Topology optimization of large-scale systems subject to uncertainty

A Data Management Plan created using DMPonline.be

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Project abstract:

Topology Optimization (TO) is a powerful method for optimizing the design of industrial systems. Incorporating uncertainty analysis into the design process is essential for devising more robust and reliable systems that are better suited to real-world conditions. Unfortunately, current TO methods have limitations when it comes to dealing with uncertainty in three-dimensional real-world large- scale situations featuring multiple physics, design constraints, and requiring flexible risk controls. This project will bridge these gaps by achieving three main objectives: 1) achieving significant speed-up in the propagation of uncertainties using geometric low-rank methods and High Performance Computing leveraging GPU implementations for physical state solvers, 2) developing new optimization methods for accounting for uncertain design constraints and flexible formulations of robust optimization, and 3) demonstrating the efficiency of the methods on ambitious three- dimensional large scale Topology Optimization test cases featuring multiple physics and uncertainty. In summary, the methodologies of this project will allow to systematically account for uncertainty in optimal design in contexts close to realistic industrial needs.

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Topology optimization of large-scale systems subject to uncertainty
DPIA

DPIA

Have you performed a DPIA for the personal data processing activities for this project?

- Not applicable

Topology optimization of large-scale systems subject to uncertainty
GDPR

GDPR

Have you registered personal data processing activities for this project?

- Not applicable

Topology optimization of large-scale systems subject to uncertainty
Application DMP

Questionnaire

Describe the datatypes (surveys, sequences, manuscripts, objects …) the research will collect and/or generate and /or (re)use. (use up to 700 characters)

The research will generate:

- Manuscripts (papers in preparation to be submitted to peer-reviewed international journals)
- Software. The software will be custom-made software written in various languages such as Python/FreeFEM/C/C++/CUDA implementing the Topology Optimization methods described for the project.

The numerical experiments performed will be described in detail within the software repository. The corresponding input data will also be made available in data files or in the form of scripts that generate this input data. This means that the code as well as the corresponding explanation will be made available as text files.

Specify in which way the following provisions are in place in order to preserve the data during and at least 5 years after the end of the research? Motivate your answer. (use up to 700 characters)

1. The responsible person will be F. Feppon, Department of Computer Science, KU Leuven
2. Internal reports as well as papers will be made openly available using the Lirias system (KU Leuven).
3. Software source codes will be stored for the long term as git repositories on KU Leuven Gitlab server (http://gitlab.kuleuven.be).
4. Research data such as optimized results or PDE solutions will be stored on the NetApp-based storage solution at the Department of Computer Science, KU Leuven and Secure backups are automatically stored at a second location at KU Leuven, so loss of data is minimized.

What's the reason why you wish to deviate from the principle of preservation of data and of the minimum preservation term of 5 years? (max. 700 characters)

There is no reason to deviate from the minimum preservation of 5 years. Following KU Leuven policy, storage is foreseen for at least 10 years.

Are there issues concerning research data indicated in the ethics questionnaire of this application form? Which specific security measures do those data require? (use up to 700 characters)

There are no such issues. No personal data will be collected in this project focusing purely on physical and industrial applications. To date, there is no potentially identified collaboration with a company regarding the applications of the projects. However, should this change during the project, and should proprietary data be involved, a proper license agreement would be set up with the assistance of Leuven Research & Development (LRD, KU Leuven).

Which other issues related to the data management are relevant to mention? (use up to 700 characters)

There are no other relevant issues.

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FWO DMP (Flemish Standard DMP)

1. 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.

				Only for digital data	Only for digital data	Only for digital data	Only for physical data
Dataset Name	Description	New or reused	Digital or Physical	Digital Data Type	Digital Data format	Digital data volume (MB/GB/TB)	Physical volume
		Please choose from the List and describe all datasets or research materials that you plan to generate/collect or reuse during your research projfollowing options: • Generate new data • Reuse existing data	*Please choose from the following options:* • Digital • Physical	*Please choose from the following options:* • Observational • Experimental • Compiled/aggregated data • Simulation data • Software • Other • NA	*Please choose from the following options:* • .por, .xml, .tab, .csv,.pdf, .txt, .rtf, .dwg, .gml, … • NA	*Please choose from the following options:* • <100MB • <1GB • <100GB • <1TB • <5TB • <10TB • <50TB • >50TB • NA	
PDE software	Numerical software for solving parameter dependent PDEs	New software	Digital	Software	Python/FreeFEM/C++/CUDA code	<100MB (source code)	
PDE solutions	Numerical solutions of parameter dependent PDEs	New simulation data	Digital	Simulation data	.sol	<1TB	
Optim software	Numerical software for solving Topology Optimization problems	Reuse existing software	Digital	Software	Python/FreeFEM/C++/CUDA code	<100MB (source code)	
Optimized designs	Numerical designs resulting from Optim software	Generate new data	Digital	Simulation data	.meshb .solb .vtk	<10TB	

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:

The software developed will reuse the following librairies developed in my research group:
- pymedit (https://gitlab.com/florian.feppon/pymedit)
- pyfreefem (https://gitlab.com/florian.feppon/pyfreefem)
- null space optimizer (https://gitlab.com/florian.feppon/null-space-optimizer)

Are there any ethical issues concerning the creation and/or use of the data (e.g. experiments on humans or animals, dual use)? Describe these issues in the comment section. Please refer to specific datasets or data types when appropriate.

