


Parallelization of Geodesic Ray-Tracing for Arbitrary Metrics

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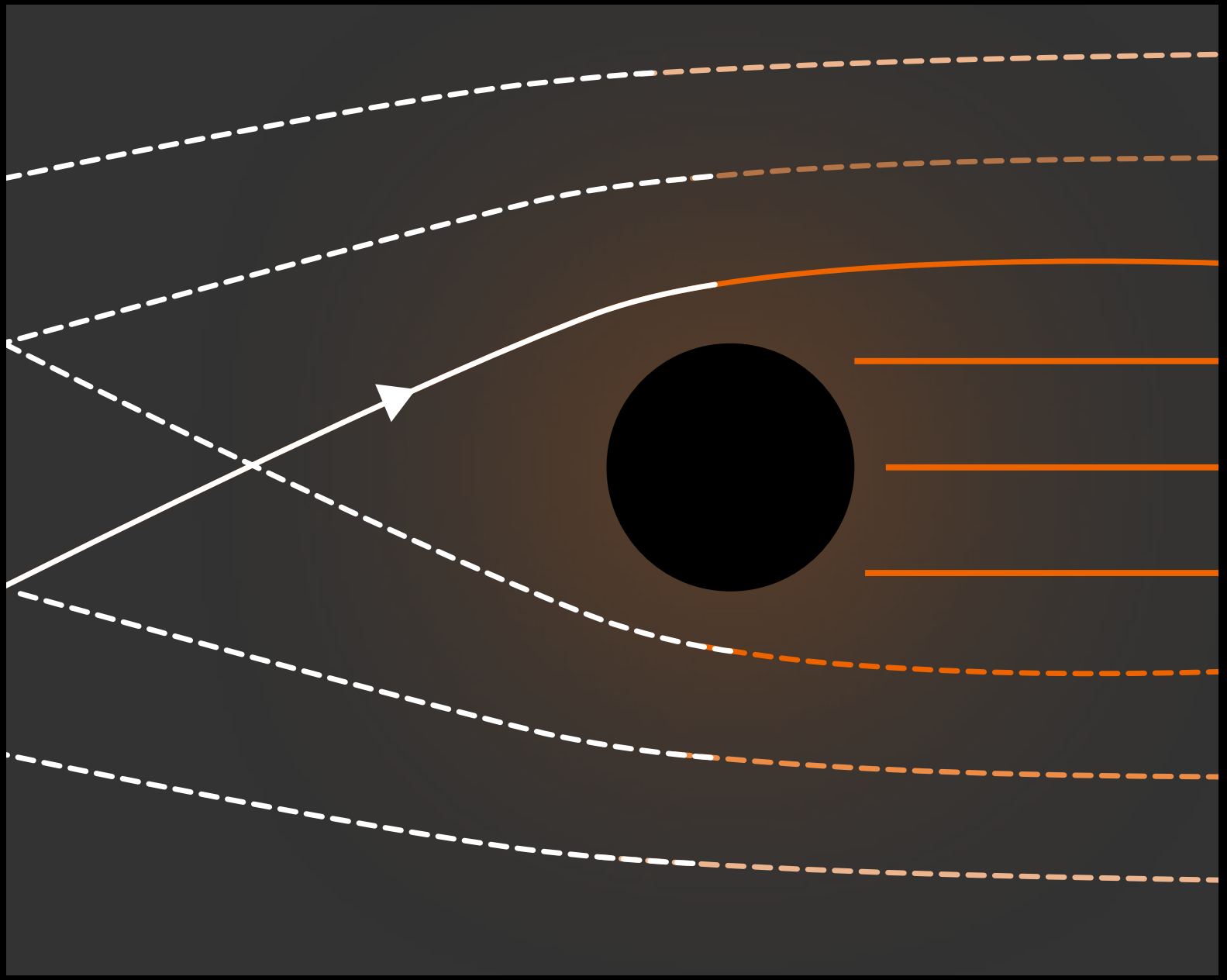
Description of the problem

