PHAS0102: Techniques of High-Performance Computing

PETSc

PETSc (Portable, Extansible Toolkit for Scientific Computation) is a fast linear algebra library written in C.

petsc4py is Python library that allows you to use PETSc in Python.
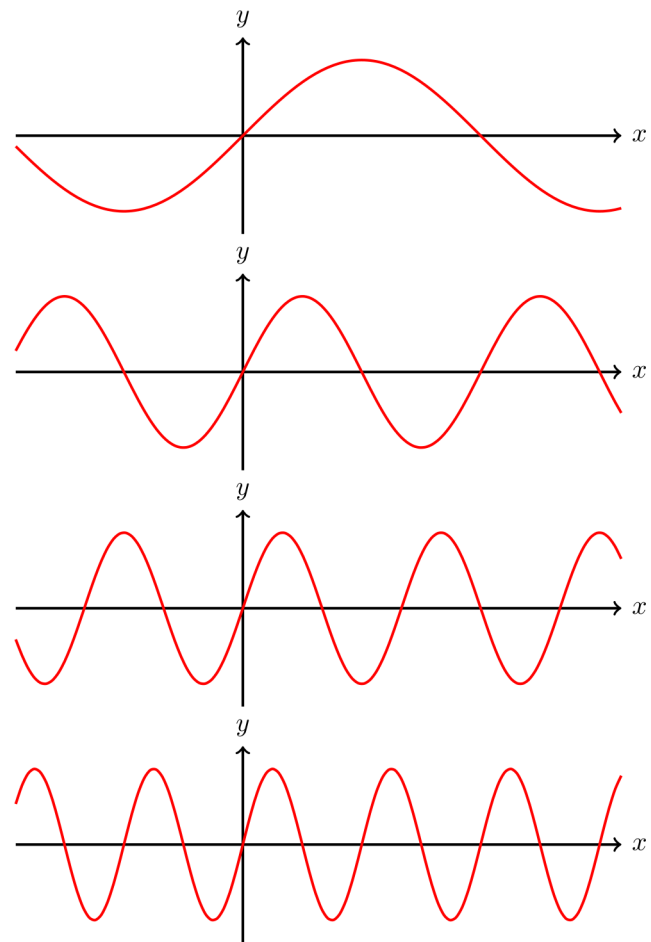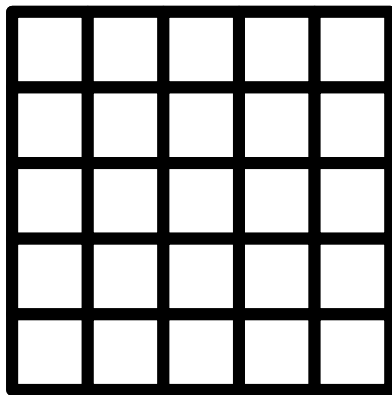
[live Python example]

Multigrid

For wave problems, it is natural to think of solutions as being made up of a combination of waves of different frequencies.

