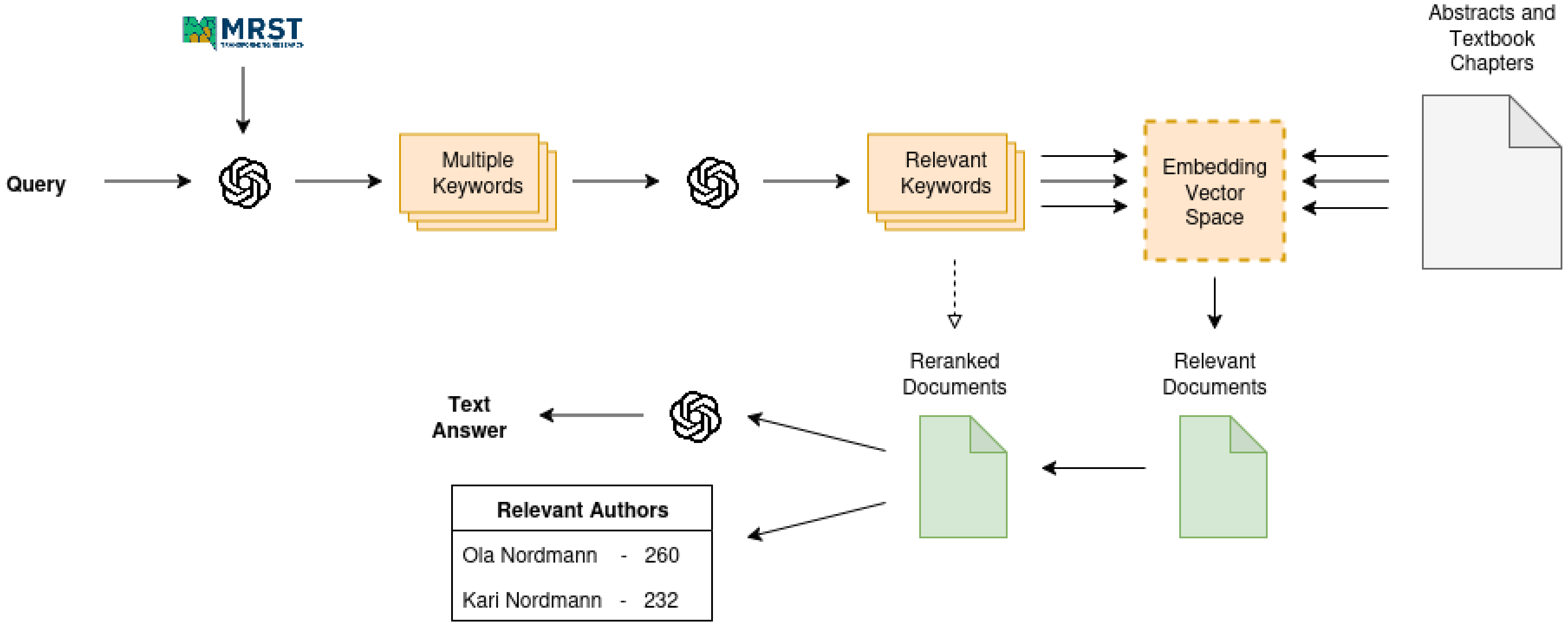
MRST – RAG based Competence Query



Query Rewriting

MultiQuery – Keyword Generation

```
@tool
{
name:" web_scrape_mrst",
description: """
Scrape a SINTEF MRST website
with filename, and return content
and explicit links to other
MRST sites
"""}
```

Start Page: MRST Modules Page

Links to specific modules (example)

MRST
TRANSFORMING RESEARCH

SINTEF

MRST | FAQ | Forum | Modules | Gallery | Download | Documentation | Publications | Contact | MRST Symposium

You are here: MRST / **Modules**

Modules

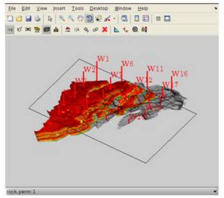
Starting from the 2011a release, MRST has been divided into core functionality and add-on modules, where the latter is defined as a set of functions and scripts that extend or modify the existing capabilities of MRST. A module may use all features of the core toolbox and may, optionally, depend on other modules.