Program and parallelization

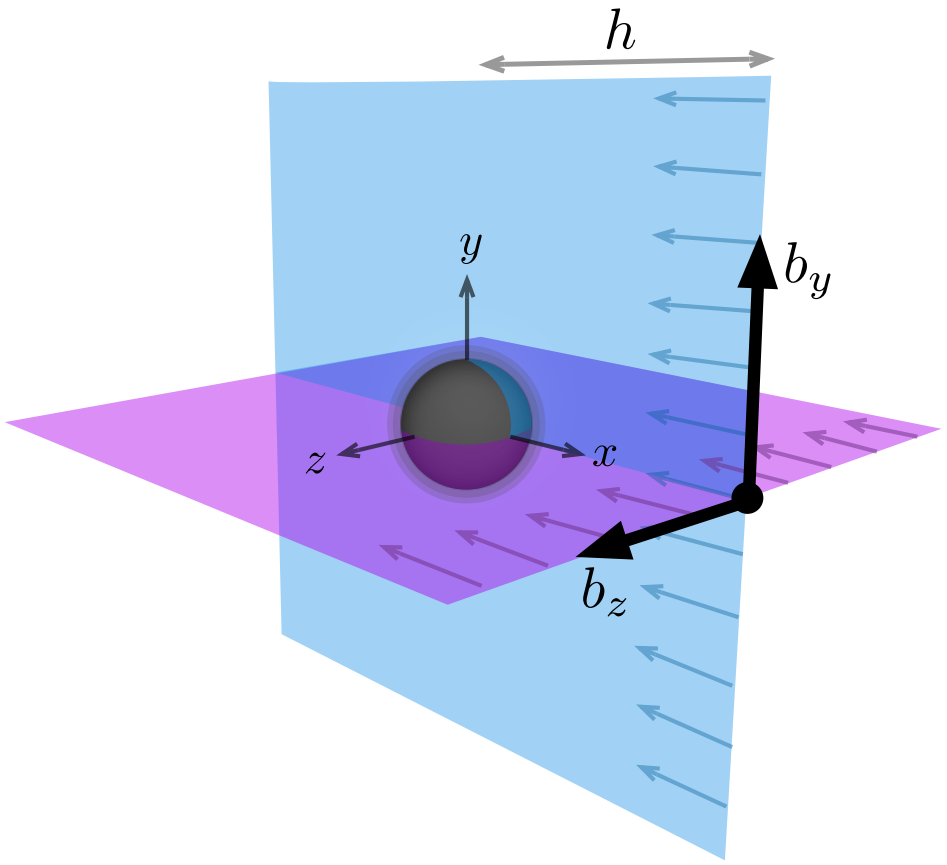
The future



What you need to know...

- Metrics describe spacetime
- Spacetime becomes curved around compact objects (neutron stars, black holes, etc.)
- Curved spacetime bends light: null geodesics
- Geodesic equations: 2nd order ODE system that contains derivatives of the metric that describe trajectories of particles
- I am solving the geodesic equations for arbitrary metrics
- I want to apply the result to:
  - Gravitational redshift of radiation emitted near a compact object $\leftarrow$
  - High resolution gravitational lenses

