GECCO 2021 Competition on the Optimal Camera placement Problem (OCP) and the Unicost Set Covering Problem (USCP)

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- Feedback
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INTRODUCTION

Why organize a competition?

Our team has some experience in competitions…

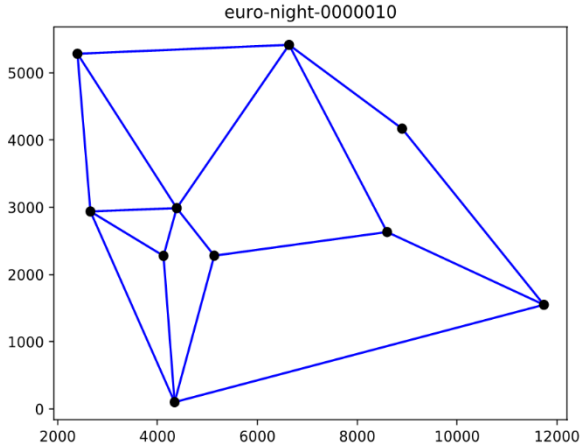
…as participants:

- Black Box Optimization Competition (CEC 2015 

, GECCO 2016)
- Bi-Objective Traveling Thief Competition (EMO 2019)
- Computational Geometry: Solving Hard Optimization Problems (SoCG 2019 

, SoCG 2020 

)



Why organize a competition?

Our team has some experience in competitions…

…and also as organizers:

- GECCO 2020 Competition on the Optimal Camera placement Problem (OCP) and the Unicost Set Covering Problem (USCP)

…Competitions are stimulating, we always enjoyed getting involved!

Why a competition on OCP and USCP?

- Our team was involved in the « OPMoPS » French-German project:

Organized Pedestrian Movement in Public Spaces:
Preparation and Crisis Management of Urban Parades
and Demonstration Marches with High Conflict Potential

- From 2017 to 2021
- Including a work package about OCP

OPMoPS
Organized Pedestrian Movement in Public Spaces

ANR AGENCE NATIONALE DE LA RECHERCHE

Bundesministerium für Bildung und Forschung

Why a competition on OCP and USCP?

- OCP and USCP structuraly **identical** [1]
- **Only few works** on the USCP applied to the OCP, and vice versa [1]
- **No benchmark** testbed for the OCP [1]
- USCP approaches **successfully applied** on OCP [2-7]

[1] Kritter J., Brévilliers M., Lepagnot J., and Idoumghar L., On the optimal placement of cameras for surveillance and the underlying set cover problem, Applied Soft Computing, 74:133 – 153, 2019. https://doi.org/10.1016/j.asoc.2018.10.025

[2] Brévilliers M., Lepagnot J., Kritter J., and Idoumghar L., Parallel preprocessing for the optimal camera placement problem, International Journal of Modeling and Optimization, 8(1):33 – 40, 2018. https://doi.org/10.7763/IJMO.2018.V8.621

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[6] Wang Y., Pan S., Al-Shihabi S., Zhou J., Yang N. and Yin M., An improved configuration checking-based algorithm for the unicost set covering problem, European Journal of Operational Research, Vol.294 No.2, pp.476-491, Elsevier, 2021. https://doi.org/10.1016/j.ejor.2021.02.015

[7] Su Z., Zhang Q., Lü Z., Li C.-M., Lin W. and Ma F., Weighting-based Variable Neighborhood Search for Optimal Camera Placement, Proceedings of the AAAI Conference on Artificial Intelligence, Vol.35 No.14, pp.12400-12408, 2021. https://ojs.aaai.org/index.php/AAAI/article/view/17471

Why a competition on OCP and USCP?

