$

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PORTFOLIO RESOURCE CHARACTERISTICS

- Existing datasets: binary

- Our approach: spectrum

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PORTFOLIO RESOURCE CHARACTERISTICS

- Resource allocation matrix

	R_1	R_2	R_3	R_4
P_1	1		1	
P_2	1	1		
P_3		1		1

Binary

	R_1	R_2	R_3	R_4
P_1	0.5		1	
P_2	1	1		
P_3		0.5		1

Fractional

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PORTFOLIO RESOURCE CHARACTERISTICS

– Resource allocation matrix

	R_1	R_2	R_3	R_4
P_1	1		1	
P_2	1	1		
P_3		1		1

Binary

	R_1	R_2	R_3	R_4
P_1	0.5		1	
P_2	1	1		
P_3		0.5		1

Fractional

Project 1 has a resource demand for resource type 1

50% of the activities of project 1 require resource type 1

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PORTFOLIO RESOURCE CHARACTERISTICS

– Resource Sharing Ratio:
density of fractional matrix

$$\frac{\sum_{j \in J} \sum_{k \in K} f_{jk} - |K|}{|J| \cdot |K| - |K|}$$

	R_1	R_2	R_3	R_4
P_1	0.5		1	
P_2	1	1		
P_3		0.5		1

$$\text{RSR} = \frac{5-4}{12-4} = 0.125$$

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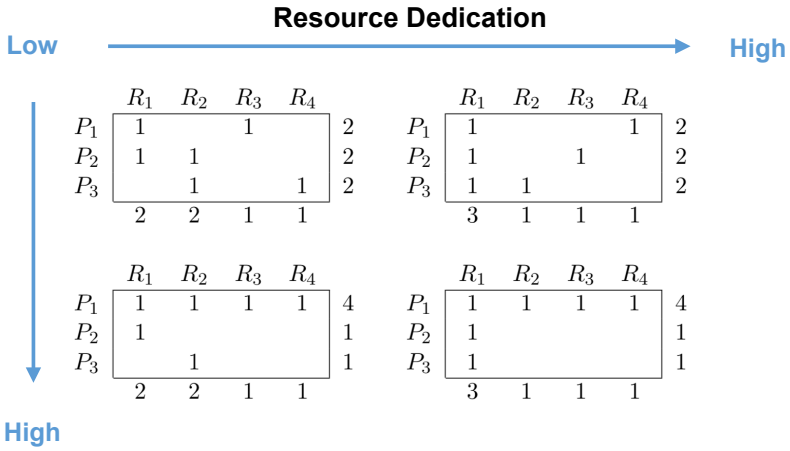
PORTFOLIO RESOURCE CHARACTERISTICS

– Project Dedication and Resource Dedication: based on row and column sums of binary matrices



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DATASET GENERATION AND EVALUATION

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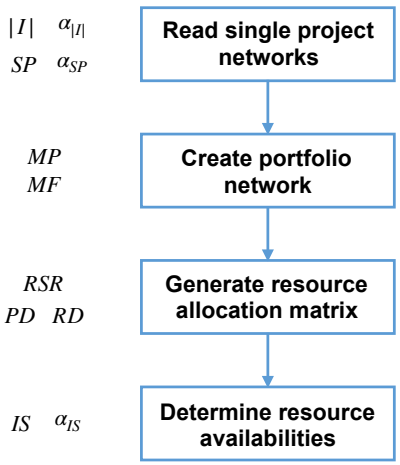
GENERATION PROCEDURE



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DATASET DESIGN

	Set 1	Set 2	Set 3	Set 4
Basic characteristics	Yes	Yes	Yes	Yes
Multiproject network		Yes		Yes
Multiproject resource			Yes	Yes

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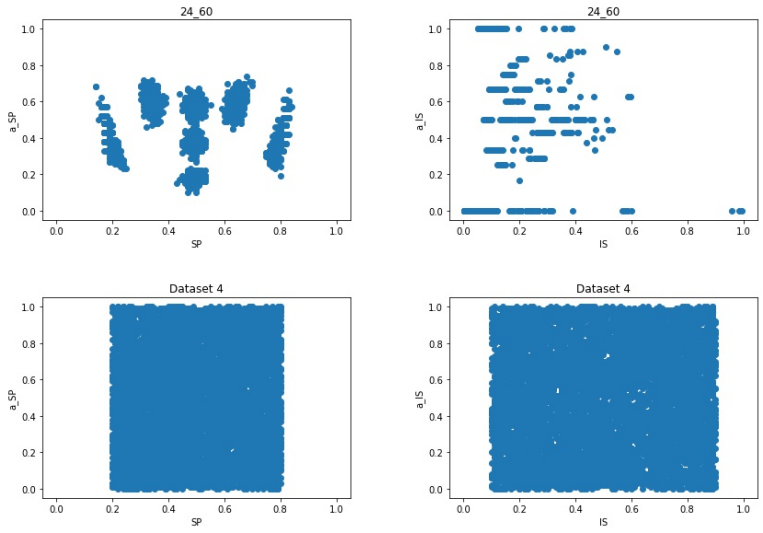
DATASET EVALUATION



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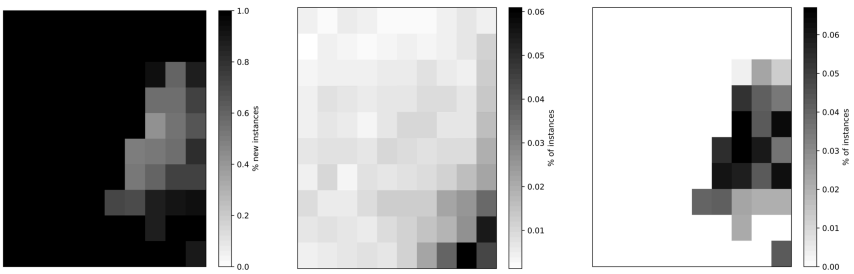
DATASET EVALUATION

– Self Organizing Map: clusters similar instances



% of new instances per cluster | Distribution new instances | Distribution old instances

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IMPACT ON SOLUTION ALGORITHMS

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PRIORITY RULES

Top 10 ranking PRs
(project rule - activity rule)

New sets	24_60
MINRCP-MINSLKd	**MINCP-MINSLKd**
MINRCP-MINLST	**MINCP-MINLST**
MINRCP-MINLFT	**MINCP-MINLFT**
MINCP-MINSLKd	MINSP-MINSLKd
MINCP-MINLST	MINSP-MINLST
MINCP-MINLFT	MINCP-MINSLKs
MINACT-MINSLKd	MINSP-MINLFT
MINTWR-MINSLKd	MINCP-MAXWK
MINACT-MINLST	MINSP-MINSLKs
MINTWR-MINLST	MINCP-MINEST

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GENETIC ALGORITHM

- Improvement upon best performing PR

Set	Improvement
Set 1	12.46 %
Set 2	5.64 %
Set 3	13.16 %
Set 4	4.48 %

CONCLUSION

- Developed new summary measures
- Generate new datasets covering wider range of feature space
- The new features impact algorithm performance

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FACULTY OF ECONOMICS AND BUSINESS ADMINISTRATION

Rob Van Eynde
PhD Researcher

DEPARTMENT OF OPERATIONS
MANAGEMENT AND BUSINESS INFORMATICS

E rob.vaneynde@ugent.be

Universiteit Gent
@ugent
Ghent University

www.ugent.be

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