Initial conditions



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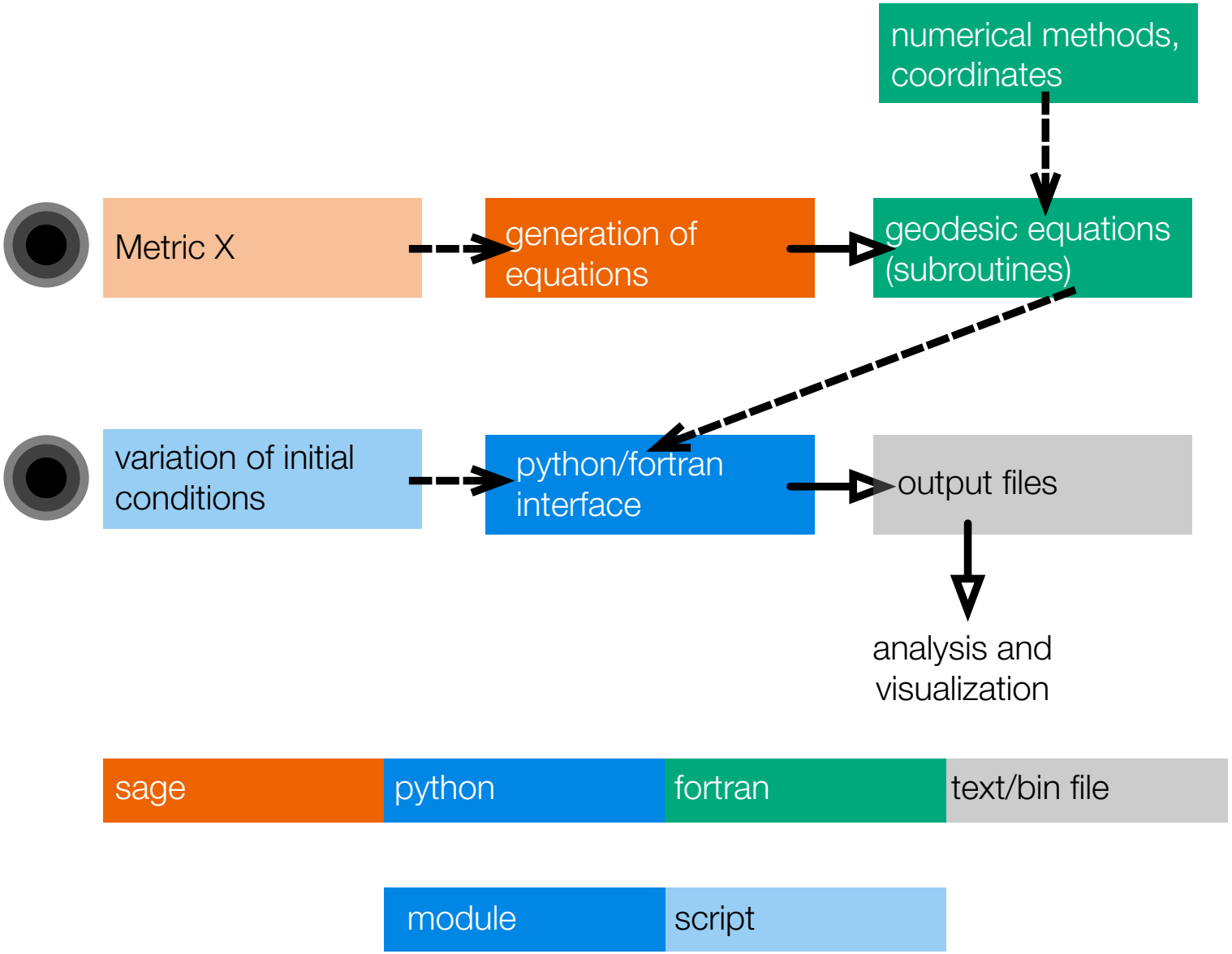
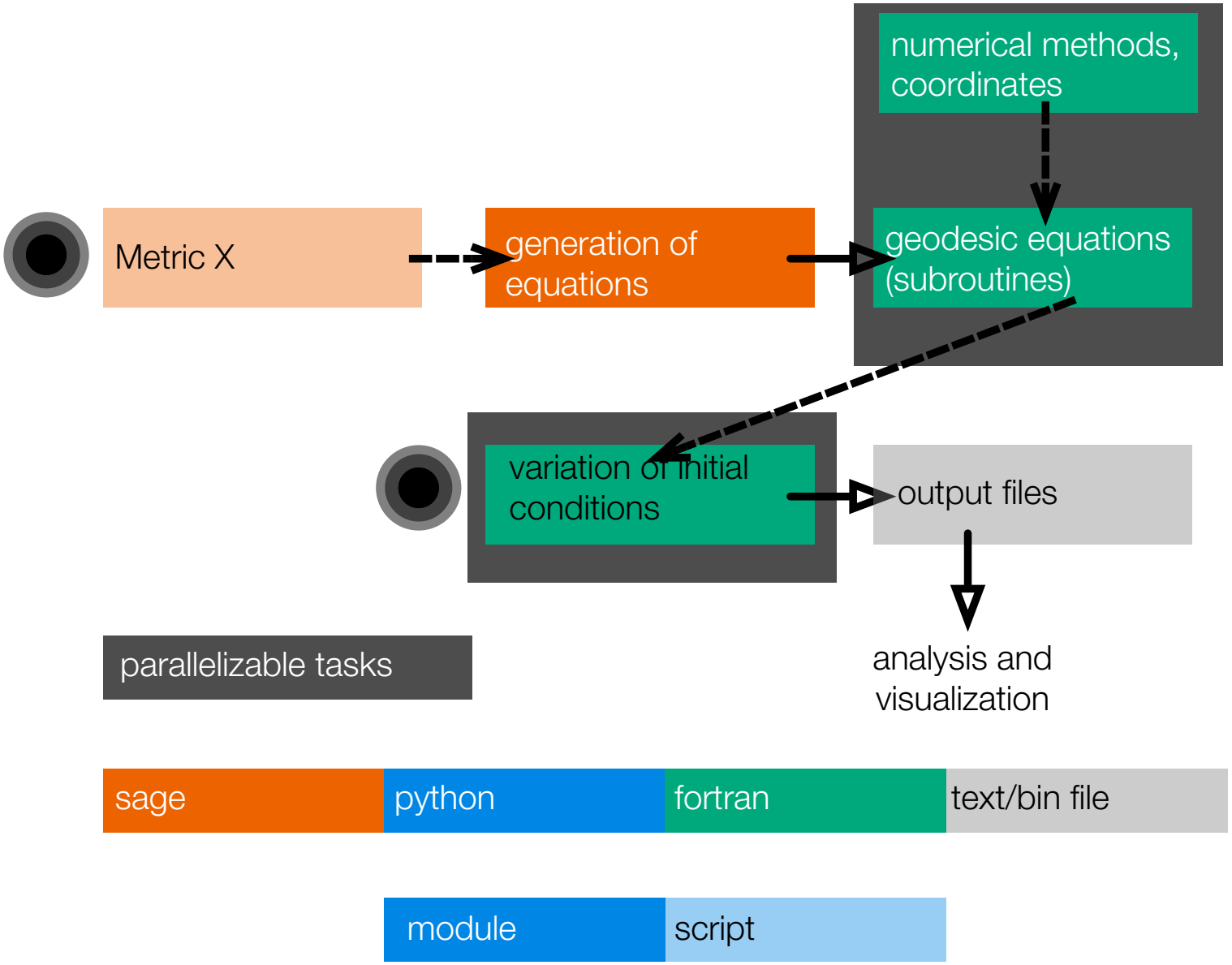
Structure of the program