Starting from release 2020a we have categorised all modules within MRST in terms of how mature they are / how likely they are to change in future releases. Please see the module categories page for more information.

To learn more about how to operate the module system, please consult the this page.

Basic Functionality

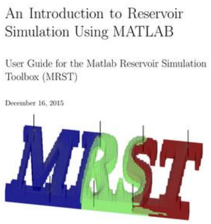
to top



Graphical interface for reservoir visualization

Graphical interfaces for interactive visualization of reservoir states and petrophysical data. The module includes additional routines for improved visualization (histograms, well data, etc) as well as a few utility functions that enable you to override some of MATLAB's settings to enable faster 3D visualization (rotation, etc).

In MRST: `mrstModule add mrst-gui`



Book

Module containing all the scripts used for the examples, exercises, and figures in the book "An introduction to reservoir simulation using MATLAB" by Knut-Andreas Lie.

In MRST: `mrstModule add book`

More about the book

Module categories

- Basic functionality
- Discretization and Solvers
- Multiscale Methods
- Special Simulation Models
- Workflow Tools
- Utilities

All modules:

Legacy

- adjoint
- dfm
- enkf
- libgeometry
- mimetic
- msfvm
- msmfem
- remso
- steady-state
- streamlines
- triangle

Stable

- ad-core
- ad-props
- agglom
- book
- coarsegrid
- co2lab
- core
- deckformat
- diagnostics
- incomp
- mrst-gui
- spe10
- upr
- upscaling

Prompt

System:
You are going to extract keywords and a problem description from the user query. The keywords should help distinguish different SINTEF researchers MRST expertize fields, so you should be extremely specific when generating keywords.

Human:
What can you tell me about Multiscale mixed finite-element methods

Output

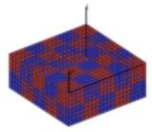
Tools call:
filename:
https://sintef.no/projectweb/mrst/modules/msmfem/

You are here: MRST / Modules / **Multiscale Mixed Finite Elements Module**

Multiscale Mixed Finite Elements Module

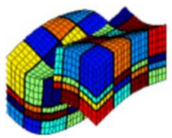
The basic idea of the MsMFE method is to use a mixed finite-element method on a coarse scale with special basis functions that satisfy local flow problems and thereby account for subgrid variations. This way, an approximate fine-scale solution is constructed at the cost of solving a coarse-scale problem

Tutorials



MsMFE on Cartesian grids

We discuss the MsMFE method for solving the single-phase pressure equation on a Cartesian grid with isotropic, homogeneous permeability
Read more...



MsMFE on corner-point grids

We demonstrate how to use the multiscale flow solver for a simple corner-point model with wavy geometry and a single fault.
Read more ...

Description

The MsMFE method is formulated using two grids, a fine underlying grid on which the media properties are given, and a coarse simulation grid where each block can consists of an arbitrary connected collection of cells from the fine grid. In this sense, the method is very flexible and can be applied to almost any grid, structured or unstructured, and can easily be built on-top-of existing pressure solvers.

The MsMFE offers fast, accurate, and robust pressure solvers for highly heterogeneous porous media and can be used for

- direct simulation on high-resolution grid models with multimillion cells
- fast simulation of multiple (stochastic) realisations of reservoir heterogeneity
- model reduction to provide instant simulation of flow responses

Read more...

Literature

The basics of the method is described in the following papers:

1. J. E. Aarnes, S. Krogstad, and K.-A. Lie. Multiscale mixed/mimetic methods on corner-point grids. Computational Geosciences, Special issue on multiscale methods, 2008. DOI: 10.1007/s10596-007-9072-8
2. J. E. Aarnes, S. Krogstad, and K.-A. Lie. A hierarchical multiscale method for two-phase flow based upon mixed finite elements and nonuniform coarse grids, Multiscale Modelling and Simulation, Vol. 5, No. 2, pp. 337-363, 2006. DOI: 10.1137/050634566.