1. To encourage innovative research works
   that build bridges between OCP and USCP

2. To promote a common and challenging benchmark testbed

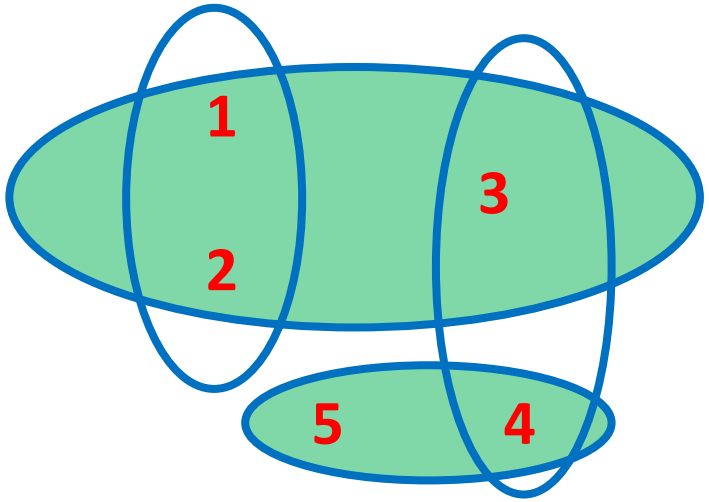
3. To attract the interest of the scientific community in this direction

COMPETITION DESCRIPTION

The problem: OCP stated as USCP

- USCP:
  - Given a set of elements I to be covered,
  - Given a collection of sets J such that the union of all sets in J is I,
  - Find the smallest subset of J which covers I.

- OCP = USCP so that :
  - Elements of I are sample points to be covered,
  - Sets of J are camera candidates.

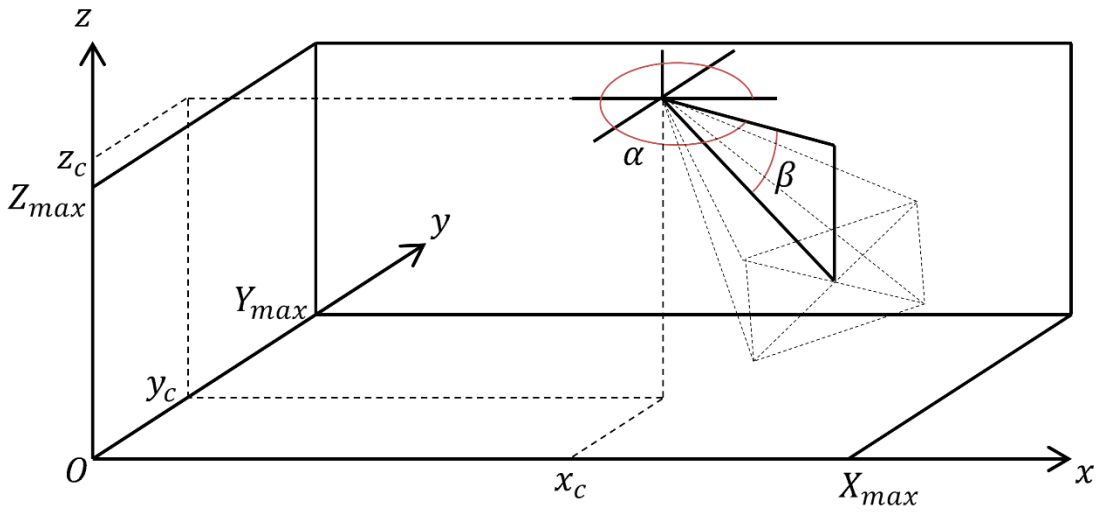


$I = \{\ 1, 2, 3, 4, 5\ \}$

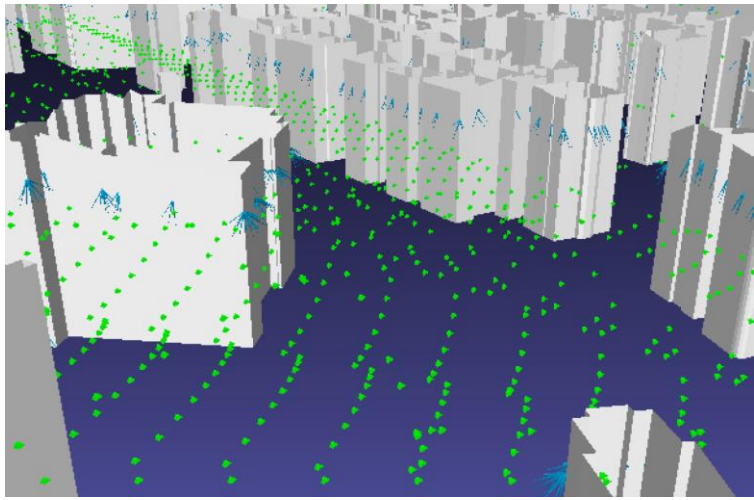
$J = \{\ \{1,2\}, \{3,4\}, \{4,5\}, \{1,2,3\}\ \}$

