



Firedrake

pyop3 is coming

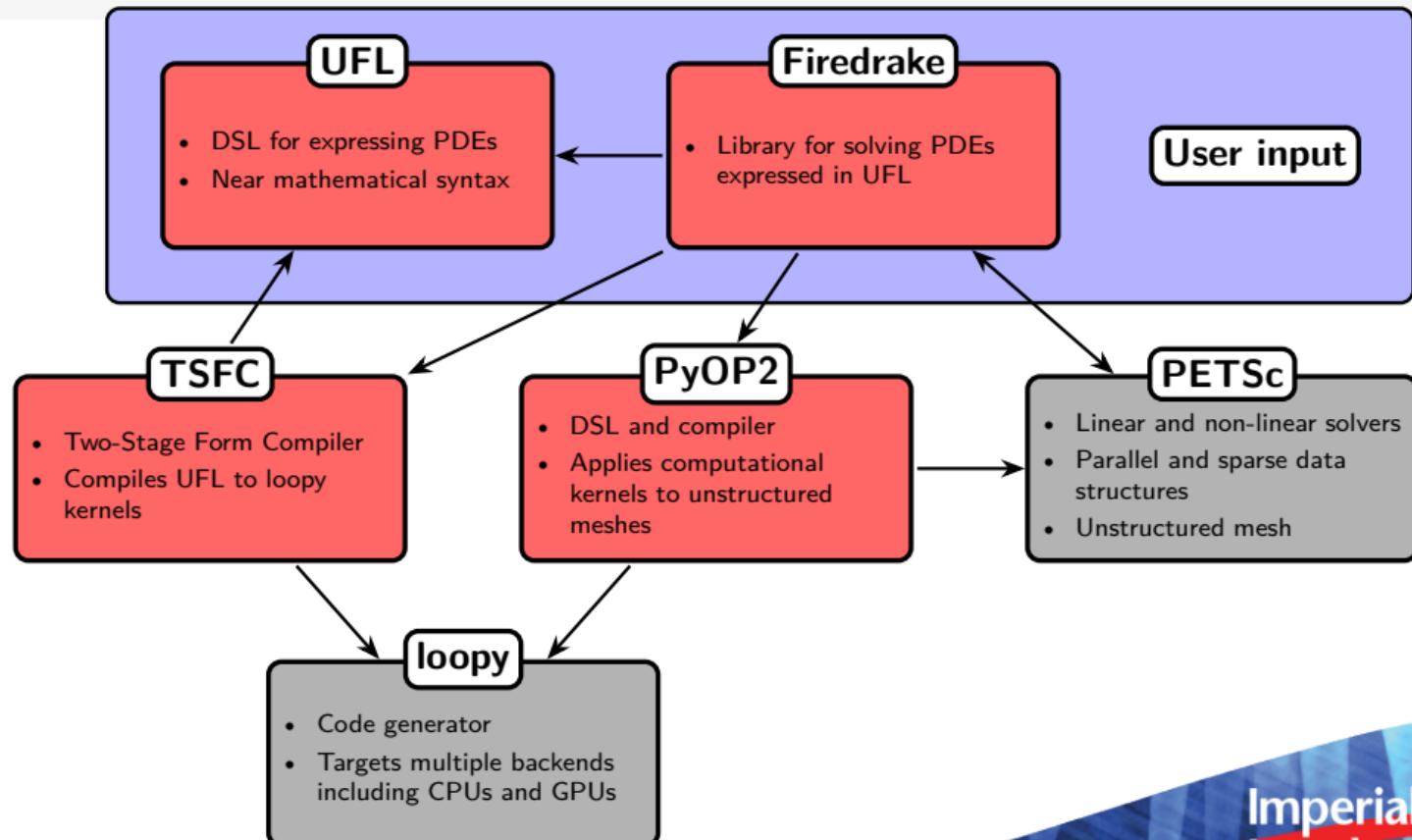
Connor Ward, David Ham, Jack Betteridge

16/09/2024

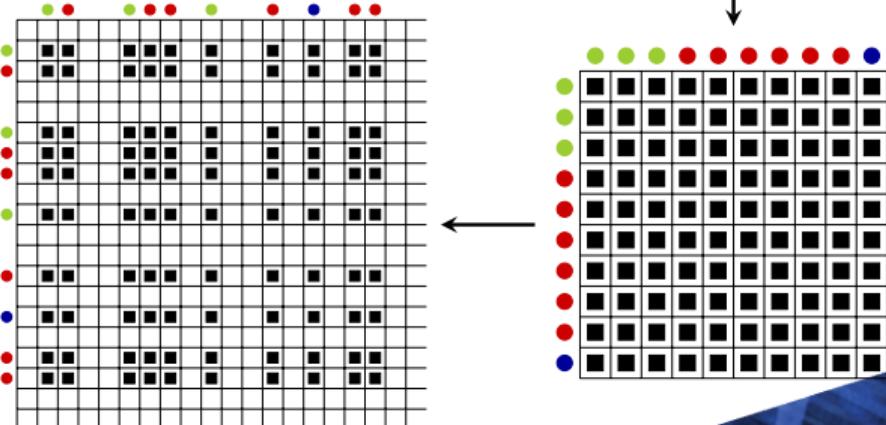
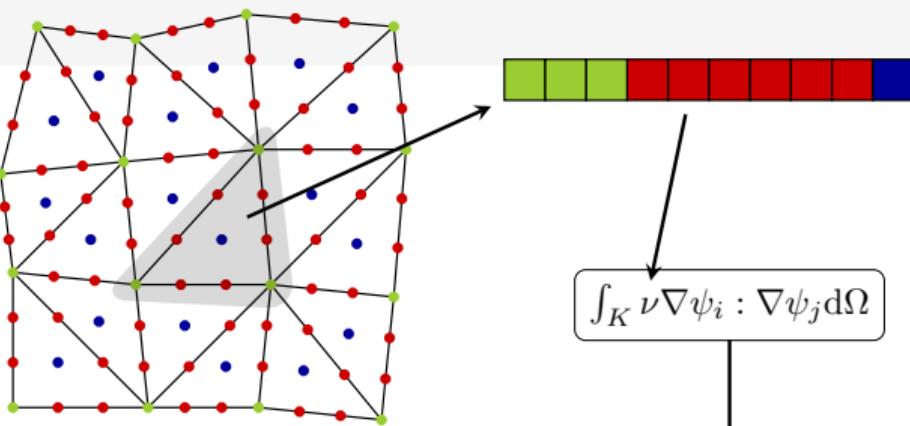
- I have made a new package for **mesh stencil calculations**.
- It is called **pyop3**.
- It will **soon replace** PyOP2 in Firedrake.
- This presentation will focus on the impact this will have on you, Firedrake users and developers.
- And hopefully inspire some of you to give it a try.



Introducing PyOP2



Introducing PyOP2



Why a mesh stencil abstraction?



- Writing one assembly loop is easy, writing many is hard.
- Changing algorithms and architectures mean that we need to be able to make high-level changes to various aspects of the computation. We don't want to write these all by hand.
- Also code generation is much faster than library functions.

Why do we need something new?



PyOP2 is a wonderful tool, but...

- It was designed specifically for FEM. More complex algorithms like additive-Schwartz methods (PCPatch) and hybridisation (SLATE) are possible but need hackery. This makes them inherently fragile.

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- It commits to one data layout, which is suboptimal in some circumstances.



Introducing pyop3

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An example: vertex-based slope limiter



An example: vertex-based slope limiter



Data layout transformations





- preconditioners (SLATE, PCPatch)



- Hopefully extremely minimal. The top-level API is unchanged.
- If you are frequently interacting directly with the arrays (i.e. `function.dat.data`) then you *may* notice changes.
- Obviously any PyOP2 will need porting.
- Code performance may change (for better or worse). In principle shouldn't slow anything down.

Die, extruded mesh! Die! Die! Die!



