PSYDAC: a parallel finite element solver with automatic code generation

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PSYDAC is a Python 3 library for the solution of partial differential equations. Its current focus is on isogeometric analysis using B-spline finite elements, but extensions to other methodologies are under consideration. In order to use PSYDAC [1], the user defines geometry and model equations in an abstract form using SymPDE [2], an extension of Sympy [3] that provides the mathematical expressions and checks their semantic validity. Once a finite element discretization has been chosen, PSYDAC maps the abstract concepts into concrete objects, the basic building blocks being MPI-distributed vectors and matrices. Python code is generated for the all the computationally intensive operations (matrix and vector assembly, matrix-vector products, etc.), and it is accelerated using either Numba [4] or Pyccel [5]. We present the library design, the user interface, and the performance results.

References

[1] PSYDAC: https://github.com/pyccel/psydac
[2] SymPDE: https://github.com/pyccel/sympde
[3] Sympy: https://www.sympy.org
[4] Numba: https://numba.pydata.org
[5] Pyccel: https://github.com/pyccel/pyccel