
C3PO: Optimisation algorithms for 3D irregular cutting&packing problems with real-world constraints

A Data Management Plan created using DMPonline.be

Creator: Tony Wauters

Affiliation: KU Leuven (KUL)

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Project abstract:

In logistics and manufacturing, it is often the case that items or objects must be optimally positioned within a 3D volume (container).

This is a challenging optimization task, which becomes even more challenging when the items or objects in question have irregular shapes and can be rotated in multiple ways. This problem of positioning 3D objects within a 3D volume can be seen as an optimization problem. More specifically, it belongs to the class of 3D Cutting & Packing optimization problems. These problems are unique in the fact that they combine geometric computations with (combinatorial) optimization. Some of the most challenging cutting & packing problems are those featuring 3D irregular objects (3ICP). Some applications in which these objects are present include additive manufacturing (3D printing), robust product engineering, design centering (inscribing one shape in another), circuit manufacturing, transportation of machine components, furniture transportation, and gemstone cutting. Despite their omnipresence in practice, there is a distinct lack of algorithms available for solving 3ICPs.

Furthermore, few studies incorporate multiple real-world constraints originating from physical properties such as gravity, weight balance, stability, minimal distance requirements, grouping and stacking. While the most common objectives to optimize are material cost or volume utilization, in real-world applications additional objectives such as time or stability should also be considered.

In this project, which we term C3PO, we intend to advance state-of-the-art algorithms for solving 3ICPs by developing highly efficient and parallel optimization algorithms. We will also perform the emerging technique of instance space analysis to better understand the 3ICP landscape and algorithm performance.

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Research Data Summary

List and describe all datasets or research materials that you plan to generate/collect or reuse during your research project. For each dataset or data type (observational, experimental etc.), provide a short name & description (sufficient for yourself to know what data it is about), indicate whether the data are newly generated/collected or reused, digital or physical, also indicate the type of the data (the kind of content), its technical format (file extension), and an estimate of the upper limit of the volume of the data.

| Dataset name / ID | Description | New or reuse | Digital or Physical data | Data Type | File format | Data volume | Physical volume |
|-------------------------|--|--|--|--|-------------|---|-----------------|
| | | <i>Indicate: N(ew data) or E(xisting data)</i> | <i>Indicate: D(igital) or P(hysical)</i> | <i>Indicate: Audiovisual Images Sound Numerical Textual Model SOftware Other (specify)</i> | | <i>Indicate: <1GB <100GB <1TB <5TB >5TB NA</i> | |
| 3D irregular dataset V1 | A collection of 3D objects and meshes. | E | D | T | .STL, .OBJ | <1GB | - |
| 3D irregular dataset V2 | A collection of 3D objects and meshes. | N | D | T | .STL, .OBJ | <1GB | . |
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If you reuse existing data, please specify the source, preferably by using a persistent identifier (e.g. DOI, Handle, URL etc.) per dataset or data type:

3D irregular dataset V1:

<https://gitlab.kuleuven.be/codes/datasets/3d-irregular-data-sets>

Are there any ethical issues concerning the creation and/or use of the data (e.g. experiments on humans or animals, dual use)? If so, refer to specific datasets or data types when appropriate and provide the relevant ethical approval number.

- No

Will you process personal data? If so, please refer to specific datasets or data types when appropriate and provide the KU Leuven or UZ Leuven privacy register number (G or S number).

- No

Does your work have potential for commercial valorization (e.g. tech transfer, for example spin-offs, commercial exploitation, ...)? If so, please comment per dataset or data type where appropriate.

- No

Do existing 3rd party agreements restrict exploitation or dissemination of the data you (re)use (e.g. Material or Data transfer agreements, Research collaboration agreements)? If so, please explain in the comment section to what data they relate and what restrictions are in place.

- No

Are there any other legal issues, such as intellectual property rights and ownership, to be managed related to the data you (re)use? If so, please explain in the comment section to what data they relate and which restrictions will be asserted.

- No

Documentation and Metadata

Clearly describe what approach will be followed to capture the accompanying information necessary to keep data understandable and usable, for yourself and others, now and in the future (e.g. in terms of documentation levels and types required, procedures used, Electronic Lab Notebooks, README.txt files, codebook.tsv etc. where this information is recorded).

A README.txt file will be provided for each (sub)dataset.

The readme will contain the origin of the data or information on how it was generated.

In addition some important properties (file names, convex/not-convex, number of triangles, file size and used format) will also be provided.

Will a metadata standard be used to make it easier to find and reuse the data?

If so, please specify which metadata standard will be used.

If not, please specify which metadata will be created to make the data easier to find and reuse.

- No

Data Storage & Back-up during the Research Project

Where will the data be stored?

- Other (specify below)

KU Leuven Gitlab and a copy on our local NAS storage.

How will the data be backed up?

- Personal back-ups I make (specify below)

Since gitlab is an ICTS maintained KU Leuven service it can be considered safe.

In addition, our NAS has an active backup solution.

Is there currently sufficient storage & backup capacity during the project?

If no or insufficient storage or backup capacities are available, explain how this will be taken care of.

- Yes

More than sufficient storage capacity available.

How will you ensure that the data are securely stored and not accessed or modified by unauthorized persons?

KU Leuven Gitlab has its own security measures (authentication, ..).

Our local NAS is frequently updated to the latest firmware/software. The NAS can only be accessed on the campus network.

What are the expected costs for data storage and backup during the research project? How will these costs be covered?

The costs are very small (<250 EUR per year) and can be easily covered for a long period of time.

Data Preservation after the end of the Research Project

Which data will be retained for 10 years (or longer, in agreement with other retention policies that are applicable) after the end of the project?

In case some data cannot be preserved, clearly state the reasons for this (e.g. legal or contractual restrictions, storage/budget issues, institutional policies...).

- All data will be preserved for 10 years according to KU Leuven RDM policy

Where will these data be archived (stored and curated for the long-term)?

- KU Leuven RDR
- Other (specify below)

We will also keep it on the Gitlab if possible.

What are the expected costs for data preservation during the expected retention period? How will these costs be covered?

The costs are very small (<250 EUR per year) and can be easily covered for a long period of time.

Data Sharing and Reuse

Will the data (or part of the data) be made available for reuse after/during the project?

Please explain per dataset or data type which data will be made available.

- Yes, as open data

If access is restricted, please specify who will be able to access the data and under what conditions.

No restrictions.

Are there any factors that restrict or prevent the sharing of (some of) the data (e.g. as defined in an agreement with a 3rd party, legal restrictions)?

Please explain per dataset or data type where appropriate.

- No

Where will the data be made available?

If already known, please provide a repository per dataset or data type.

- KU Leuven RDR (Research Data Repository)
- Other data repository (specify below)

Public Gitlab repository and once final we will put it on RDR.

When will the data be made available?

- Upon publication of research results

Which data usage licenses are you going to provide?

If none, please explain why.

- CC-BY 4.0 (data)

Do you intend to add a persistent identifier (PID) to your dataset(s), e.g. a DOI or accession number? If already available, please provide it here.

- Yes, a PID will be added upon deposit in a data repository

What are the expected costs for data sharing? How will these costs be covered?

Very little expected costs.

Responsibilities

Who will manage data documentation and metadata during the research project?

PhD student working on this project.

Who will manage data storage and backup during the research project?

PhD student working on this project.

Who will manage data preservation and sharing?

Tony Wauters (coordinator)

Who will update and implement this DMP?

Tony Wauters (coordinator)

PhD student working on this project.