- No

This concern is not relevant for the project which do not involve external human or animal input data.

Will you process personal data? If so, briefly describe the kind of personal data you will use in the comment section. Please refer to specific datasets or data types when appropriate.

- No

In this project we will not collect data.
The challenges in this project are motivated by real-world, industrial cases in other projects. Although we do not foresee this, if a real-world use case would be deemed
valuable to validate this project and a need for data sharing or collection arises, we will follow the required procedures. For personal data, an approval request will be
submitted to the ethics committe at KU Leuven (PRET/SMEC) and the approval will be communicated with FWO.

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.

- Yes

"Optim software" has the potential for being used in future valorization projects if a company is interested in applying the developed optimization methods under uncertainty for its own research.

The computer code generated (i.e., the algorithms) have potential for commercial valorization. The code will be released as open-source where valuable for the research objectives. When potential for valorization is identified the benefits of a proprietary license will be analyzed first together with KU Leuven Research & Development.
When releasing the code as open-source, this will either as modifications of the existing open source software under the GPL3 licence (pymedit, pyfreefem, nullspace-optimizer). An further software release will be the object of discussions with KU Leuven R&D department regarding the choice of a licence.

Do existing 3rd party agreements restrict exploitation or dissemination of the data you (re)use (e.g. Material/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

2. 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).

The software developed will be documented with clear docstrings and a documentation in the sphynx format.
Gitlab Repositories will be supplemented by a proper README.md file explaining how to use/compile the code.

Will a metadata standard be used to make it easier to find and reuse the data? If so, please specify (where appropriate per dataset or data type) which metadata standard will be used. If not, please specify (where appropriate per dataset or data type) which metadata will be created to make the data easier to find and reuse.

- No

3. Data storage & back-up during the research project

Where will the data be stored?

Code is stored and versioned using the KU Leuven Gitlab repository server.
The datasets used for experiments will be stored on the Dept CS in-house storage solution (NetApp). Additionally, datasets are available online in the original repositories.
A snapshot of the code, experiments and data will be created for every publication.

How will the data be backed up?

The Gitlab repository server and the NetApp data storage at CS are both backed up using the KU Leuven backup services.

Is there currently sufficient storage & backup capacity during the project? If yes, specify concisely.
If no or insufficient storage or backup capacities are available, then explain how this will be taken care of.

- Yes

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

The Gitlab repository server and the NetApp data storage are only accessible (via authentication) to members of the project.

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

The Gitlab repository server is offered by KU Leuven.
The Dept CS NetApp datastorage is covered by the budget of this project. After this project ends this cost is taken over by the research group(s)' reserves.

4. Data preservation after the end of the research project

Which data will be retained for at least five 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 code generated will be stored in the KU Leuven Gitlab repository server and on the Dept CS NetApp storage (the latter guaranteed for 10 years).
Additionally, the open-source code will also be available in public repositories such as GitLab.

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

The Dept CS NetApp storage solution (>10TB) will retain snapshots for every publication (source code, experiments, manuscript) for at least 10 years.

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

The Dept CS NetApp longterm storage is covered by the research group's reserves. For this project, this is expected to be <100 euros / year (this does not include costs for computation which is only relevant during the project).

5. Data sharing and reuse

Will the data (or part of the data) be made available for reuse after/during the project? In the comment section please explain per dataset or data type which data will be made available.

- Yes, in an Open Access repository
- Yes, in a restricted access repository (after approval, institutional access only, …)
- No (closed access)

All publications will be made available as Open Access in Lirias.
All open-source code will be made available via Gitlab repositories.
All proprietary code (if deemed necessary for a valorisation track) will not be made available outside of the research group.
The datasets are third party and already available under an open-source license (or similar for the purpose of the research).
Simulation results or optimized geometry will not be diffused due to their storage cost but can be regenerated from the released source codes.

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

Proprietary code will only be available to team members of this project. If a followup valorisation trajectory is defined, members to that track will also be given access.
This is to be defined later.

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 in the comment section per dataset or data type where appropriate.

- Yes, Intellectual Property Rights
- No

All results of this research can be shared without any restrictions, with the exception of code that will be used in a valorisation track.

Where will the data be made available? If already known, please provide a repository per dataset or data type.

Source code will be shared using public and popular repository servers such as Gitlab.

When will the data be made available?

Open-source code will be shared after publication of the research.

Which data usage licenses are you going to provide? If none, please explain why.

Improvements to existing open-source codes (nullspace-optimizer, pymedit, pyfreefem) are published under the GNU3 licence.
Further withdrawal of data will be done according to the guidance of KU Leuven LRD.

Do you intend to add a PID/DOI/accession number to your dataset(s)? If already available, you have the option to provide it in the comment section.

- No

Only software might be distributed. The generated data are not part of the released open data set.

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

There is no cost, we will make use of publicly offered services.

6. Responsibilities

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

Prof. Florian Feppon and PhD student Javier Bevia Ripoll

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

Prof. Florian Feppon and PhD student Javier Bevia Ripoll

Who will manage data preservation and sharing?

Prof. Florian Feppon and PhD student Javier Bevia Ripoll

Who will update and implement this DMP?

Prof. Florian Feppon and PhD student Javier Bevia Ripoll