Solutions to other problems can also be treated this way (Fourier series).
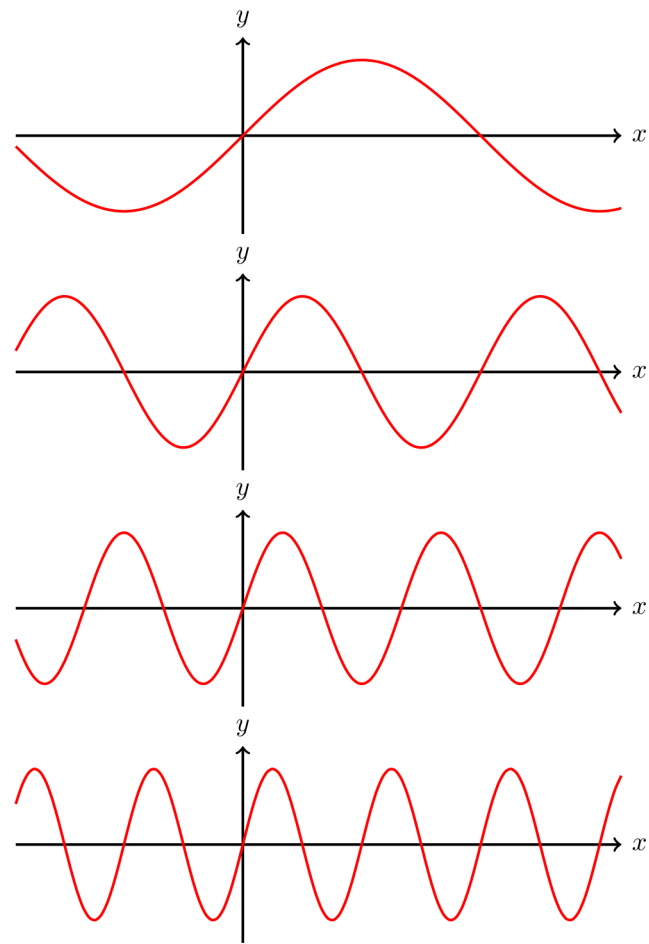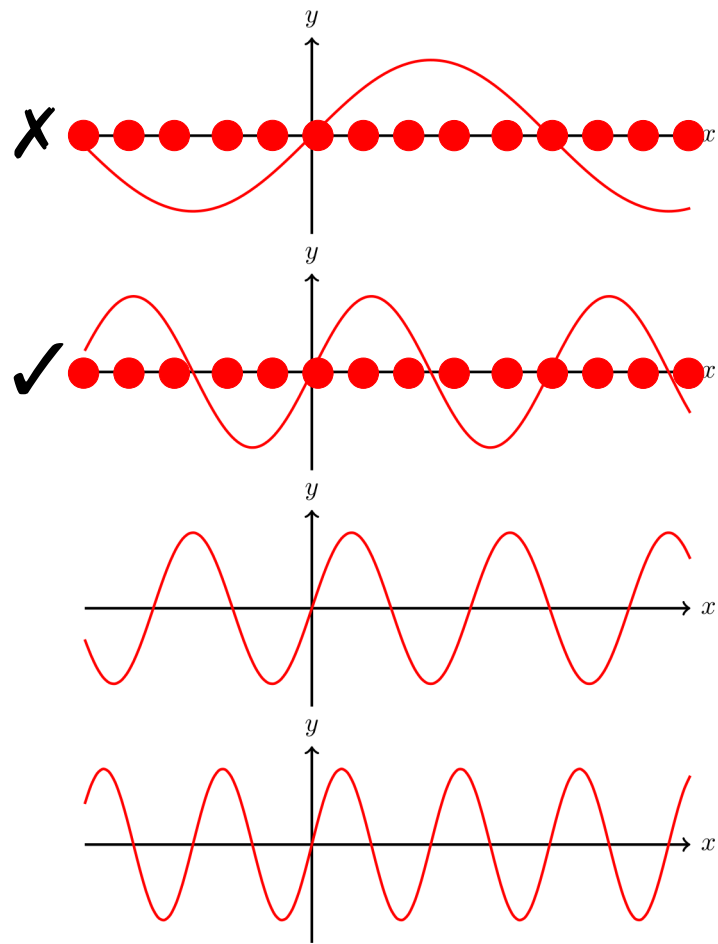
Multigrid

