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

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Outline

- Introduction
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- Feedback
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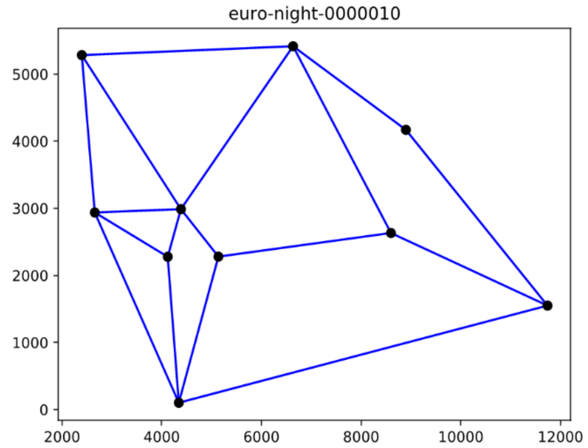
INTRODUCTION

Why organize a competition?

Our team has some experience in competitions…



- 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 

)

…Competitions are stimulating, we always enjoyed participating

Why a competition on OCP and USCP?

- Our team is 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
- Including Julien Kritter's PhD

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 [2,3,4]

[1] J. Kritter, M. Brévilliers, J. Lepagnot, and L. Idoumghar. 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] M. Brévilliers, J. Lepagnot, J. Kritter, and L. Idoumghar. 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

[3] M. Brévilliers, J. Lepagnot, L. Idoumghar, M. Rebai, and J. Kritter. Hybrid differential evolution algorithms for the optimal camera placement problem. Journal of Systems and Information Technology, 20(4):446 – 467, 2018. https://doi.org/10.1108/JSIT-09-2017-0081

[4] J. Kritter, M. Brévilliers, J. Lepagnot, and L. Idoumghar. On the real-world applicability of state-of-the-art algorithms for the optimal camera placement problem. In 2019 6th IEEE International Conference on Control, Decision and Information Technologies (CoDIT), pages 1103–1108, April 2019. https://doi.org/10.1109/CoDIT.2019.8820295

Why a competition on OCP and USCP?

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

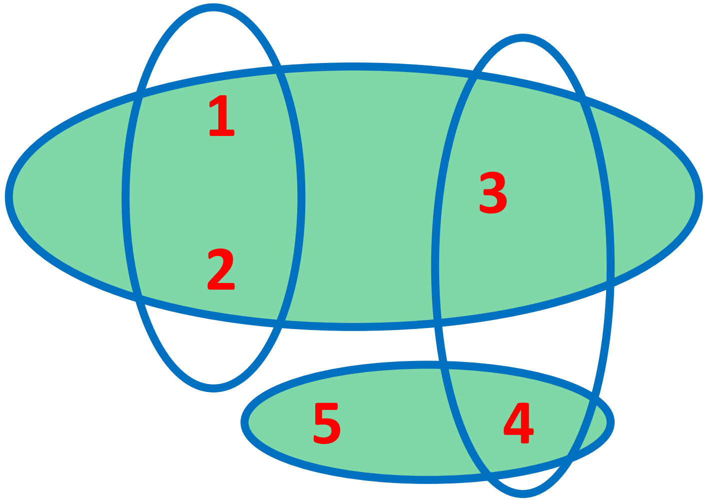
2. To provide a common and challenging benchmark testbed

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.



