



Multigrid and Multiscale Solution Methods

(or: the mathematics behind Christopher Nolan's 2010 hit movie "Inception")

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Project work 1

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Multigrid for solving complex-valued Helmholtz problems



Project work 1 Deadline and file format

- Project deadline: Tuesday December 19, 2023, 24h00.
- This gives ≈ 6 weeks to finish the project. Make sure to start in time!
- What is expected?

Email to siegfried.cools@uantwerp.be with an attached .zip file called "*yourfirst_lastname.zip*", containing:

- A .pdf file with your project report (no page limit for this project).
- All Matlab .m files used in your project.
- The script file main.m produces all output in your project.
Use sections to structure this file if required (cf. %% <Section header>).
- Final code and project report are written **individually!**
(Exchanging thoughts on work-in-progress is of course allowed.)



Project work 1

Assignment structure

Project has a logical build-up

- Section 1: Failure of the Multigrid method for Helmholtz problems: analysis.
- Section 2: Solving the complex-valued Helmholtz problem using Multigrid.
- Section 3: Multigrid as a preconditioner for Krylov subspace methods.

For the last part: look up/recap what preconditioning is and how to use it in combination with Krylov subspace methods. Krylov subspace methods have pre-implemented Matlab functionalities (e.g. `gmres.m`) which you can use.

Note: For overall convenience it is recommended to use the same section / subsection / paragraph / etc. numbering as on the assignment sheets throughout your report.



Clarification of terminology

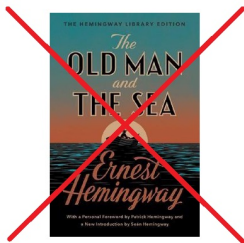
- “*analytical*”:
show the **formulae**, calculations, elaborations, etc. in your report;
- “*numerical*”:
compute **using Matlab** (e.g. using eig.m) and add a plot if required;
- “*convergence history*”:
plot the **norm of the error** as a function of iterations. The exact solution can be obtained using Matlab’s backslash ($u = A \backslash f$). Only in specific cases the residual is used (see Section 3).



Project work 1

Additional remarks

- Include **only** the **figures** (plots) that are **asked for** in the assignment pages.
- Although no strict page limit is imposed for this project, try to be **concise** but **complete** in your answers.





- Questions? You can contact me directly at siegfried.cools@uantwerp.be
(Disclaimer: instant-speed-lightning-fast reaction time is not guaranteed).



- Final lecture in week 12, December 12, 2023, at the usual time and place.
 - Time for Q&A on the first project work.
 - Presentation of / discussion on the second project work assignment.
 - Reminder email will follow later.