PyLith Modeling Tutorial
Debugging PyLith Simulations

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June 18, 2016
What parameters are available?

Parameters are specified as a hierarchy of components and properties

- Components (Facilities) are the object building blocks
  - Problem TimeDependent
  - Boundary conditions DirichletBC
  - Faults FaultCohesiveKin
  - Materials MaxwellViscoelastic3D
  - Output managers OutputSolnSubset
  - Readers MeshI0Cubit

- Properties are the basic types
  - String `mat_viscoelastic.spatialdb`
  - Integer 4
  - Float 2.3
  - Dimensioned quantity 2.5*year
  - Array of Strings, Integers, or Floats [0, 0, 1]
How do I show the values of the current parameters?

Case study: examples/3d/hex8/step01

- All current parameters and their values
  
  ```
  pylithinfo [--verbose] [-o pylith.parameters.txt] [-h] [PyLith args]
  
  pylithinfo --verbose step01.cfg
  ```

- Components and properties for given component --help
  
  ```
  step01.cfg [pylithapp.timedependent.bc.z.neg]
  shell: pylith step01.cfg --timedependent.bc.z_neg.help
  ```

- Current components of a given component --help-components
  
  ```
  step01.cfg [pylithapp.timedependent.bc.z.neg]
  shell: pylith step01.cfg --timedependent.bc.z_neg.help-components
  ```

- Current properties of a given component --help-properties
  
  ```
  step01.cfg [pylithapp.timedependent.bc.z.neg]
  shell: pylith step01.cfg --timedependent.bc.z_neg.help-properties
  ```
What about a GUI?

Browser-based GUI under development

- Use web browser as GUI to parameters
  - See all parameters with descriptions
  - See possible choices for components and properties
- Basic validation of parameters
- Export parameters to single file
  Facilitate archiving parameters used in given simulation

Started in Oct 2013 but v2.0 and v3.0 releases have higher priority
Debugging Examples
See examples/debugging

Step01 Simple shear using Dirichlet BC in static simulation
Step02 Prescribed fault slip with Dirichlet BC
  • Static simulation
  • Fault is embedded within the domain
Step03 Spontaneous rupture with Dirichlet BC
  • Static simulation
  • Static friction ($\mu_f = 0.6$)
  • Slip driven by simple shear

Correct files are provided for reference
Step01: Error 1
Error found while doing very basic validation of parameters

$ pylith step01.cfg

Python stacktrace

Traceback (most recent call last):
  File "/Volumes/Tools/unix/pylith-dev/clang-3.6.0/bin/pylith", line 27, in <module>
    start(applicationClass=PyLithApp)
  File "/Volumes/Tools/unix/cig/clang-3.6.0/lib/python2.7/site-packages/pythia-0.8.1.15-py2.7.egg/pyre/applications/Shell.py", line 125, in run
    app.applyConfiguration(context)
  File "/Volumes/Tools/unix/cig/clang-3.6.0/lib/python2.7/site-packages/pythia-0.8.1.15-py2.7.egg/pyre/inventor/Configurable.py", line 84, in applyConfiguration
    raise ValueError("\nBacktrace — Component %s"
  % (err.message, aliases))

Error message

ValueError: Error while configuring Dirichlet boundary condition (dirichletbc, x_pos):
Error while configuring boundary condition (dirichletbc, x_pos):
Label for group/nodeset/pset in mesh not specified.

Component hierarchy

Backtrace — Component dirichletbc, x_pos
Backtrace — Component bc
Backtrace — Component timedependent, problem
Backtrace — Component pylithapp
Step01: Error 1 Resolution
Error found while doing very basic validation of parameters

Error message

ValueError: Error while configuring Dirichlet boundary condition (dirichletbc, x_pos):
Error while configuring boundary condition (dirichletbc, x_pos):
Label for group/nodeset/pset in mesh not specified.

Component hierarchy

Backtrace — Component dirichletbc, x_pos
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Step01: Error 1 Resolution
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Error message
ValueError: Error while configuring Dirichlet boundary condition (dirichletbc, x_pos):
Error while configuring boundary condition (dirichletbc, x_pos):
Label for group/nodeset/pset in mesh not specified.

Component hierarchy
Backtrace — Component dirichletbc, x_pos
Backtrace — Component bc
Backtrace — Component timedependent, problem
Backtrace — Component pylithapp

Debug: Examine parameters for pylithapp.problem.bc.x_pos
Step01: Error 1 Resolution
Error found while doing very basic validation of parameters

Error message

ValueError: Error while configuring Dirichlet boundary condition (dirichletbc, x.pos):
Error while configuring boundary condition (dirichletbc, x.pos):
Label for group/nodeset/pset in mesh not specified.

Component hierarchy

Backtrace — Component dirichletbc, x.pos
Backtrace — Component bc
Backtrace — Component timedependent, problem
Backtrace — Component pylithapp

Debug: Examine parameters for pylithapp.problem.bc.x_pos
Resolution

[pylithapp.timedependent.bc.x_pos]
Step01: Error 2
Error found in parsing .cfg file

$ pylith step01.cfg

.cfg file with line number

>> step01.cfg:99:

Error message

— pyre.inventory(error)
— pylithapp.timedependent.implicit.output.outputsoln.write.filename <-- 'output/step01.vtk'
— unknown component
'pylithapp.timedependent.implicit.output.outputsoln.write'

Usage information

usage: pylith [---<property>=<value>] [---<facility>,<property>=<value>] [FILE.cfg] ...
component 'pylithapp'
    properties: help, help-components, help-persistence, help-properties, initialize_only, job,
    facilities: job,launcher,mesh_generator,perf_logger,petsc,problem,scheduler,weaver
For more information:
—help—properties: prints details about user settable properties
—help—components: prints details about user settable facilities and components
pylithapp: configuration error(s)
Step01: Error 2 Resolution
Error found in parsing .cfg file

Error message

— pyre.inventory(error)
— pylithapp.timedependent.implicit.output.outputsoIn.write.filename ← 'output/step01.vtk'
— unknown component
'pylithapp.timedependent.implicit.output.outputsoIn.write'
Step01: Error 2 Resolution
Error found in parsing .cfg file