In addition, we list a few selected papers that show applications of the MsMFE method:

1. M. Pal, S. Lamine, K.-A. Lie, and S. Krogstad Multiscale method for simulating two and three-phase flow in porous media. Paper SPE 163669 presented at the 2013 SPE Reservoir Simulation Symposium, The Woodlands, Texas, USA, 18-20 February 2013.
2. J. R. Natvig, K.-A. Lie, S. Krogstad, Y. Yang, and X.-H. Wu. Grid adaption for upscaling and multiscale methods. Proceedings of ECMOR XIII, Biarritz, France, 10-13 September 2012.
3. F. O. Alpak, M. Pal, and K.-A. Lie. A multiscale method for modeling flow in stratigraphically complex reservoirs. SPE J., Vol. 17, No. 4, pp. 1056-1070, 2012. DOI: 10.2118/140403-PA
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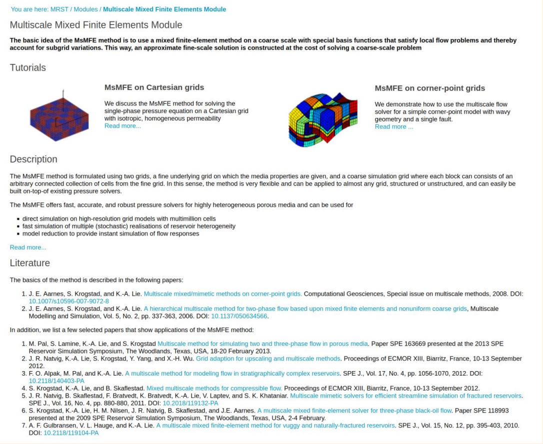

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Output

Keywords:
- Multiscale mixed finite-element methods
- MsMFE
- coarse-scale problem
- fine-scale solution
- heterogeneous porous media
- pressure solvers
- grid adaptation
- two-phase flow
- three-phase flow
- stratigraphically complex reservoirs

Problem Description: The user is seeking information about multiscale mixed finite-element methods (MsMFE) and their applications in solving flow problems in porous media.

Retrieval

Cosine Similarity

$$x_{ij} = \frac{\langle \vec{x_i}, \vec{x_j} \rangle}{x_i x_j}$$

Okapi BM25?

Reranking

Semantic Match Matrix

- n query keywords
- k article keywords
- most common bigrams

- (n x k) Semantic Match Matrix

Example

query = """Who should I contact about coupled flow and geomechanics for CO_2?"""

Evaluating geophysical monitoring strategies for a CO2 storage project

Susan Anyosa, Jo Eidsvik, Dario Grana

ABSTRACT

Evaluating geophysical monitoring strategies for a CO2 storage project

	Decision making	Geophysical data	Value information	Geophysical monitoring	Monitoring co2	Max
Coupled flow	0.07	0.09	0.06	0.12	0.07	0.12
geomechanics	0.1	0.46	0.05	0.48	0.02	0.48
CO2 storage	0.06	0.11	0.05	0.09	0.65	0.65
co2lab	0.12	0.18	0.11	0.2	0.65	0.65
Discrete Fracture Matrix (DFM)	0.13	0.03	0.15	0.03	-0.12	0.15

0.41

Evaluating geophysical monitoring strategies for a CO2 storage project

	Seismic data	Geophysical data	co2 plume	co2 saturation	resistivity data	Max
Coupled flow	0.1	0.09	0.17	0.13	0.05	0.17
geomechanics	0.44	0.46	0.01	0.0	0.2	0.46
CO2 storage	0.07	0.11	0.56	0.57	0.06	0.57
co2lab	0.15	0.18	0.58	0.55	0.21	0.58
Discrete Fracture Matrix (DFM)	0.12	0.03	-0.09	-0.07	0.16	0.16

0.39

A combined Markov Chain Monte Carlo and Levenberg–Marquardt inversion method for heterogeneous subsurface reservoir modeling

Jarbas A. Fernandes, Juarez S. Azevedo, Saulo P. Oliveria

ABSTRACT

A combined Markov Chain Monte Carlo and Levenberg–Marquardt inversion method for heterogeneous subsurface reservoir modeling

	porosity permeability	permeability fields	optimization method	study systematically	systematically investigate	Max
Coupled flow	0.16	0.29	0.1	0.01	0.03	0.29
geomechanics	0.31	0.24	0.14	0.07	0.08	0.31
CO2 storage	0.13	0.06	0.11	-0.04	-0.03	0.13
co2lab	0.12	0.09	0.24	0.09	0.14	0.24
Discrete Fracture Matrix (DFM)	0.11	0.16	0.11	-0.02	0.03	0.16