$Best\ solution = \{\ \{1,2,3\}, \{4,5\}\ \}$

69 problem instances



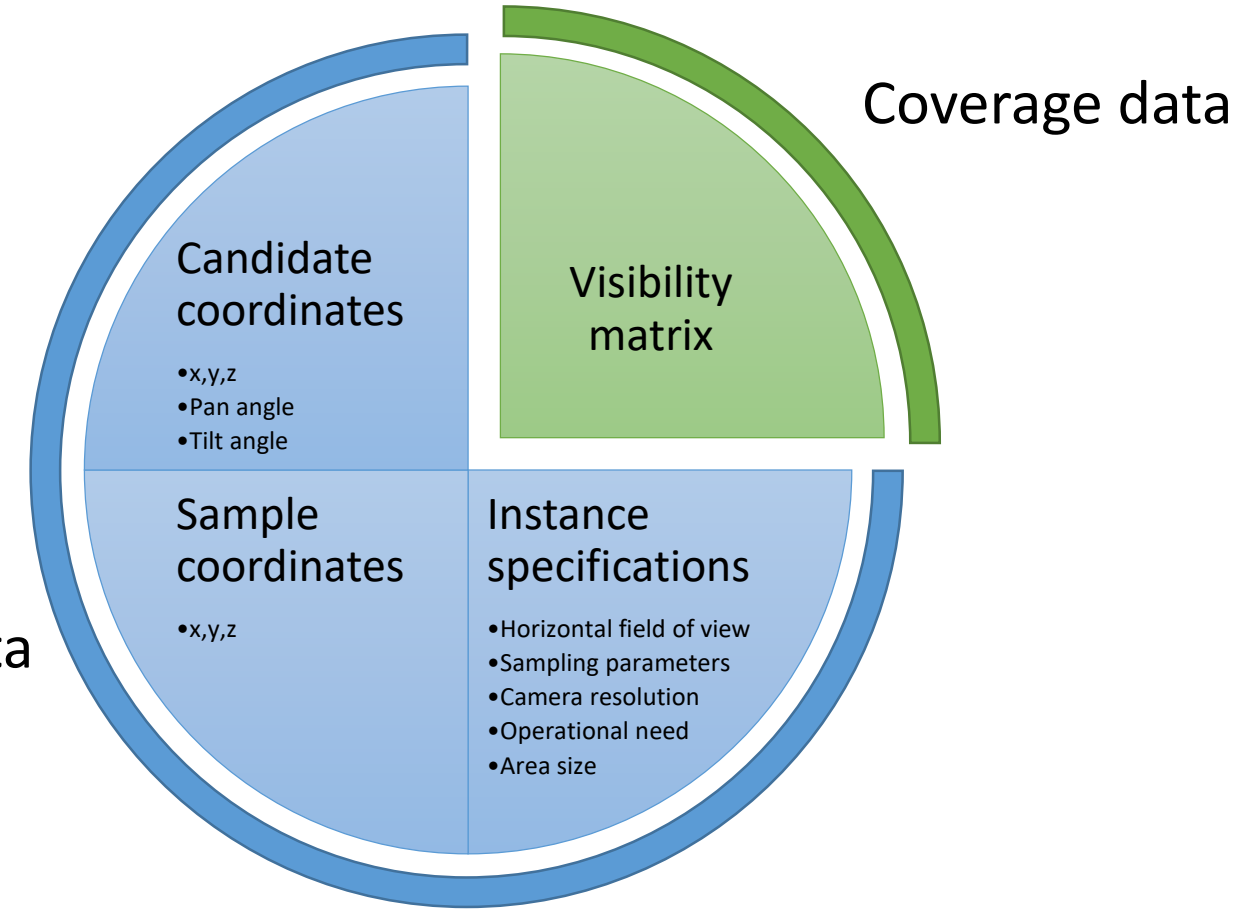
- **<u>32 academic instances</u>**
  - Empty rooms with cameras on the ceiling
  - Artificially generated with various sizes and discretizations
  - From 605 samples and 2 904 candidates
  - To 804 005 samples and 3 859 224 candidates



- **<u>37 real-world instances</u>**
  - Generated using map and elevation data from actual urban areas
  - With various sizes and discretizations
  - From 14 423 samples and 79 947 candidates
  - To 90 050 samples and 654 068 candidates