Error message

— pyre.inventory(error)
— pylithapp.timedependent.implicit.output.outputsoIn.write.filename ← 'output/step01.vtk'
— unknown component
'pylithapp.timedependent.implicit.output.outputsoIn.write'

Debug: Look up the properties of the OutputSoln object
Error message

```python
pyre.inventory(error)
pylithapp.timedependent.implicit.output.outputsoln.write.filename < 'output/step01.vtk'
unknown component
'pylithapp.timedependent.implicit.output.outputsoln.write'
```

**Debug:** Look up the properties of the OutputSoln object

**Resolution**

```python
[pylithapp.problem.formulation.output.domain]
writer.filename = output/step01.vtk
```
Step01: Error 3
Error found when initializing integrators

$ pylith step01.cfg

Python stacktrace

Fatal error. Calling MPI_Abort() to abort PyLith application.
Traceback (most recent call last):
  File "/Volumes/Tools/unix/pylith-dev/clang-3.6.0/lib/python2.7/site-packages/pylith/apps/PetscApplication.py", line 64, in onComputeNodes
    self.main(*args, **kwds)
  File "/Volumes/Tools/unix/pylith-dev/clang-3.6.0/lib/python2.7/site-packages/pylith/apps/PyLithApp.py", line 125, in main
    self.problem.initialize()
  File "/Volumes/Tools/unix/pylith-dev/clang-3.6.0/lib/python2.7/site-packages/pylith/problems/TimeDependent.py", line 120, in initialize
    self.formulation.initialize(self.dimension, self.normalizer)
  File "/Volumes/Tools/unix/pylith-dev/clang-3.6.0/lib/python2.7/site-packages/pylith/problems/Formulation.py", line 470, in initialize
    integrator.initialize(totalTime, numTimeSteps, normalizer)
  File "/Volumes/Tools/unix/pylith-dev/clang-3.6.0/lib/python2.7/site-packages/pylith/feassemble/ElasticityImplicit.py", line 56, in initialize
    ModuleElasticityImplicit.initialize(self, self.mesh())
  File "/Volumes/Tools/unix/pylith-dev/clang-3.6.0/lib/python2.7/site-packages/pylith/feassemble/feassemble.py", line 357, in initialize

Error message

RuntimeError: Error occurred while reading spatial database file 'mat_elastic.spatialdb'. Spatial distribution with data dimensions of 0 cannot have more than one point. Found 3 points in distribution.

Abort message

application called MPI_Abort(MPI_COMM_WORLD, -1) – process 0

Step01: Error 3 Resolution
Error found when initializing integrators

Error message

```
RuntimeError: Error occurred while reading spatial database file 'mat_elastic.spatialdb'.
Spatial distribution with data dimensions of 0 cannot have more than one point.
Found 3 points in distribution.
```
Step01: Error 3 Resolution
Error found when initializing integrators

Error message

RuntimeError: Error occurred while reading spatial database file 'mat_elastic.spatialdb'. Spatial distribution with data dimensions of 0 cannot have more than one point. Found 3 points in distribution.

Debug: Look at mat_elastic.spatialdb for errors in data
Step01: Error 3 Resolution
Error found when initializing integrators

Error message

```
RuntimeError: Error occurred while reading spatial database file 'mat_elastic.spatialdb'. Spatial distribution with data dimensions of 0 cannot have more than one point. Found 3 points in distribution.
```

Debug: Look at `mat_elastic.spatialdb` for errors in data

Resolution

```
num_locs = 1 // number of locations
```
Step01: Error 4
Error found when initializing integrators

$ pylith step01.cfg

Python stacktrace

Fatal error. Calling MPI_Abort() to abort PyLith application.
Traceback (most recent call last):
  File "/Volumes/Tools/unix/pylith-dev/clang-3.6.0/lib/python2.7/site-packages/pylith/apps/PetscApplication.py", line 64, in onComputeNodes
    self.main(*args, **kwds)
  File "/Volumes/Tools/unix/pylith-dev/clang-3.6.0/lib/python2.7/site-packages/pylith/apps/PyLithApp.py", line 125, in main
    self.problem.initialize()
  File "/Volumes/Tools/unix/pylith-dev/clang-3.6.0/lib/python2.7/site-packages/pylith/problems/TimeDependent.py", line 120, in initialize
    self.formulation.initialize(self.dimension, self.normalizer)
  File "/Volumes/Tools/unix/pylith-dev/clang-3.6.0/lib/python2.7/site-packages/pylith/problems/Implicit.py", line 121, in initialize
    _initialize(dimension, normalizer)
  File "/Volumes/Tools/unix/pylith-dev/clang-3.6.0/lib/python2.7/site-packages/pylith/problems/Formulation.py", line 470, in _initialize
    integrator.initialize(totalTime, numTimeSteps, normalizer)
  File "/Volumes/Tools/unix/pylith-dev/clang-3.6.0/lib/python2.7/site-packages/pylith/feassemble/ElasticityImplicit.py", line 56, in initialize
    ModuleElasticityImplicit.initialize(self, self.mesh())
  File "/Volumes/Tools/unix/pylith-dev/clang-3.6.0/lib/python2.7/site-packages/pylith/feassemble/feassemble.py", line 357, in initialize

Error message

RuntimeError: Error occurred while reading spatial database file 'mat_elastic.spatialdb'.
Number of dimensions in coordinates of spatial distribution (2) does not match number of dimensions in coordinate system (3)

Abort message

application called MPI_Abort(MPI_COMM_WORLD, -1) – process 0
Step01: Error 4 Resolution
Error found when initializing integrators

Error message

```
RuntimeError: Error occurred while reading spatial database file 'mat_elastic.spatialdb'.
Number of dimensions in coordinates of spatial distribution (2) does not match number of dimensions in coordinate system (3)
```
Error message

```
RuntimeError: Error occurred while reading spatial database file 'mat_elastic.spatialdb'. Number of dimensions in coordinates of spatial distribution (2) does not match number of dimensions in coordinate system (3)
```