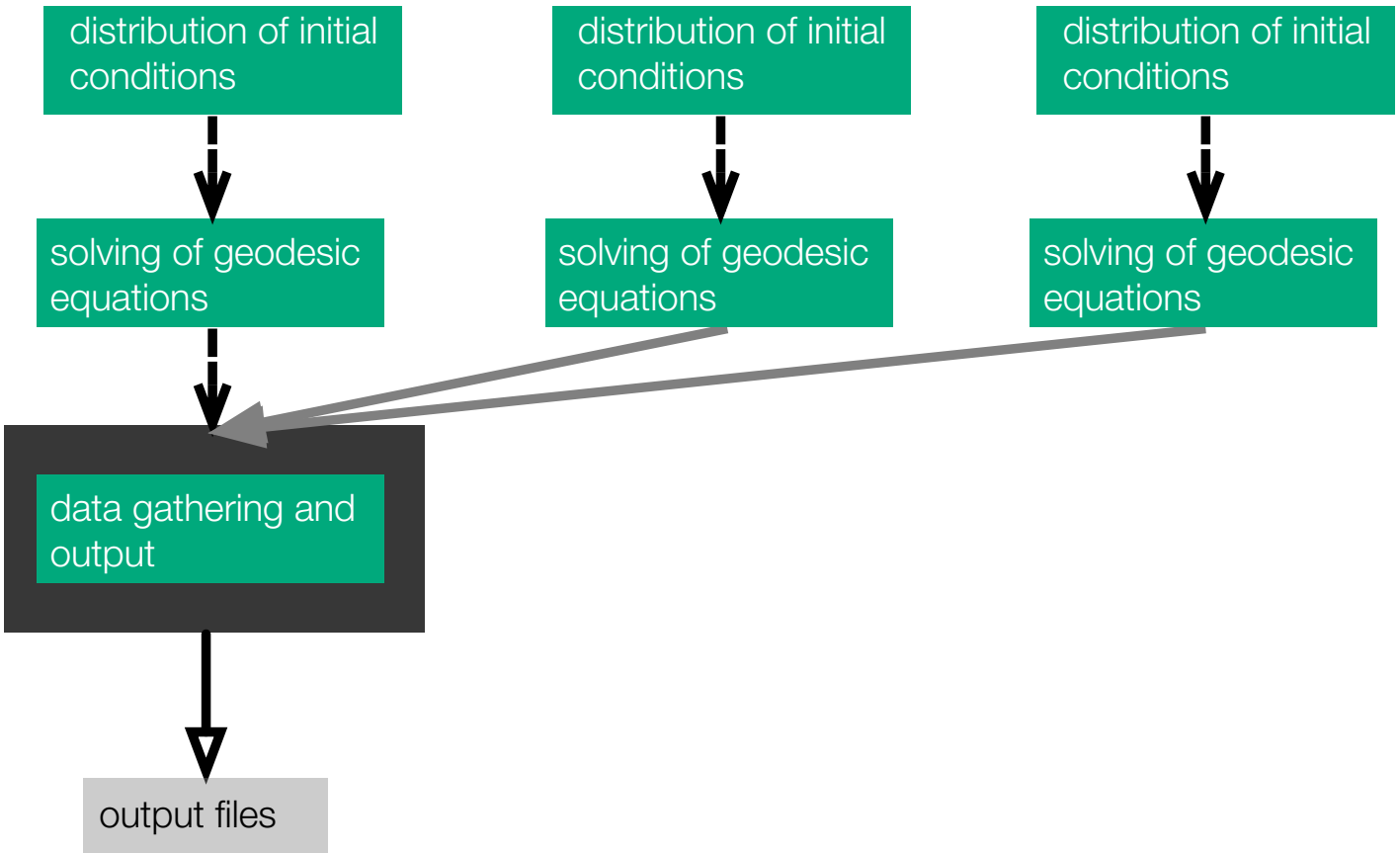
Problems with the serial version

- For low resolutions works decently fine (aprox. 1-5 minutes)
- Increasing the size of the region increases considerably the time!
- I need lots of runs! — Different parameters
- Theoretically it's easy to parallelize and use available resources