0.22

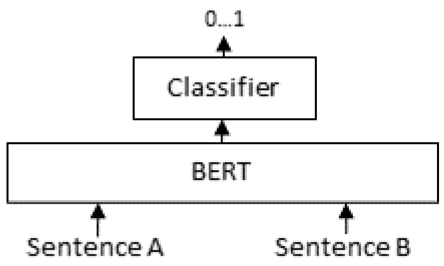
A combined Markov Chain Monte Carlo and Levenberg–Marquardt inversion method for heterogeneous subsurface reservoir modeling

	porosity permeability	Pressure saturation	Permeability fields	https doi	doi org	Max
Coupled flow	0.16	0.22	0.29	0.12	0.06	0.29
geomechanics	0.31	0.19	0.24	0.06	0.07	0.31
CO2 storage	0.13	0.18	0.06	0.04	0.06	0.18
co2lab	0.12	0.24	0.09	0.16	0.21	0.24
Discrete Fracture Matrix (DFM)	0.11	0.05	0.16	0.02	0.04	0.16

0.23

Cross-Encoders

- Individual language model (memory)
- Ranks the relevance of text pairs
- Powerful, but computationally expensive
- 2 seconds per paper, 1 second per abstract
- Shorter searches
- Smaller Datasets



Semantic Match Matrix

- Based on same embedding model (memory efficient)
- Ranks the relevant topics in queries/documents
- Computationally fast
- Large Datasets

