

psub__metadata

March 14, 2021

1 Detailed execution time for cadCAD models

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This notebook shows how you can use metadata on PSUBs in order to do pre-processing on the simulations. We use two keys for flagging them: the `ignore` which indicates which PSUBs we want to skip, and the `debug`, which informs us what are the ones which we want to monitor the policies execution time.

```
[1]: from time import time
import logging
from functools import wraps
logging.basicConfig(level=logging.DEBUG)

def print_time(f):
    """
    """
    @wraps(f)
    def wrapper(*args, **kwargs):
        # Current timestep
        t = len(args[2])
        t1 = time()
        f_out = f(*args, **kwargs)
        t2 = time()
        text = f"{t}|{f.__name__} output (exec time: {t2 - t1:.2f}s): {f_out}"
        logging.debug(text)
        return f_out
    return wrapper
```

1.1 Dependences

```
[2]: %%capture
!pip install cadcad
```

```
[3]: import pandas as pd
import matplotlib.pyplot as plt
import numpy as np
from cadCAD.configuration import Experiment
from cadCAD.configuration.utils import config_sim
from cadCAD.engine import ExecutionMode, ExecutionContext, Executor
```

```
DEBUG:matplotlib:(private) matplotlib data path:
/github/home/.local/lib/python3.9/site-packages/matplotlib/mpl-data
DEBUG:matplotlib:matplotlib data path: /github/home/.local/lib/python3.9/site-
packages/matplotlib/mpl-data
DEBUG:matplotlib:CONFIGDIR=/github/home/.config/matplotlib
DEBUG:matplotlib:matplotlib version 3.3.4
DEBUG:matplotlib:interactive is False
DEBUG:matplotlib:platform is linux
DEBUG:matplotlib:loaded modules: ['sys', 'builtins', '_frozen_importlib',
'_imp', '_thread', '_warnings', '_weakref', '_frozen_importlib_external',
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 'pandas._libs.hashtable', 'pandas._libs.algos', 'pandas._libs.interval',
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 'pandas.core.dtypes.generic', 'pandas.core.dtypes.base',
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 'pandas.io.formats', 'pandas.io.formats.console',
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 'pandas.compat.chainmap', 'pandas.core.computation.scope',
 'pandas.core.computation.ops', 'pandas.core.computation.engines',
 'pandas.core.computation.parsing', 'pandas.core.computation.expr',
 'pandas.core.computation.eval', 'pandas.core.computation.api',
 'pandas.core.reshape.merge', 'pandas.core.reshape.pivot',

```

'pandas.core.reshape.reshape', 'pandas.core.reshape.tile',
'pandas.core.reshape.api', 'pandas.api.extensions', 'pandas.api.indexers',
'pandas.core.dtypes.api', 'pandas.api.types', 'pandas.api',
'pandas.util._print_versions', 'pandas.io.clipboards', 'pandas._libs.parsers',
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'pandas.io.excel._pyxlsb', 'pandas.io.excel._xlrd', 'pandas.io.excel._base',
'pandas._libs.json', 'pandas.io.formats._color_data', 'pandas.io.formats.css',
'pandas.io.formats.excel', 'pandas.io.excel._odswriter',
'pandas.io.excel._xlsxwriter', 'pandas.io.excel._xlwt', 'pandas.io.excel',
'pandas.io.feather_format', 'pandas.io.gbq', 'pandas.io.html',
'pandas.io.json._normalize', 'pandas.io.json._table_schema',
'pandas.io.json._json', 'pandas.io.json', 'pandas.io.orc', 'pandas.io.parquet',
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'matplotlib._animation_data', 'matplotlib.animation', 'pyparsing',
'matplotlib.fontconfig_pattern', 'matplotlib.docstring',
'matplotlib._color_data', 'matplotlib.colors', 'cycler', 'matplotlib.rcsetup',
'matplotlib._version', 'matplotlib.ft2font', 'kiwisolver']
DEBUG:matplotlib:CACHEDIR=/github/home/.cache/matplotlib
DEBUG:matplotlib.font_manager:Using fontManager instance from
/github/home/.cache/matplotlib/fontlist-v330.json
DEBUG:matplotlib.pyplot:Loaded backend module://ipykernel.pylab.backend_inline
version unknown.
DEBUG:matplotlib.pyplot:Loaded backend module://ipykernel.pylab.backend_inline
version unknown.

```

1.2 Definitions

1.2.1 Initial conditions and parameters

```

[4]: initial_conditions = {
    'prey_population': 100,
    'predator_population': 15
}

params = {
    "prey_birth_rate": [1.0],
    "predator_birth_rate": [0.01],
    "predator_death_const": [1.0],
    "prey_death_const": [0.03],
    "dt": [0.1] # Precision of the simulation. Lower is more accurate / slower
}

```