Debug: Look at coordinate system in `mat_elastic.spatialdb` header
Step01: Error 4 Resolution
Error found when initializing integrators

Error message

RuntimeError: Error occurred while reading spatial database file 'mat_elastic.spatialdb'. Number of dimensions in coordinates of spatial distribution (2) does not match number of dimensions in coordinate system (3)

Debug: Look at coordinate system in mat_elastic.spatialdb header
Resolution

space−dim = 3
Step01: Error 5
Error found when setting up solution field

$ pylith step01.cfg

Python stacktrace

Fatal error. Calling MPI_Abort() to abort PyLith application.
Traceback (most recent call last):
  File "/Volumes/Tools/unix/pylith-dev/clang-3.6.0/lib/python2.7/site-packages/pylith/apps/PetscApplication.py", line 64, in onComputeNodes
    self.main(*args, **kwds)
  File "/Volumes/Tools/unix/pylith-dev/clang-3.6.0/lib/python2.7/site-packages/pylith/apps/PyLithApp.py", line 125, in main
    self.problem.initialize()
  File "/Volumes/Tools/unix/pylith-dev/clang-3.6.0/lib/python2.7/site-packages/pylith/problems/TimeDependent.py", line 120, in initialize
    self.formulation.initialize(self.dimension, self.normalizer)
  File "/Volumes/Tools/unix/pylith-dev/clang-3.6.0/lib/python2.7/site-packages/pylith/problems/Implicit.py", line 121, in initialize
    self.initialize(dimension, normalizer)
  File "/Volumes/Tools/unix/pylith-dev/clang-3.6.0/lib/python2.7/site-packages/pylith/problems/Formulation.py", line 516, in initialize
    constraint.setConstraintSizes(solution)
  File "/Volumes/Tools/unix/pylith-dev/clang-3.6.0/lib/python2.7/site-packages/pylith/bc/bc.py", line 218, in setConstraintSizes
    def setConstraintSizes(self, *args):
      return _bc.DirichletBC_setConstraintSizes(self, *args)

Error message

RuntimeError: Found overly constrained point while setting up constraints for DirichletBC boundary condition

Abort information

application called MPI_Abort(MPI_COMM_WORLD, -1) — process 0
/Volumes/Tools/unix/cig/clang-3.6.0/bin/nemesis: mpirun: exit 255
/Volumes/Tools/unix/pylith-dev/clang-3.6.0/bin/pylith: /Volumes/Tools/unix/cig/clang-3.6.0/bin/
Step01: Error 5 Resolution
Error found when setting up solution field

Error message

```
RuntimeError: Found overly constrained point while setting up constraints for DirichletBC boundary
```

Error Messages  
Step01
Step01: Error 5 Resolution
Error found when setting up solution field

Error message

RuntimeError: Found overly constrained point while setting up constraints for DirichletBC boundary

Debug: Look at overlap of constraints in Dirichlet BC
Step01: Error 5 Resolution
Error found when setting up solution field

Error message

```
RuntimeError: Found overly constrained point while setting up constraints for DirichletBC boundary condition 'face zneg'. Number of DOF at point 503 is 3 and number of attempted constraints is 4.
```

Debug: Look at overlap of constraints in Dirichlet BC
Resolution

```
[pylithapp.timedependent.bc.y_pos]
bc_dof = [0]
...
[pylithapp.timedependent.bc.y_neg]
bc_dof = [0]
```
$ pylith step02.cfg

Configuration error

>>> step02.cfg:30:
   — pyre.inventory(error)
   — timedependent.nondimelasticquasistatic.relaxation_time <= '2.0*years'
   — name 'years' is not defined
pylithapp: configuration error(s)
Error message

```python
>>> step02.cfg:30:
   — pyre.inventory(error)
   — timedependent.nondimelasticquasistatic.relaxation_time ← '2.0*years'
   — name 'years' is not defined
pylithapp: configuration error(s)
```
Step02: Error 1 Resolution

Error found in parsing .cfg file

Error message

```python
>>> step02.cfg:30:
    — pyre.inventory(error)
    — timedependent.nondimelasticquasistatic.relaxation_time <- '2.0*years'
    — name 'years' is not defined
pylithapp: configuration error(s)
```

Debug: Pyre is poorly documented. Look for example. :(

Error Messages
Step02: Error 1 Resolution
Error found in parsing .cfg file

Error message

```python
>>> step02.cfg:30:
   pyre.inventory(error)
   timedependent.nondimelasticquasistatic.relaxation_time <- '2.0*years'
   name 'years' is not defined
pylithapp: configuration error(s)
```

Debug: Pyre is poorly documented. Look for example. :(  

```bash
$ python
```

```python
>>> from pyre.units.time import *
>>> dir()
['__builtins__', '__doc__', '__name__', '__package__', 'day', 'hour', 'micro', 'microsecond', 'milli', 'millisecond', 'minute', 'ms', 'nano', 'nanosecond', 'ns', 'pico', 'picosecond', 'ps', 's', 'second', 'us', 'year']
```

