## Running Mace4 with the Isomorphic Cubes Algorithms

### File Organization

top directory

```
|-- bin           # directory for executables
    |-- mace4     # Mace 4 executable
|-- p9m4          # top working directory
    |-- inputs    # Mace4 inputs files
    |-- utils
        |-- mace                  # scripts to generate models
            |-- bootstrap.py      # top script to kick off model enumeration process
            |-- extend_cubes.py   # functions to extend the length of cubes using Mace4
            |-- multi_cube_analyzer.py   # helper functions to remove isomorphic cubes
            |-- iso_cubes.py             # functions to check for isomorphism between cubes
            |-- run_cubes.py             # functions to execute Mace4 to enumerate models
            |-- some other scripts for future use and for testing
```

### Model Enumeration

The algebra supported are listed in bootstrap.py, and the input files in Mace4 format are in . . . /p9m4/inputs. Edit bootstrap.py to specify the algebra, order, and the desired target cube length. E.g. to enumerate all models of semigroups of order 7, using cubes of length 25:

```
algebra = "semi"
target_cube_length = 25
order = 7
```

The supported cube lengths for each type of algebra are listed at the top of the file bootsrap.py. For example, semigroups contains only 1 binary and the supported cube lengths are:

```
cube_sequence_2 = [2, 4, 9, 16, 25, 36, 49, 64]
```

All parameters for running semigroups is in the following entry in the run_data dictionary:

```
        'semi':   {'seq': cube_sequence_2, 'relations': [False],
                      'input': 'semi', 'arities': [2], 'radius': r_2, 'remove': -1},
```

To run the script, issue the command in the . . . /p9m4 directory

```
utils/mace4/bootsctrap.py
```