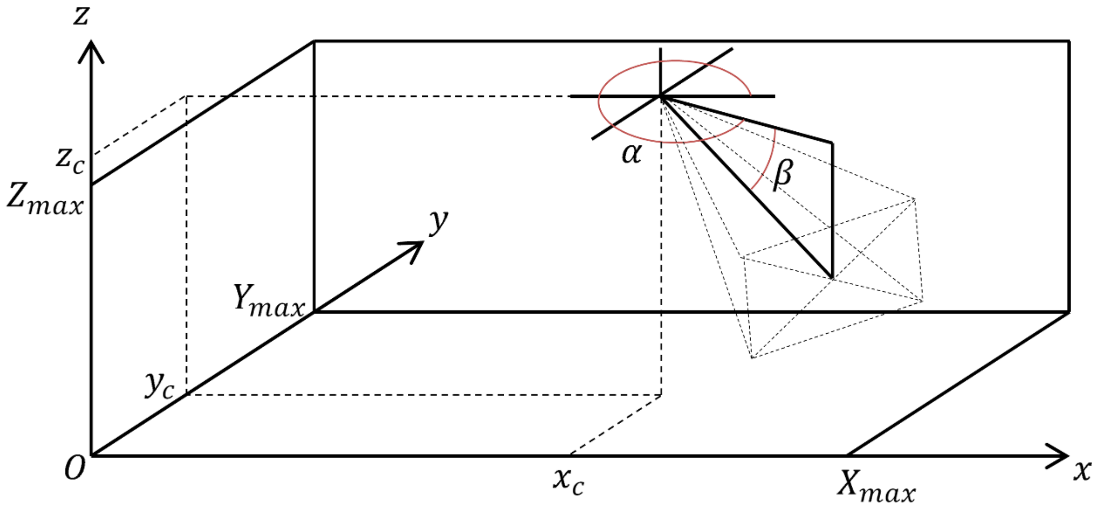
$I = \{ 1, 2, 3, 4, 5 \}$

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

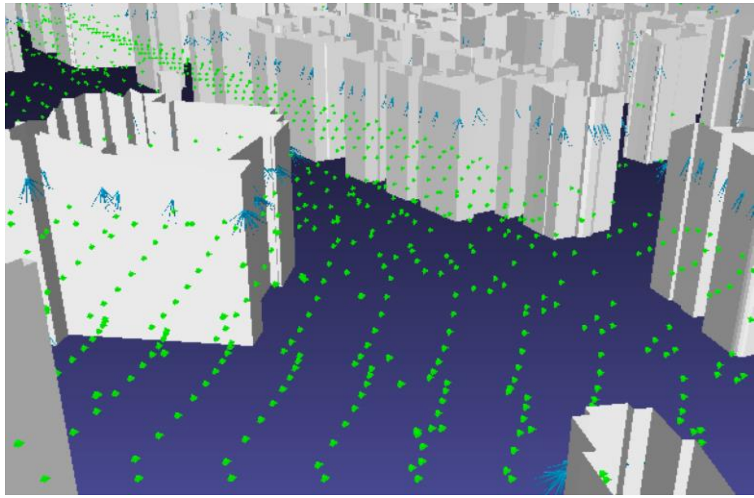
$Best\ solution = \{ \{1,2,3\}, \{4,5\} \}$