Resolution

```python
relaxation_time = 2.0*year
```
**Step02: Error 2**

Error doing some basic validation of input

```bash
$ pylith step02.cfg
```

**Python stacktrace**

Fatal error. Calling MPI_Abort() to abort PyLith application.
Traceback (most recent call last):
  File "/Volumes/Tools/unix/pylith-dev/clang-3.6.0/lib/python2.7/site-packages/pylith/apps/PetscApplication.py", line 64, in onComputeNodes
    self.main(*args, **kwds)
  File "/Volumes/Tools/unix/pylith-dev/clang-3.6.0/lib/python2.7/site-packages/pylith/apps/PyLithApp.py", line 123, in main
    self.problem.verifyConfiguration()
  File "/Volumes/Tools/unix/pylith-dev/clang-3.6.0/lib/python2.7/site-packages/pylith/problems/TimeDependent.py", line 105, in verifyConfiguration
    self.formulation.verifyConfiguration()
  File "/Volumes/Tools/unix/pylith-dev/clang-3.6.0/lib/python2.7/site-packages/pylith/problems/Formulation.py", line 180, in verifyConfiguration
    integrator.verifyConfiguration()
  File "/Volumes/Tools/unix/pylith-dev/clang-3.6.0/lib/python2.7/site-packages/pylith/problems/FaultCohesiveKin.py", line 140, in verifyConfiguration
    ModuleFaultCohesiveKin.verifyConfiguration(self, self.mesh())
  File "/Volumes/Tools/unix/pylith-dev/clang-3.6.0/lib/python2.7/site-packages/pylith/problems/faults.py", line 365, in verifyConfiguration
```

**Error message**

RuntimeError: Quadrature is incompatible with cell for fault 'fault_ext'. Cell 256 has 4 edges

**Abort info**

application called MPI_Abort(MPI_COMM_WORLD, -1) — process 0
/Volumes/Tools/unix/cig/clang-3.6.0/bin/nemesis: mpirun: exit 255
/Volumes/Tools/unix/pylith-dev/clang-3.6.0/bin/pylith: /Volumes/Tools/unix/cig/clang-3.6.0/bin/
Error message

```
RuntimeError: Quadrature is incompatible with cell for fault 'fault_ext'. Cell 256 has 4 edges
```
Error message

RuntimeError: Quadrature is incompatible with cell for fault 'fault_ext'. Cell 256 has 4 edges

Debug: Turn on journal for quadrature

$ pylith step02.cfg --problem.interfaces.fault.quadrature.help-components

facilities of 'quadrature':
cell=<component name>: Reference cell with basis fns and quadrature rules.
current value: 'fiatsimplex', from {default}
configurable as: fiatsimplex, cell
Step02: Error 2 Resolution

Error doing some basic validation of input

Error message

RuntimeError: Quadrature is incompatible with cell for fault 'fault_ext'. Cell 256 has 4 edges

Debug: Turn on journal for quadrature

$ pylith step02.cfg --problem.interfaces.fault.quadrature.help-components

facilities of 'quadrature':
  cell=<component name>: Reference cell with basis fns and quadrature rules.
  current value: 'fiatsimplex', from {default}
  configurable as: fiatsimplex, cell

[pylithapp.journal.info]
fiatlagrange = 1
fiatsimplex = 1

Resolution

[pylithapp.timedependent.interfaces.fault]
quadrature.cell = pylith.feassemble.FIATLagrange
Step02: Error 3
Error found when initializing integrators

$ pylith step02.cfg

Python stacktrace

Fatal error. Calling MPI_Abort() to abort PyLith application.
Traceback (most recent call last):
  File "/Volumes/Tools/unix/pylith-dev/clang-3.6.0/lib/python2.7/site-packages/pylith/apps/PetscApplication.py", line 64, in onComputeNodes
    self.main(*args, **kwds)
  File "/Volumes/Tools/unix/pylith-dev/clang-3.6.0/lib/python2.7/site-packages/pylith/apps/PyLithApp.py", line 125, in main
    self.problem.initialize()
  File "/Volumes/Tools/unix/pylith-dev/clang-3.6.0/lib/python2.7/site-packages/pylith/problems/TimeDependent.py", line 120, in initialize
    self.formulation.initialize(self.dimension, self.normalizer)
  File "/Volumes/Tools/unix/pylith-dev/clang-3.6.0/lib/python2.7/site-packages/pylith/problems/Implicit.py", line 121, in initialize
    self._initialize(dimension, normalizer)
  File "/Volumes/Tools/unix/pylith-dev/clang-3.6.0/lib/python2.7/site-packages/pylith/problems/Formulation.py", line 470, in initialize
    integrator.initialize(totalTime, numTimeSteps, normalizer)
  File "/Volumes/Tools/unix/pylith-dev/clang-3.6.0/lib/python2.7/site-packages/pylith/feassemble/ElasticityImplicit.py", line 56, in initialize
    ModuleElasticityImplicit.initialize(self, self.mesh())
  File "/Volumes/Tools/unix/pylith-dev/clang-3.6.0/lib/python2.7/site-packages/pylith/feassemble/feassemble.py", line 357, in initialize
    def initialize(self, *args):
        return _feassemble.IntegratorElasticityInitializer.initialize(self, *args)

Error message

RuntimeError: Determinant of Jacobian (1.25e-07) for cell 0 is smaller than minimum permissible value (1e-06)!
The two most likely causes of this are highly distorted cells and nondimensionalization with a

Abort info

application called MPI_Abort(MPICOMM_WORLD, -1) — process 0
/Volumes/Tools/unix/cig/clang-3.6.0/bin/nemesis: mpirun: exit 255
/Volumes/Tools/unix/pylith: /Volumes/Tools/unix/cig/clang-3.6.0/bin/nemesis: exit 1
Step02: Error 3 Resolution
Error found when initializing integrators

Error message

RuntimeError: Determinant of Jacobian (1.25e−07) for cell 0 is smaller than minimum permissible value.
The two most likely causes of this are highly distorted cells and nondimensionalization with a
Step02: Error 3 Resolution

Error found when initializing integrators

Error message

RuntimeError: Determinant of Jacobian (1.25e−07) for cell 0 is smaller than minimum permissible value!
The two most likely causes of this are highly distorted cells and nondimensionalization with a

Debug: Look at nondimensional scales relative to the parameters

$ pylith step02.cfg --problem.normalizer.help-properties

length_scale=<dimensional>: Value to nondimensionalize length scale.
  default value: 1000*m
  current value: 1e+06*m, from {file='step02.cfg', line=28, column=-1}
  validator: (greater than 0*m)

relaxation_time=<dimensional>: Relaxation time to nondimensionalize time.
  default value: 3.15576e+07*s
  current value: 6.31152e+07*s, from {file='step02.cfg', line=30, column=-1}
  validator: (greater than 0*s)

shear_modulus=<dimensional>: Shear modulus to nondimensionalize pressure.
  default value: 3e+10*m**−1*kg*s**−2
  current value: 3e+10*m**−1*kg*s**−2, from {file='step02.cfg', line=29, column=-1}
  validator: (greater than 0*m**−1*kg*s**−2)
Step02: Error 3 Resolution
Error found when initializing integrators

Error message

RuntimeError: Determinant of Jacobian (1.25e−07) for cell 0 is smaller than minimum permissible value (1e−06)!
The two most likely causes of this are highly distorted cells and nondimensionalization with a large length scale.

Debug: Look at nondimensional scales relative to the parameters

$ pylith step02.cfg --problem.normalizer.help-properties

length_scale=<dimensional>: Value to nondimensionalize length scale.
  default value: 1000*m
  current value: 1e+06*m, from {file ='step02.cfg', line=28, column=-1}
  validator: (greater than 0*m)

relaxation_time=<dimensional>: Relaxation time to nondimensionalize time.
  default value: 3.15576e+07*s
  current value: 6.31152e+07*s, from {file ='step02.cfg', line=30, column=-1}
  validator: (greater than 0*s)

shear_modulus=<dimensional>: Shear modulus to nondimensionalize pressure.
  default value: 3e+10*m**−1*kg*s**−2
  current value: 3e+10*m**−1*kg*s**−2, from {file ='step02.cfg', line=29, column=-1}
  validator: (greater than 0*m**−1*kg*s**−2)

Resolution

[pylithapp.problem.normalizer]
length_scale = 1.0*km
Step02: Error 4
Error found when initializing fault

$ pylith step02.cfg

Python stacktrace

Fatal error. Calling MPI_Abort() to abort PyLith application.
Traceback (most recent call last):
File "/Volumes/Tools/unix/pylith-dev/clang-3.6.0/lib/python2.7/site-packages/pylith/apps/PetscApplication.py", line 64, in onComputeNodes
self.main(*args, **kwds)
File "/Volumes/Tools/unix/pylith-dev/clang-3.6.0/lib/python2.7/site-packages/pylith/apps/PyLithApp.py", line 125, in main
self.problem.initialize()
File "/Volumes/Tools/unix/pylith-dev/clang-3.6.0/lib/python2.7/site-packages/pylith/problems/TimeDependent.py", line 120, in initialize
self.formulation.initialize(self.dimension, self.normalizer)
File "/Volumes/Tools/unix/pylith-dev/clang-3.6.0/lib/python2.7/site-packages/pylith/problems/Formulation.py", line 470, in initialize
integrator.initialize(totalTime, numTimeSteps, normalizer)
File "/Volumes/Tools/unix/pylith-dev/clang-3.6.0/lib/python2.7/site-packages/pylith/faults/FaultCohesive.py", line 166, in initialize
FaultCohesive.initialize(self, totalTime, numTimeSteps, normalizer)
File "/Volumes/Tools/unix/pylith-dev/clang-3.6.0/lib/python2.7/site-packages/pylith/faults/Fault.py", line 170, in initialize
ModuleFault.initialize(self, self.mesh(), self.upDir)

Error message

RuntimeError: Could not find value left-lateral-slip in spatial database
Final slip. Available values are:
lateral-slip
reverse-slip
fault-opening
Error message