Many methods for solving problems are mesh/grid based (eg finite difference method, finite element method)
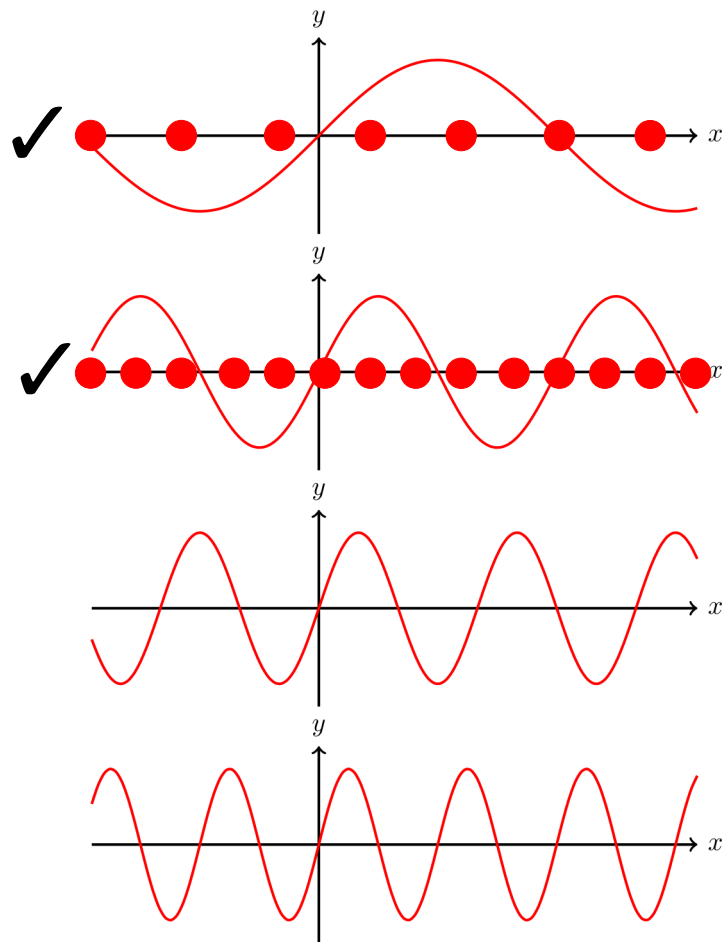
Multigrid

Mesh methods are good at resolving components where the wavelength and mesh size are of the same order of magnitude.

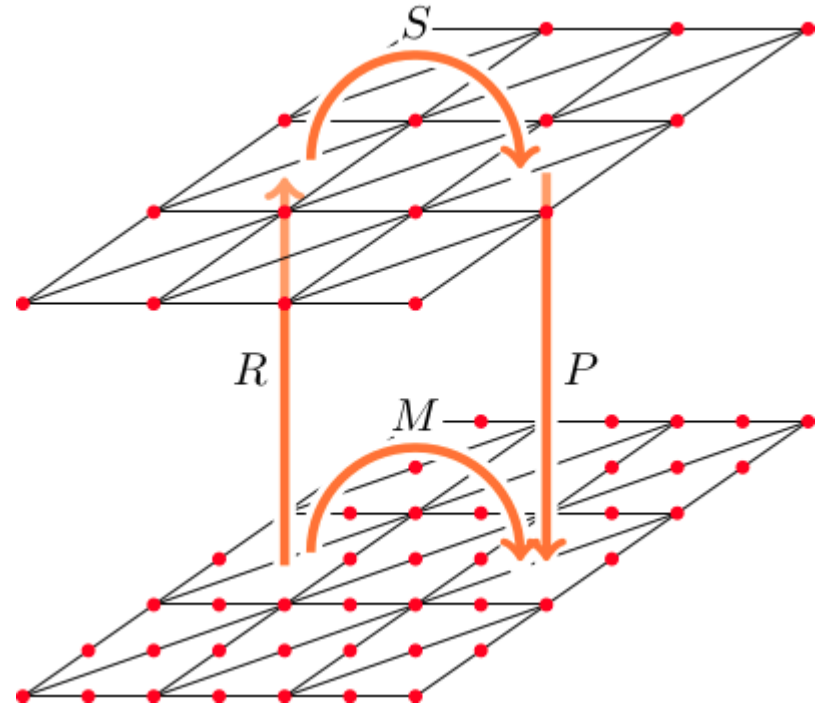The are less good at resolving the lower frequency parts.

Multigrid

Idea: Resolve lower frequency parts on coarser meshes

Multigrid

One iteration is:

– Apply M to get x_n

– Calculate residual (r_n)

– Apply R then S then P to r_n

– Add this to x_n

Algebraic multigrid (AMG)

What we've looked at so far has been geometric multigrid (GMG).

Algebraic multigrid (AMG) is a method inspired by GMG that can be applied without needing the hierarchy of grids.

AMG is commonly used as a preconditioner.

pyamg

pyamg is an AMG solver that can be used from Python

[live Python example]

Next week's Friday lecture

- Next Tuesday, Wednesday, Friday, and Saturday, there are train strikes

- Lecture will probably held using Zoom (will confirm via message on Moodle)

- (Monday will go ahead as normal)