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

69 problem instances



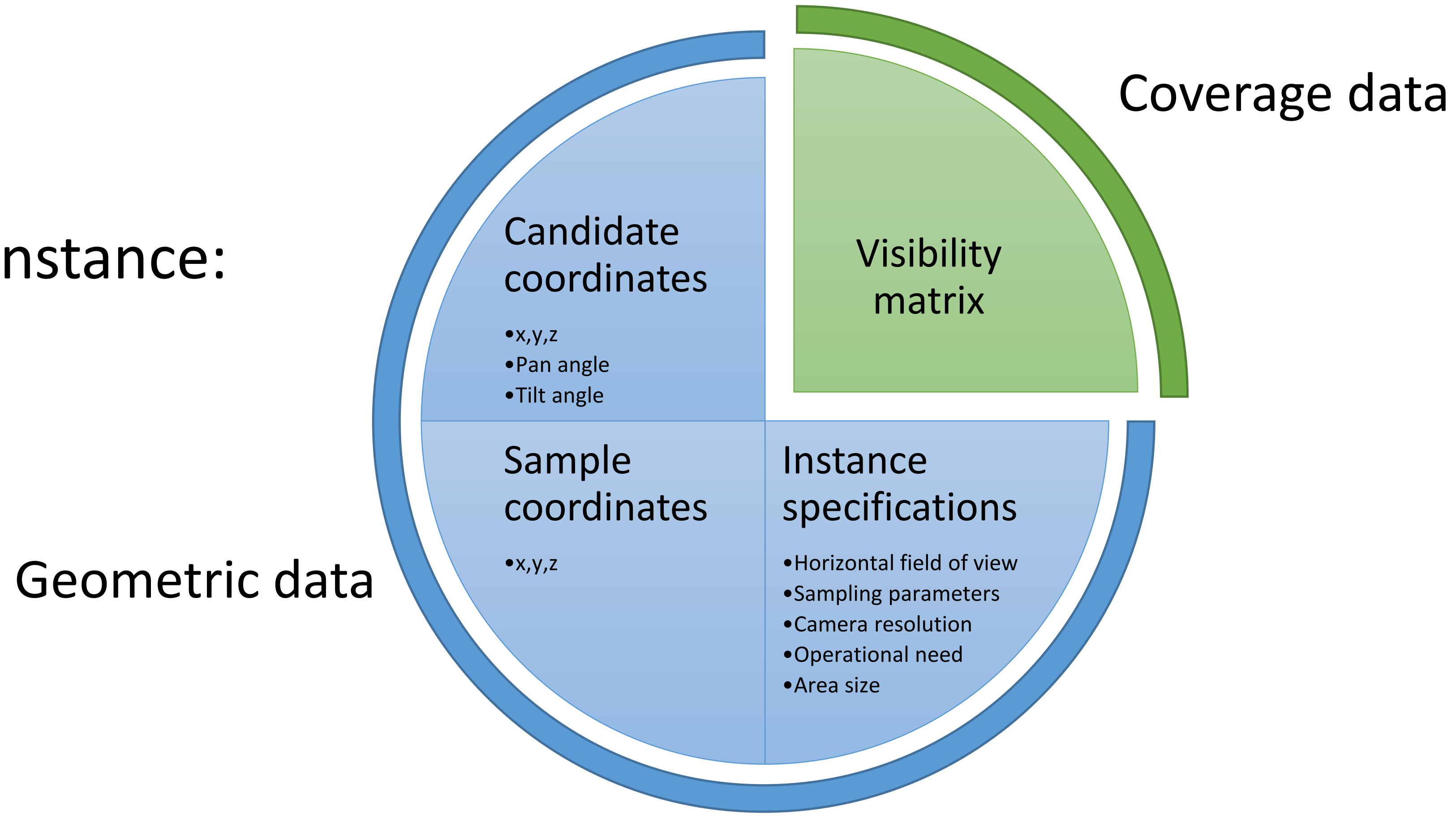
- **<u>32 academic instances</u>**
  - Empty rooms with cameras on the ceiling
  - Artificially generated with various sizes and discretizations
  - From 605 samples and 2 904 candidates
  - To 804 005 samples and 3 859 224 candidates



- **<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

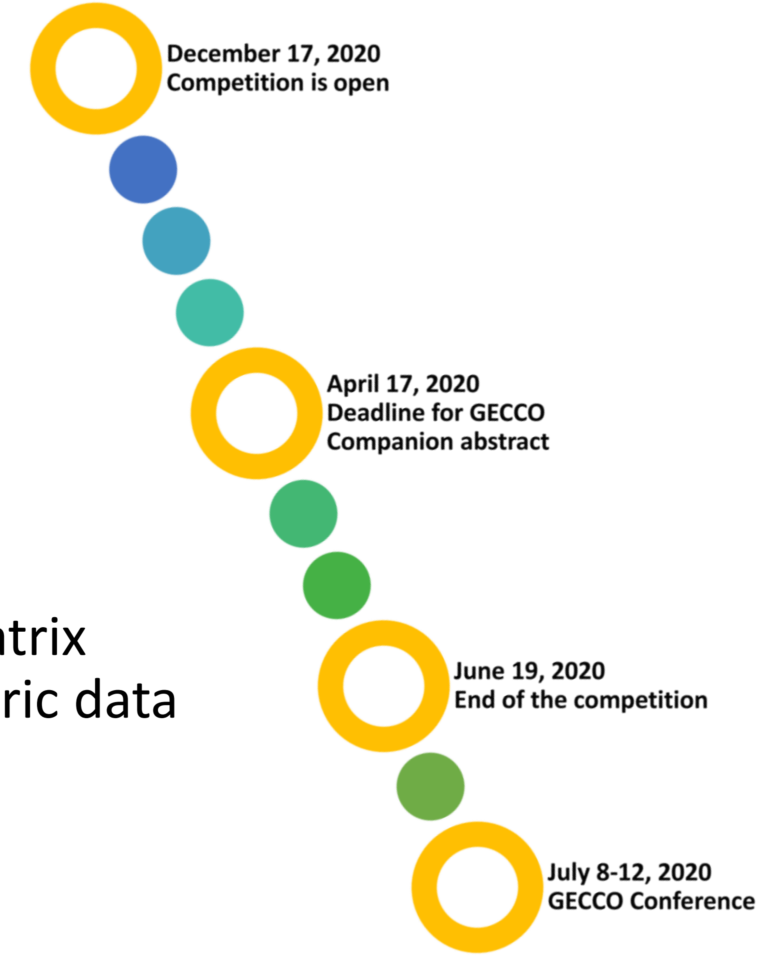
Data

- ≈18 Gb
- 4 files for each instance:



Organization

- 6 months of competition
- Opportunity to publish in the GECCO Companion
- 2 tracks:
  - Track 1 - USCP : algorithms that only use the visibility matrix
  - Track 2 - OCP : algorithms that also benefit from geometric data
- Expected submission:
  - 69 solution files (1 for each instance)
  - A 2-page description of the algorithm
- 1200 euros prizes to be shared among the winners



Main rules

- 1 registration = 1 algorithm in 1 track
- 1 team ≥ 1 registration

- 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
    - 3 independant rankings: 1 for each track and 1 general ranking
    - Prizes are awarded according to the general ranking

Ranking method

1. Rank for each instance.

2. Ranks are converted into scores.

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

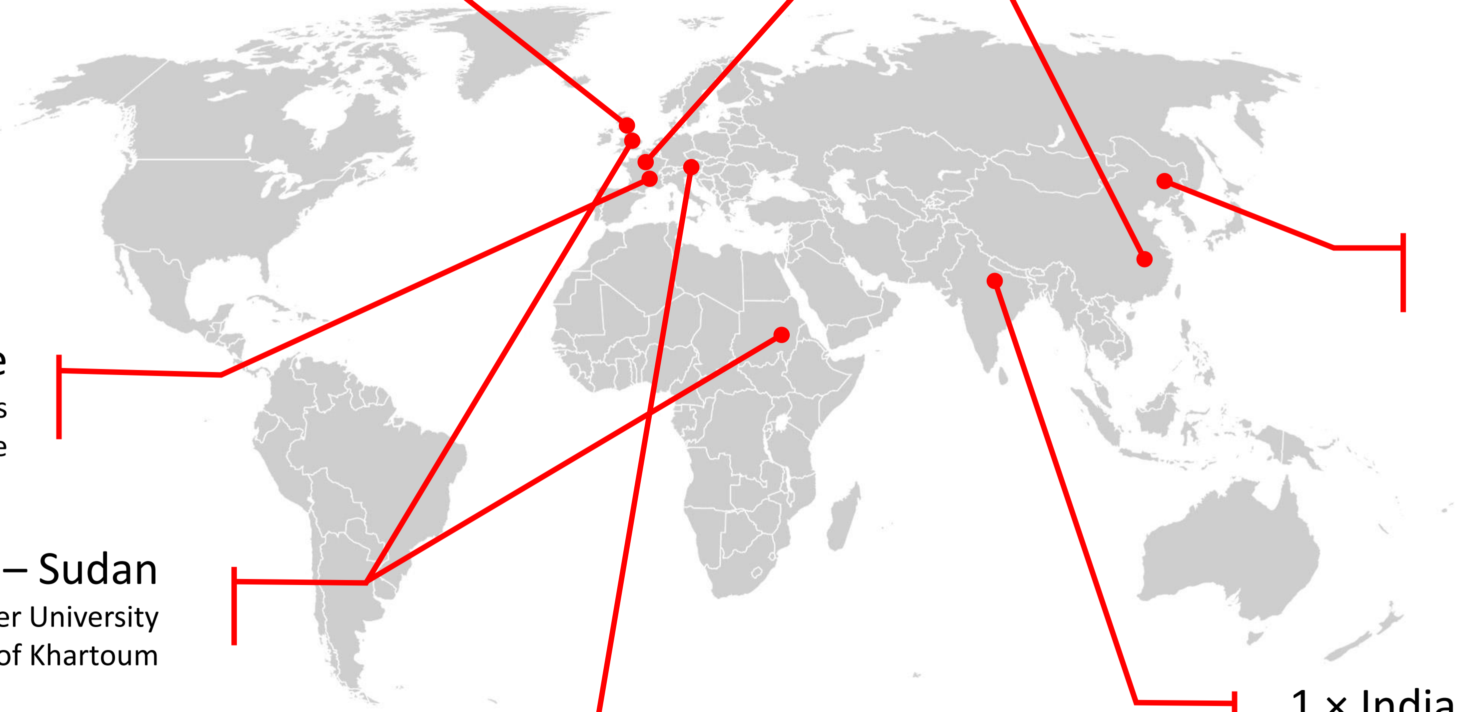
   where n is the number of different results for the considered instance.