```
RuntimeError: Could not find value left-lateral-slip in spatial database
Final slip. Available values are:
  lateral-slip
  reverse-slip
  fault-opening
```
Step02: Error 4 Resolution
Error found when initializing fault

Error message

```
RuntimeError: Could not find value left-lateral-slip in spatial database
Final slip. Available values are:
  lateral-slip
  reverse-slip
  fault-opening
```

Resolution

```python
slip.values = [left-lateral-slip, reverse-slip, fault-opening]
```
Step02: Error 5
Error found when setting up solution field

$ pylith step02.cfg

Python stacktrace

Fatal error. Calling MPI_Abort() to abort PyLith application.
Traceback (most recent call last):
  File "/Volumes/Tools/unix/pylith-dev/gcc-4.7.3/lib/python2.7/site-packages/pylith/apps/PetscApplication.py", line 64, in onComputeNodes
    self.main(*args, **kwds)
  File "/Volumes/Tools/unix/pylith-dev/gcc-4.7.3/lib/python2.7/site-packages/pylith/apps/PyLithApp.py", line 125, in main
    self.problem.initialize()
  File "/Volumes/Tools/unix/pylith-dev/gcc-4.7.3/lib/python2.7/site-packages/pylith/problems/TimeDependent.py", line 119, in initialize
    self.formulation.initialize(self.dimension, self.normalizer)
  File "/Volumes/Tools/unix/pylith-dev/gcc-4.7.3/lib/python2.7/site-packages/pylith/problems/Implicit.py", line 122, in initialize
    self._initialize(dimension, normalizer)
  File "/Volumes/Tools/unix/pylith-dev/gcc-4.7.3/lib/python2.7/site-packages/pylith/problems/Formulation.py", line 522, in initialize
    integrator.checkConstraints(solution)
  File "/Volumes/Tools/unix/pylith-dev/gcc-4.7.3/lib/python2.7/site-packages/pylith/faults/faults.py", line 366, in checkConstraints

Error message

RuntimeError: Vertex with label '396' on negative side of fault 'fault_ext' is constrained.
Fault vertices cannot be constrained.

Abort info

application called MPI_Abort(MPI_COMM_WORLD, -1) — process 0
/Volumes/Tools/unix/cig/gcc-4.7.3/bin/nemesis: mpirun: exit 255
Step02: Error 5 Resolution
Error found when setting up solution field

Error message

```
RuntimeError: Vertex with label '396' on negative side of fault 'fault_ext' is constrained. Fault vertices cannot be constrained.
```
Step02: Error 5 Resolution
Error found when setting up solution field

Error message

```
RuntimeError: Vertex with label '396' on negative side of fault 'fault_ext' is constrained. Fault vertices cannot be constrained.
```

Debug: Oops. Didn’t mean to use through-going fault!
Step02: Error 5 Resolution
Error found when setting up solution field

Error message