Data

- ≈18 Gb
- 4 files for each instance:



Organization

- Almost 6 months of competition
- Opportunity to publish in the GECCO Companion
- 2 types of solver allowed:
  - USCP : algorithms that only use the visibility matrix
  - OCP : algorithms that also benefit from geometric data
- Expected submission:
  - 69 solution files (1 for each instance)
  - A 2-page description of the algorithm

Main rules

- 1 team = 1 or more submission(s)
- 1 submission = 1 algorithm

- No restriction on the type of algorithm
- No restriction on the hardware
- No restriction on the runtime

Evaluation procedure

1. Solution available ?
   - No solution submitted ⇨ worst solution is considered (all candidates)

2. Full coverage ?
   - Partial coverage ⇨ worst solution is considered (all candidates)

3. Ranking

Ranking method

1. Rank for each instance.

2. Ranks are converted into scores.

   Rank k participants get $score(k) = \max\{0, \log(\frac{n+1}{2}) - \log(k)\}$

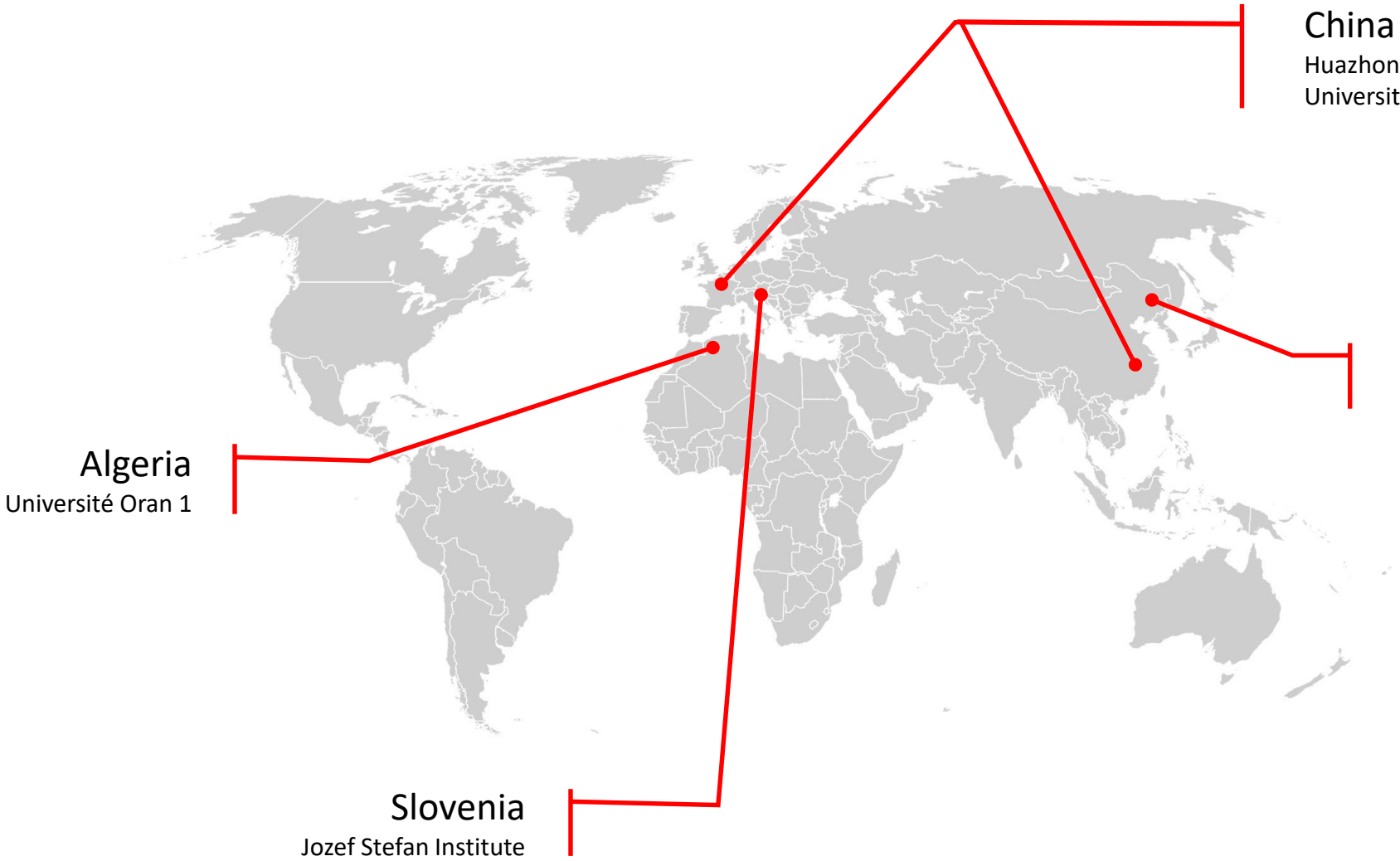
   where n is the number of different results for the considered instance.