$$\begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix}$$

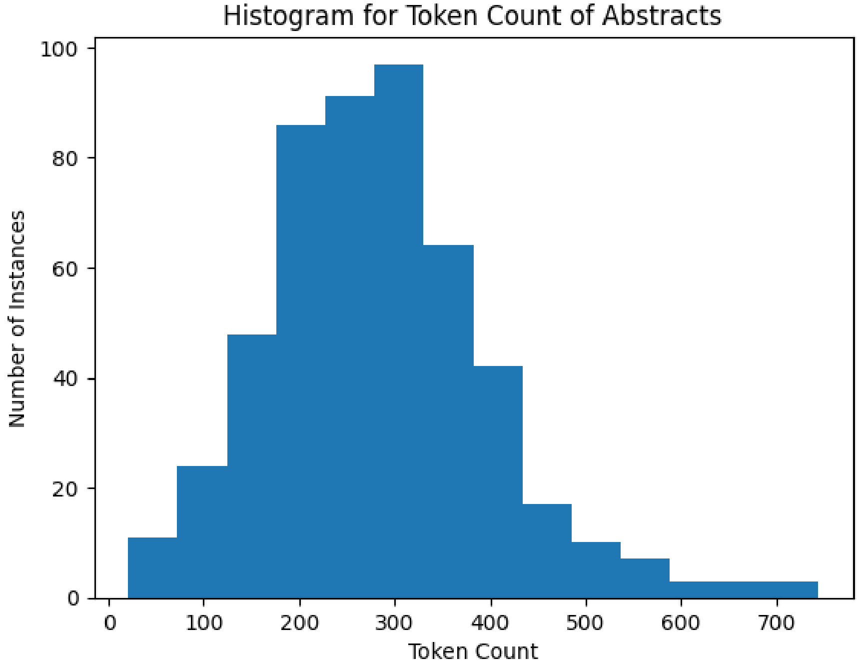
Live DEMO

Experiences

Document/Chunk Size

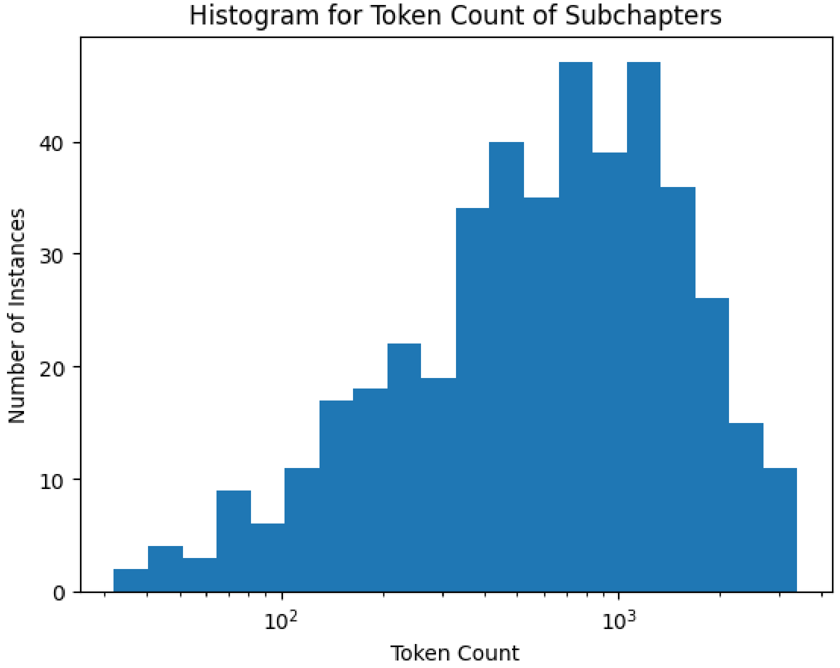
Scientific Articles

- 100 to 500 tokens per chunk is optimal
- Abstracts fall perfectly in the middle of this interval
- Overlap in chunks



Textbook

- The Textbook subchapters do generally become a bit too big
- Could be interesting to see other ways to chunk
- **NB:** x-axis is logarithmic



HyDE

Hypothetical Document Embeddings

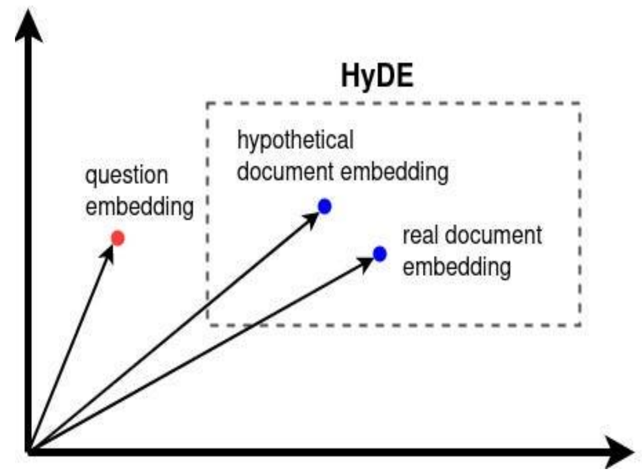
Scientific abstracts

- Can work in specific competence query searches, as long as the prompt gives reasonable context
- For general searches, you're better off rewriting the query or generating keywords to capture relevant research areas

(You are probably better off generating keywords)

General Documents

- Difficult if you've got a database consisting of documents of many types



Clustering

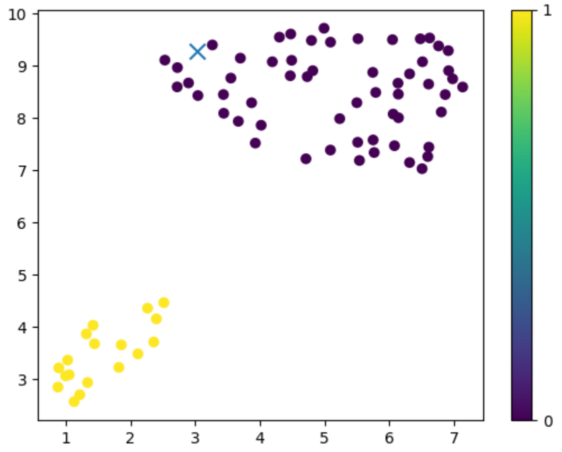
Gathering Clusters

- Density based clusters (DBSCAN, HDBSCAN,..)
- Reduce dimensions (UMAP) (768 - 50) (3072 - 100)