```
RuntimeError: Vertex with label '396' on negative side of fault 'fault_ext' is constrained. Fault vertices cannot be constrained.
```

Debug: Oops. Didn’t mean to use through-going fault!
Resolution

```
[pylithapp.timedependent.interfaces.fault]
label = fault
```
$ pylith step02.cfg

Python stacktrace

Fatal error. Calling MPIAbort() to abort PyLith application.
Traceback (most recent call last):
  File "~/Volumes/Tools/unix/pylith-dev/clang-3.6.0/lib/python2.7/site-packages/pylith/apps/PetscApplication.py", line 64, in onComputeNodes
    self.main(*args, **kwds)
  File "~/Volumes/Tools/unix/pylith-dev/clang-3.6.0/lib/python2.7/site-packages/pylith/apps/PyLithApp.py", line 125, in main
    self.problem.initialize()
  File "~/Volumes/Tools/unix/pylith-dev/clang-3.6.0/lib/python2.7/site-packages/pylith/problems/TimeDependent.py", line 120, in initialize
    self.formulation.initialize(self.dimension, self.normalizer)
  File "~/Volumes/Tools/unix/pylith-dev/clang-3.6.0/lib/python2.7/site-packages/pylith/problems/Implicit.py", line 121, in initialize
    initialize(dimension, normalizer)
  File "~/Volumes/Tools/unix/pylith-dev/clang-3.6.0/lib/python2.7/site-packages/pylith/problems/Formulation.py", line 470, in initialize
    integrator.initialize(totalTime, numTimeSteps, normalizer)
  File "~/Volumes/Tools/unix/pylith-dev/clang-3.6.0/lib/python2.7/site-packages/pylith/faults/FaultCohesiveKin.py", line 166, in initialize
    FaultCohesive.initialize(self, totalTime, numTimeSteps, normalizer)
  File "~/Volumes/Tools/unix/pylith-dev/clang-3.6.0/lib/python2.7/site-packages/pylith/faults/faults.py", line 321, in initialize
    def initialize(self, *args):
      return faults.Faultinitialize(self, *args)

Error message

RuntimeError: Error computing orientation of cell face. Cannot resolve tangential components into unambiguous directions.
Up direction (0, 0, 1) cannot be parallel to the face normal (0, 0, 1).
If the face is horizontal, adjust the up_dir parameter.

Abort info
Error message

```
RuntimeError: Error computing orientation of cell face. Cannot resolve tangential components in direction (0, 0, 1)
Up direction (0, 0, 1) cannot be parallel to the face normal (0, 0, 1).
If the face is horizontal, adjust the up_dir parameter.
```
Error message

RuntimeError: Error computing orientation of cell face. Cannot resolve tangential components into unambiguous directions.
Up direction (0, 0, 1) cannot be parallel to the face normal (0, 0, 1).
If the face is horizontal, adjust the up_dir parameter.

Debug: Change up-dir

up_dir = [1, 0, 1]
Step02: Error 6 Resolution
Error found when initializing fault

Error message

```
RuntimeError: Error computing orientation of cell face. Cannot resolve tangential components in Up direction (0, 0, 1) cannot be parallel to the face normal (0, 0, 1).
If the face is horizontal, adjust the up_dir parameter.
```

Debug: Change up-dir
```
up_dir = [1,0,1]
```

Debug: Look at fault surface
Error message

RuntimeError: Error computing orientation of cell face. Cannot resolve tangential components into unambiguous directions.
Up direction (0, 0, 1) cannot be parallel to the face normal (0, 0, 1).
If the face is horizontal, adjust the up_dir parameter.

Debug: Change up-dir

up_dir = [1,0,1]

Debug: Look at fault surface

Resolution: Mark buried edges

[pylithapp.timedependent.interfaces.fault]
label = fault
edge = fault.edge
up_dir = [0,0,1]
Insertion of Cohesive Cells

(a) Original mesh

(b) Add colocated vertices

(c) Update cells with fault faces

(d) Classify cells and update remaining cells

Error Messages

Fault Edges
Forgetting to Mark Buried Edges

PyLith will extend the fault one cell in an arbitrary fashion

Purple region shows intended fault surface.
Step03: Error 1

Error doing basic validation on parameters

$ pylith step02.cfg

Python stacktrace

Fatal error. Calling MPI_Abort() to abort PyLith application.
Traceback (most recent call last):
File "/Volumes/Tools/unix/pylith-dev/gcc-4.7.3/lib/python2.7/site-packages/pylith/apps/PetscApplication.py", line 64, in onComputeNodes
    self.main(*args, **kwds)
...
File "/Volumes/Tools/unix/pylith-dev/gcc-4.7.3/lib/python2.7/site-packages/pylith/faults/FaultCohesive.py", line 145, in verifyConfiguration
    FaultCohesive.verifyConfiguration(self)
File "/Volumes/Tools/unix/pylith-dev/gcc-4.7.3/lib/python2.7/site-packages/pylith/faults/Fault.py", line 156, in verifyConfiguration
    self.output.verifyConfiguration(self.mesh())
File "/Volumes/Tools/unix/pylith-dev/gcc-4.7.3/lib/python2.7/site-packages/pylith/meshio/OutputManager.py", line 128, in verifyConfiguration
    self._verifyFields(self.dataProvider().availableFields)
raise ValueError(msg)

Error message

ValueError: Requested fields not available for output.
Data provider: 'faultcohesivedyn'
Field type: 'vertex'
Data type: 'data'
Available fields: 'slip' 'slip_rate' 'traction'
Fields not available: 'initial_traction'

Abort info

application called MPI_Abort(MPI_COMM_WORLD, -1) — process 0
Abort info: mpirun: exit 255
Step03: Error 1 Resolution
Error doing basic validation on parameters

Error message