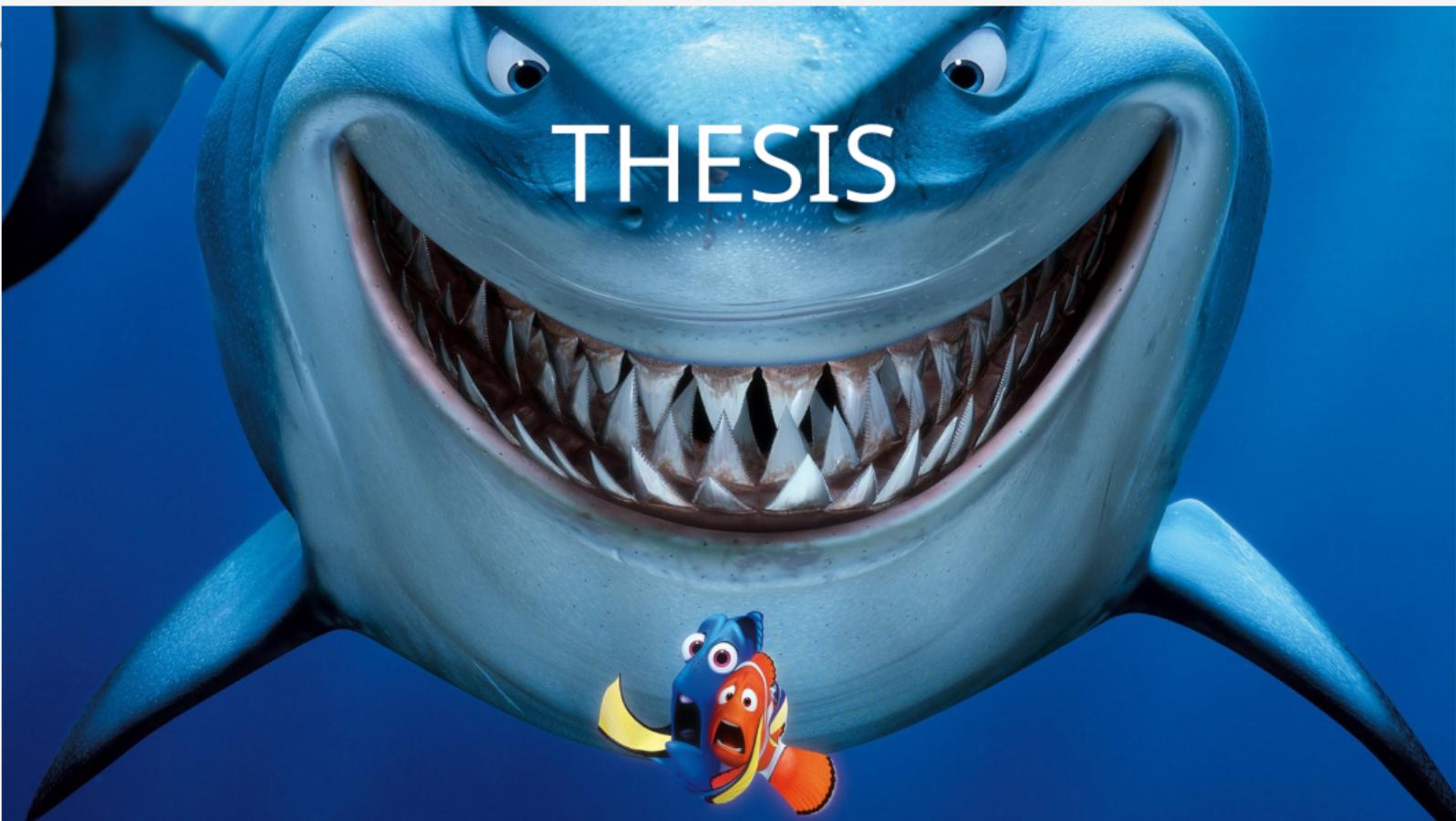
What next?



Wh



THESIS



But then?



- pyop3 should be merged within the next 6 months.
- It will be in a usable state well before then.
- Hopefully then we will have funding for me to get it working on GPUs.