3. Scores are added up.

4. Final ranking according to the total scores.

FEEDBACK

10 registrations…



1 × United Kingdom
University College London

3 × China – France
Huazhong University of Science and Technology
Huawei Technologies Co.
Université de Picardie Jules Verne

1 × France
Université Grenoble Alpes
Artelys France

2 × China
Northeast Normal University

1 × United Kingdom – Sudan
Lancaster University
University of Khartoum

1 × India
Squado Info Ltd

1 × Austria
TU Wien

…and finally 8 contributions (536 solutions submitted)…

Track	Team	Affiliation	Algorithm
1 – USCP	Alkaid-X	Huazhong University of Science and Technology Huawei Technologies Co. Université de Picardie Jules Verne	Weighting-based Parallel Local Search (WPLS)
	fontan-libralesso	Université Grenoble Alpes Artelys France	A hybrization of a MILP solver and a large neighborhood search
	Isula	University College London	An ant colony approach: Tacurú
	NENUAI_WangPZY	Northeast Normal University	A local search algorithm: MSEC
	SDN	Lancaster University University of Khartoum	Sequence-based Selection Hyper-Heuristic (SSHH)
2 – OCP	Alkaid-X	Huazhong University of Science and Technology Huawei Technologies Co. Université de Picardie Jules Verne	Weighting-based Parallel Local Search (WPLS) with a tiling method
	HUST	Huazhong University of Science and Technology Huawei Technologies Co. Université de Picardie Jules Verne	Weighting-based Local Search (WLS)
	NENUAI_EC	Northeast Normal University	Divide-and-Conquer Row-Weighting Local Search (dcRWLS)

…1 of which is published in the GECCO Companion…

Weighting-Based Parallel Local Search for Optimal Camera Placement and Unicost Set Covering

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Wuhan, China

Chumin Li
Université de Picardie Jules Verne
Amiens, France

Zhipeng Lü
Huazhong University of Science and Technology
Wuhan, China

…12 problem instances solved to optimality…

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

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

…improvement of 10 best known solutions

Instance name	New BKS	Old BKS – Algorithm (see [3])
AC_08	25	28 – RWLS
AC_11	64	67 – RWLS
AC_12	136	149 – DEsim-CPLEX
AC_13	232	262 – DEsim-CPLEX
AC_14	353	414 – DEsim-CPLEX
AC_15	501	600 – DEsim-CPLEX
AC_16	868	1043 – DEsim-CPLEX
AC_17	1334	1601 – DEsim-CPLEX
AC_18	1906	2277 – DEsim-CPLEX
AC_19	2571	3104 – DEsim-CPLEX

CONCLUSION

Concluding remarks

- Modest success in terms of registration (10) and submission (8)
  - But encouraging for a first competition

- Interesting contibutions with good results

- Few issues to be adressed for future competitions, e.g.
  - Easy ranking according to the present rules, but difficult to make a fair comparison (various hardware and experimental settings)
  - Competition visibility and attractiveness

Thank you!

- GECCO 2020 organizers
- Competition chair: Markus Wagner
- UHA and IRIMAS

- All the participants

RESULTS

Track 1 – USCP

Alkaid-X

fontan-libralesso

NENUAI_WangPZY

4. SDN
5. Isula

Track 2 – OCP

Alkaid-X

HUST

NENUAI_EC

General

Alkaid-X 🥇 (Track 2 – OCP)

Alkaid-X (Track 1 – USCP)

HUST 🥈

4. fontan-libralesso 🥉
5. NENUAI_WangPZY
6. NENUAI_EC
7. SDN
8. Isula

References

[1] J. Kritter, M. Brévilliers, J. Lepagnot, and L. Idoumghar. 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

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