```
ValueError: Requested fields not available for output.
Data provider: 'faultcohesivedyn'
Field type: 'vertex'
Data type: 'data'
Available fields: 'slip' 'slip_rate' 'traction'
Fields not available: 'initial_traction'
```
Step03: Error 1 Resolution
Error doing basic validation on parameters

Error message

ValueError: Requested fields not available for output.
Data provider: 'faultcohesivedyn'
Field type: 'vertex'
Data type: 'data'
Available fields: 'slip' 'slip_rate' 'traction'
Fields not available: 'initial_traction'

Resolution

vertex_data_fields = [slip, slip_rate, traction]
$ pylith step03.cfg

Python stacktrace

Fatal error. Calling MPI_Abort() to abort PyLith application.
Traceback (most recent call last):
  File "/Volumes/Tools/unix/pylith-dev/gcc-4.7.3/lib/python2.7/site-packages/pylith/apps/PetscApplication.py", line 64, in onComputeNodes
    self.main(*args, **kwds)
  File "/Volumes/Tools/unix/pylith-dev/gcc-4.7.3/lib/python2.7/site-packages/pylith/apps/PyLithApp.py", line 125, in main
    self.problem.initialize()
  File "/Volumes/Tools/unix/pylith-dev/gcc-4.7.3/lib/python2.7/site-packages/pylith/problems/TimeDependent.py", line 119, in initialize
    self.formulation.initialize(self.dimension, self.normalizer)
  File "/Volumes/Tools/unix/pylith-dev/gcc-4.7.3/lib/python2.7/site-packages/pylith/problems/Implicit.py", line 122, in initialize
    self._initialize(dimension, normalizer)
  File "/Volumes/Tools/unix/pylith-dev/gcc-4.7.3/lib/python2.7/site-packages/pylith/problems/Formulation.py", line 516, in initialize
    constraint.setConstraintSizes(solution)
  File "/Volumes/Tools/unix/pylith-dev/gcc-4.7.3/lib/python2.7/site-packages/pylith/bc/bc.py", line 218, in setConstraintSizes
    def setConstraintSizes(self, *args):
      _bc.DirichletBC.setConstraintSizes(self, *args)

Error message

RuntimeError: Found overly constrained point while setting up constraints for DirichletBC boundary condition 'face_zneg'. Number of DOF at point 535 is 3 and number of attempted constraints is 4.

Abort info

application called MPI_Abort(MPI_COMM_WORLD, -1) – process 0
/Volumes/Tools/unix/cig/gcc-4.7.3/bin/nemesis: mpirun: exit 255
/Volumes/Tools/unix/pylith-dev/gcc-4.7.3/bin/pylith: exit 1

Error Messages

Step03
Error message

RuntimeError: Found overly constrained point while setting up constraints for DirichletBC boundary condition 'face_zneg'. Number of DOF at point 535 is 3 and number of attempted constraints is 4.
Error message

RuntimeError: Found overly constrained point while setting up constraints for DirichletBC boundary condition 'face_zneg'. Number of DOF at point 535 is 3 and number of attempted constraints is 4.

Debug: Look for overlap of constraints in Dirichlet BC
Error message

```
RuntimeError: Found overly constrained point while setting up constraints for DirichletBC boundary condition 'face_zneg'. Number of DOF at point 535 is 3 and number of attempted constraints is 4.
```

Debug: Look for overlap of constraints in Dirichlet BC Resolution

```python
[pylithapp.timedependent.bc.x_pos]
bc_dof = [0, 1]
...
[pylithapp.timedependent.bc.x_neg]
bc_dof = [0, 1]
```
Step03: Error 3
Error creating solution field

$ pylith step03.cfg

Python stacktrace

Fatal error. Calling MPI_Abort() to abort PyLith application.
Traceback (most recent call last):
  File "/Volumes/Tools/unix/pylith−dev/gcc−4.7.3/lib/python2.7/site−packages/pylith/apps/PetscApplication.py", line 64, in onComputeNodes
    self.main(∗args, ∗∗kwds)
  File "/Volumes/Tools/unix/pylith−dev/gcc−4.7.3/lib/python2.7/site−packages/pylith/apps/PyLithApplication.py", line 125, in main
    self.problem.initialize()
  File "/Volumes/Tools/unix/pylith−dev/gcc−4.7.3/lib/python2.7/site−packages/pylith/problems/TimeDependent.py", line 119, in initialize
    self.formulation.initialize(self.dimension, self.normalizer)
  File "/Volumes/Tools/unix/pylith−dev/gcc−4.7.3/lib/python2.7/site−packages/pylith/problems/Implicit.py", line 122, in initialize
    self._initialize(dimension, normalizer)
  File "/Volumes/Tools/unix/pylith−dev/gcc−4.7.3/lib/python2.7/site−packages/pylith/problems/Formulation.py", line 522, in initialize
    integrator.checkConstraints(solution)
  File "/Volumes/Tools/unix/pylith−dev/gcc−4.7.3/lib/python2.7/site−packages/pylith/faults/faults.py", line 366, in checkConstraints
    def checkConstraints(self, ∗args):
        return _faults.FaultCohesiveLagrange.checkConstraints(self, ∗args)

Error message

RuntimeError: Vertex with label '605' on negative side of fault 'fault_ext' is constrained. Fault vertices cannot be constrained.

Abort info

application called MPI_Abort(MPI_COMM_WORLD, −1) — process 0
/Volumes/Tools/unix/cig/gcc−4.7.3/bin/nemesis: mpirun: exit 255
/Volumes/Tools/unix/pylith−dev/gcc−4.7.3/bin/pylith:
/Volumes/Tools/unix/cig/gcc−4.7.3/bin/nemesis: exit 1
Error message

```
RuntimeError: Vertex with label '605' on negative side of fault 'fault_ext' is constrained. Fault vertices cannot be constrained.
```
Error message

RuntimeError: Vertex with label '605' on negative side of fault 'fault_ext' is constrained. Fault vertices cannot be constrained.

Debug: Look for overlap in fault and BC nodesets
Error message

RuntimeError: Vertex with label '605' on negative side of fault 'fault_ext' is constrained. Fault vertices cannot be constrained.

Debug: Look for overlap in fault and BC nodesets

Resolution

[pylithapp.timedependent.bc.z_neg]
... label = face_zneg_nofault
Step03: Error 4
No error but funky results
Step03: Error 4 Resolution

No error but funky results

Debug: Did the solver converge?
Debug: Did the solver converge?

Resolution

[pylithapp.petsc]
ksp_monitor = true
ksp.converged_reason = true
ksp.error_if_not_converged = true

snes.converged_reason = true
snes.error_if_not_converged = true
snes_monitor = true
Step03: Error 5
Nonlinear solver diverges

**PETSc error message**