Parallelizable tasks



Implementation



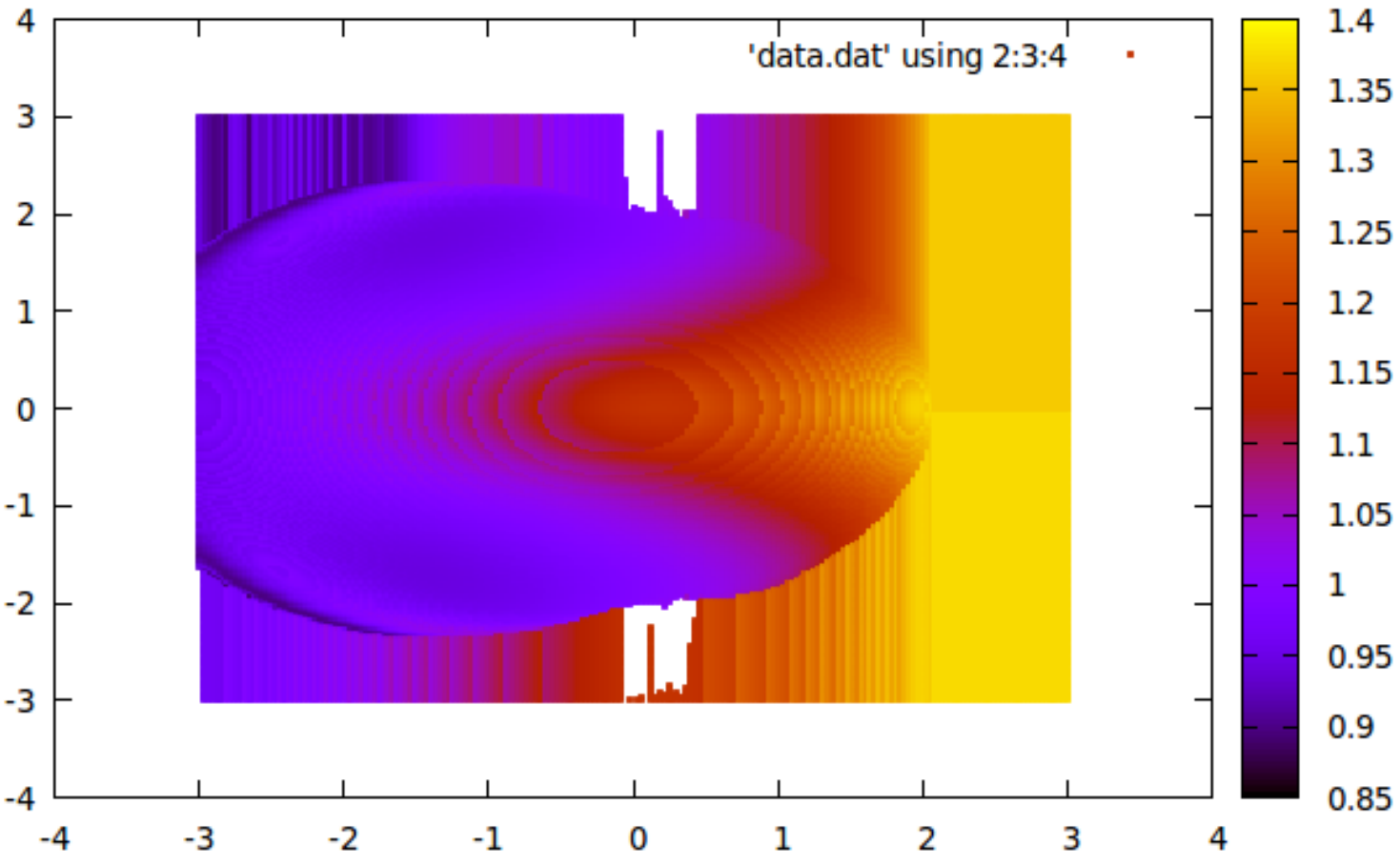
analysis and visualization

Problems and simplifications

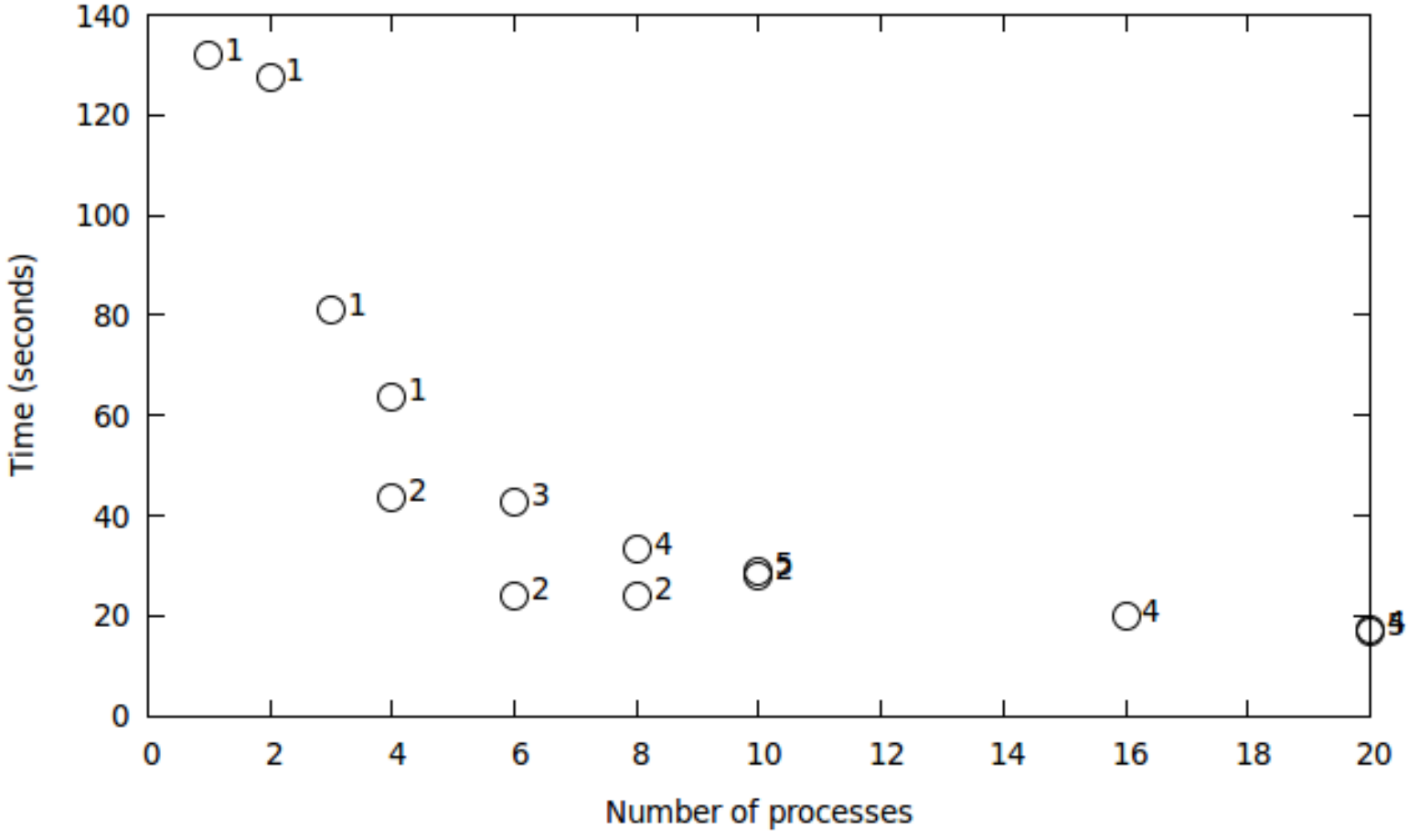
- Distribution of initial conditions manually
- Saving all iterations: with adaptive-size methods you can't predict the size of results!
- The initial and final iterations allowed me to construct one image
- Non-perfect results (nothing to do with parallelization)

Results

200 × 200 pixels



Scalability



Numbers: processes in the x direction

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Lessons learned

- All is more complicated in parallel
- Ask questions!
- Look for things already implemented!
- Start with the simplest case
- Prototyping in Python before implementing in the main code
- Version control saved my life: In the past, I had already implemented and erased some useful lines of code that I needed now!

This School helped me because...

- I can now generate higher resolution images and try more initial conditions
- I can now use the Chirripó cluster (Cinespa) for my project
- It gave me an insight about parallel programing for other projects

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Thanks

more information

www.gandreoliva.org/english