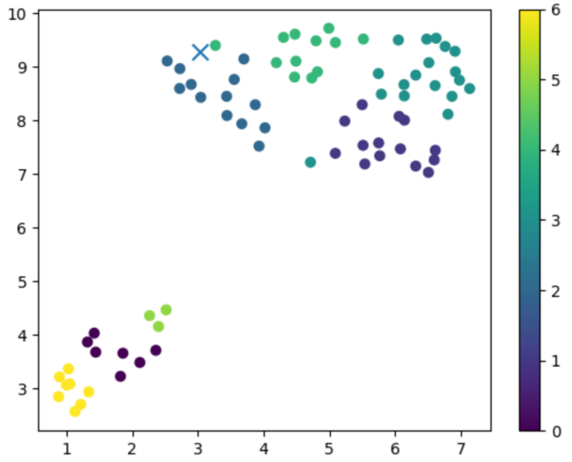
Clustered Response

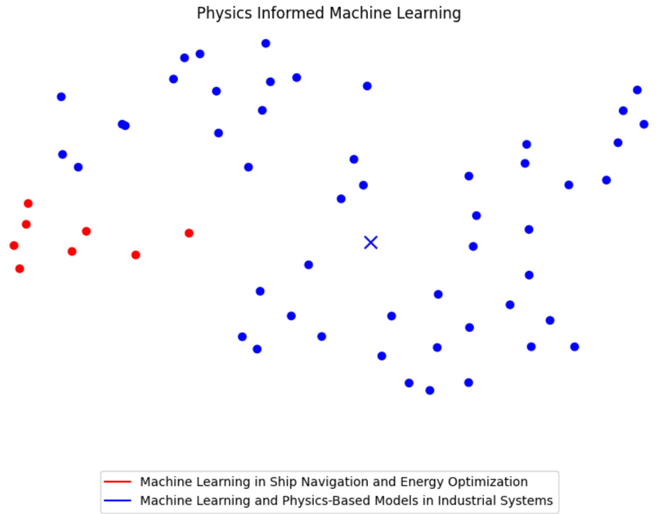
- Generate separate text answers for each cluster
- Works best for cheaper or smaller language models
- Relies heavily on clustering algorithm
- Important for general competence searches

HDBSCAN



KMEANS





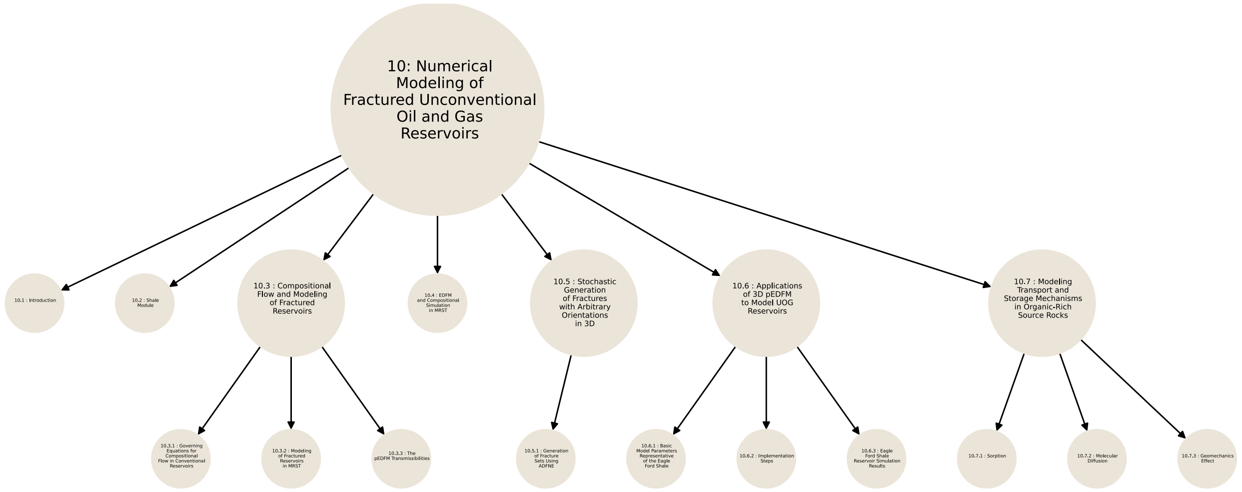
Application in other competence query search applications

Gathering Documents

- The application can only become as good as the dataset
- Academic Web Scrapes - [Semanticscholar api]
- Generate keywords for articles whilst preparing

Keep the Human In the Loop

- LLMs can write some weird stuff
- Suggestions, Context around Documents, or actual pauses in the program



General tips for working with language models

- Keep as little logic as possible up to the language model
- Use different models for different tasks (see openai models)
- Keyword generation is extremely helpful, but might remove the semantic meaning
- They can easily be confused by output formats