```
PETSC ERROR: SNES Solve has not converged
PETSC ERROR: Petsc Development GIT revision: v3.4.4-4559-g852d360 GIT Date: 2014-05-19 15:04:32

PETSC ERROR: #1 SNES Solve() line 3765 in /Volumes/Tools/unix/petsc-dev/src/snes/interface/snes.c
PETSC ERROR: #2 SNES Log Convergence History() line 150 in /Users/baagaard/src/cig/pylith/libsrc
```

**Debugging**

**Examine KSP and SNES residuals**

Fatal error. Calling MPI_Abort() to abort PyLith application.
Traceback (most recent call last):
  File "/Volumes/Tools/unix/pylith-dev/gcc-4.7.3/lib/python2.7/site-packages/pylith/apps/PetscApplication.py", line 64, in onComputeNodes
    self.main(*args, **kwds)
  File "/Volumes/Tools/unix/pylith-dev/gcc-4.7.3/lib/python2.7/site-packages/pylith/apps/PyLithApplication.py", line 135, in main
    self.problem.run(self)
  File "/Volumes/Tools/unix/pylith-dev/gcc-4.7.3/lib/python2.7/site-packages/pylith/problems/TimeDependent.py", line 154, in run
    self.formulation.step(t, dt)
    self.solver.solve(dispIncr, self.jacobian, residual)
  File "/Volumes/Tools/unix/pylith-dev/gcc-4.7.3/lib/python2.7/site-packages/pylith/problems/problems.py", line 179, in solve
```

**Abort info**

```
RuntimeError: Error detected while in PETSc function.
  Aborted at: mpirun -1 --project-name=petstd -1 --resource-spec=rpesx=16 -1 /Volumes/Tools/unix/cig/gcc-4.7.3/bin/nemesis
  Command: mpirun: exit 255
```

```
CIG
COMPUTATIONAL INFRASTRUCTURE
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```
Step03: Error 5 Resolution
Nonlinear solver diverges

PETSc error message

[0]PETSC ERROR: __________________________ Error Message __________________________
[0]PETSC ERROR: SNESolve has not converged
[0]PETSC ERROR: Petsc Development GIT revision: v3.4.4-4559-g852d360 GIT Date: 2014-05-19 15:04:32...
[0]PETSC ERROR: #1 SNESolve() line 3765 in /Volumes/Tools/unix/petsc-dev/src/snes/interface/snes.c
[0]PETSC ERROR: #2 SNESLogConvergenceHistory() line 150 in /Users/baagaard/src/cig/pylith/libsrc
Step03: Error 5 Resolution
Nonlinear solver diverges

PETSc error message

[0]PETSC ERROR: -------------------- Error Message -------------------
[0]PETSC ERROR: SNESolve has not converged
[0]PETSC ERROR: Petsc Development GIT revision: v3.4.4-4559-g852d360 GIT Date: 2014-05-19 15:04:32
...
[0]PETSC ERROR: #1 SNESolve() line 3765 in /Volumes/Tools/unix/petsc-dev/src/snes/interface/snes.c
[0]PETSC ERROR: #2 SNESLogConvergenceHistory() line 150 in /Users/baagaard/src/cig/pylith/libsrc problems/SolverNonlinear.cc

Debug: Examine KSP and SNES residuals using log file

$ pylith step03.cfg >& step03.log

$ grep "norm" step03.log
Step03: Error 5 Resolution
Nonlinear solver diverges

PETSc error message

[0]PETSC ERROR: ----------------------------- Error Message -----------------------------
[0]PETSC ERROR: SNESolve has not converged
[0]PETSC ERROR: Petsc Development GIT revision: v3.4.4-4559-g852d360 GIT Date: 2014-05-19 15:04:32

...[0]PETSC ERROR: #1 SNESolve() line 3765 in /Volumes/Tools/unix/petsc-dev/src/snes/interface/snes.c
[0]PETSC ERROR: #2 SNESLogConvergenceHistory() line 150 in /Users/baagaard/src/cig/pylith/libsrc

Debug: Examine KSP and SNES residuals using log file

$ pylith step03.cfg >& step03.log
$ grep "norm" step03.log

Resolution

[pylithapp.timedependent.interfaces.fault]
zero_tolerance = 1.0e-10

[pylithapp.petsc]
ksp_rtol = 1.0e-20
ksp_atol = 1.0e-12

snes_rtol = 1.0e-20
snes_atol = 1.0e-8
Step03: Error 6
Intended shear to drive fault slip

Debug: Check fault tractions
Step03: Error 6
Intended shear to drive fault slip

Debug: Check fault tractions
Compare $T_{\text{shear}} / T_{\text{normal}}$ against $\mu_f$
Step03: Error 6
Intended shear to drive fault slip

Debug: Check fault tractions
Compare $T_{\text{shear}} / T_{\text{normal}}$ against $\mu_f$

Resolution

```python
[pylithapp.timedependent.bc.x_pos]
...
db_initial.data = [-1.0*m, 3.0*m, 0.0*m]

[pylithapp.timedependent.bc.x_neg]
...
db_initial.data = [1.0*m, -3.0*m, 0.0*m]
```
Asking For Help
Send email to cig-short@geodynamics.org

- Try to debug on your own first
- Describe what you are trying to do
  - Overview of problem, BC (diagrams/sketches are very helpful)
  - 2-D or 3-D
  - Cell type (tri, quad, hex, tet)
  - Prescribed slip or spontaneous rupture
- Specify which version you are using AND your operating system (PyLith v2.1.2 binary on Linux x86_64)
- Send the **entire** error message, not just what you think is important (entire log of output is best)