3. Scores are added up.

4. Final ranking according to the total scores.

FEEDBACK

4 registrations…



China – France
Huazhong University of Science and Technology
Université de Picardie Jules Verne

China
Northeast Normal University

Algeria
Université Oran 1

Slovenia
Jozef Stefan Institute

…and finally 5 contributions (159 solutions submitted)…

Team	Affiliation	Algorithm	Type
lastMinute	Jozef Stefan Institute, Slovenia	Branch-And-Bound USCP Parallel solver (BAB_USCPP)	USCP
midouLITIO	Université Oran 1, Algeria	cpxPure: CPLEX MIP	USCP
midouLITIO	Université Oran 1, Algeria	cpxRedRows: CPLEX MIP with row dominant elimination technique	USCP
midouLITIO	Université Oran 1, Algeria	cpxRedRowsCols: CPLEX MIP with row dominant elimination technique, and a column elimination strategy	USCP
SmartOCP	Huazhong University of Science and Technology, China Université de Picardie Jules Verne, France	Weighting-based Variable Neighborhood Search with the use of the geometric information (WVNS-g)	OCP

…1 of which is published in the GECCO Companion…

Exact and Approximate USCP With Branch and Bound

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Jožef Stefan Institute
Ljubljana, Slovenia

…15 problem instances solved to optimality…

Instance name	Best solution
AC_01	7
AC_02	4
AC_03	3
AC_04	5
AC_05	7
AC_06	10

Instance name	Best solution
RW_05	934
RW_14	337
RW_15	341
RW_18	338
RW_19	347
RW_22	398
RW_26	464
RW_27	489
RW_36	609

…improvement of 5 best known solutions…

Instance name	New BKS	Old BKS – 2020 Team (type)
AC_26	10 038	10 039 – Alkaid-X (OCP)
AC_27	11 519	11 520 – Alkaid-X (OCP)
AC_28	13 093	13 096 – Alkaid-X (OCP)
AC_30	16 523	16 524 – Alkaid-X (OCP)
AC_32	20 341	20 342 – Alkaid-X (OCP)

…and the winner is…

…the team SmartOCP, with the algorithm WVNS-g!

Rank	Team	Affiliation	Algorithm	Type
1	**SmartOCP**	**Huazhong University of Science and Technology, China Université de Picardie Jules Verne, France**	**Weighting-based Variable Neighborhood Search with the use of the geometric information (WVNS-g)**	**OCP**
2	midouLITIO	Université Oran 1, Algeria	cpxPure: CPLEX MIP	USCP
3	midouLITIO	Université Oran 1, Algeria	cpxRedRows: CPLEX MIP with row dominant elimination technique	USCP
3	midouLITIO	Université Oran 1, Algeria	cpxRedRowsCols: CPLEX MIP with row dominant elimination technique, and a column elimination strategy	USCP
5	lastMinute	Jozef Stefan Institute, Slovenia	Branch-And-Bound USCP Parallel solver (BAB_USCPP)	USCP

CONCLUSION

Concluding remarks

- Modest success in terms of registration (4) and submission (5)
- But interesting contibutions with good results
- Successful advertisement for this OCP and USCP benchmark testbed
  - 2 GECCO competitions (2020 and 2021)
  - 1 survey [8]
  - 2 journal papers [3,6]
  - 4 conference papers [4,5,7,9]
- Scientific monitoring
  - http://www.mage.fst.uha.fr/brevilliers/ocp-uscp-benchmark/

Thank you!

- GECCO 2021 organizers
- Competition chairs: Markus Wagner and Marcella Scoczynski
- UHA and IRIMAS

- All the participants

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