```
simulation_parameters = {
    'N': 1,
    'T': range(30),
    'M': params
}
```

1.2.2 Policies

```
[5]: def p_predator_births(params, step, sL, s):
    dt = params['dt']
    predator_population = s['predator_population']
    prey_population = s['prey_population']
    birth_fraction = params['predator_birth_rate'] + np.random.random() * 0.0002
    births = birth_fraction * prey_population * predator_population * dt
    return {'add_to_predator_population': births}

def p_pre_y_births(params, step, sL, s):
    dt = params['dt']
    population = s['prey_population']
    birth_fraction = params['prey_birth_rate'] + np.random.random() * 0.1
    births = birth_fraction * population * dt
    return {'add_to_pre_y_population': births}

def p_predator_deaths(params, step, sL, s):
    dt = params['dt']
    population = s['predator_population']
    death_rate = params['predator_death_const'] + np.random.random() * 0.005
    deaths = death_rate * population * dt
    return {'add_to_predator_population': -1.0 * deaths}

def p_pre_y_deaths(params, step, sL, s):
    dt = params['dt']
    death_rate = params['prey_death_const'] + np.random.random() * 0.1
    prey_population = s['prey_population']
    predator_population = s['predator_population']
    deaths = death_rate * prey_population * predator_population * dt
    return {'add_to_pre_y_population': -1.0 * deaths}
```

1.2.3 State update functions

```
[6]: def s_pre_y_population(params, step, sL, s, _input):
    y = 'prey_population'
    x = s['prey_population'] + _input['add_to_pre_y_population']
```

```
    return (y, x)

def s_predator_population(params, step, sL, s, _input):
    y = 'predator_population'
    x = s['predator_population'] + _input['add_to_predator_population']
    return (y, x)
```

1.2.4 State update blocks

```
[7]: partial_state_update_blocks = [
    {
        'label': 'Predator dynamics',
        'ignore': False,
        'debug': True,
        'policies': {
            'predator_births': p_predator_births,
            'predator_deaths': p_predator_deaths
        },
        'variables': {
            'predator_population': s_predator_population
        }
    },
    {
        'label': 'Prey dynamics',
        'ignore': True,
        'debug': True,
        'policies': {
            'prey_births': p_prey_births,
            'prey_deaths': p_prey_deaths
        },
        'variables': {
            'prey_population': s_prey_population
        }
    }
]

# Maintain only PSUBs which doesn't have the ignore flag
partial_state_update_blocks = [psub
                                for psub in partial_state_update_blocks
                                if psub.get('ignore', False) == False]

# Only check the execution time for the PSUBs with the debug flag
for psub in partial_state_update_blocks:
    psub['policies'] = {label: print_time(f) for label, f in psub['policies'].
        ↪items()}
```

1.2.5 Configuration and Execution

```
[8]: sim_config = config_sim(simulation_parameters)

exp = Experiment()
exp.append_configs(sim_configs=sim_config,
                  initial_state=initial_conditions,
                  partial_state_update_blocks=partial_state_update_blocks)
```

```

from cadCAD import configs
exec_mode = ExecutionMode()
exec_context = ExecutionContext(exec_mode.local_mode)
executor = Executor(exec_context=exec_context, configs=configs)
(records, tensor_field, _) = executor.execute()

```

```

DEBUG:root:1|p_predator_births output (exec time: 0.00s):
{'add_to_predator_population': 1.5135791156041456}
DEBUG:root:1|p_predator_deaths output (exec time: 0.00s):
{'add_to_predator_population': -1.5061343958489797}
DEBUG:root:2|p_predator_births output (exec time: 0.00s):
{'add_to_predator_population': 1.506144510277311}
DEBUG:root:2|p_predator_deaths output (exec time: 0.00s):
{'add_to_predator_population': -1.5070711148398888}
DEBUG:root:3|p_predator_births output (exec time: 0.00s):
{'add_to_predator_population': 1.5292029875219084}
DEBUG:root:3|p_predator_deaths output (exec time: 0.00s):
{'add_to_predator_population': -1.5012311118770105}
DEBUG:root:4|p_predator_births output (exec time: 0.00s):
{'add_to_predator_population': 1.5297557748788106}
DEBUG:root:4|p_predator_deaths output (exec time: 0.00s):
{'add_to_predator_population': -1.5090505991950294}
DEBUG:root:5|p_predator_births output (exec time: 0.00s):
{'add_to_predator_population': 1.5211879321950859}
DEBUG:root:5|p_predator_deaths output (exec time: 0.00s):
{'add_to_predator_population': -1.512518126561203}
DEBUG:root:6|p_predator_births output (exec time: 0.00s):
{'add_to_predator_population': 1.5311795064605103}
DEBUG:root:6|p_predator_deaths output (exec time: 0.00s):
{'add_to_predator_population': -1.5128866173173225}
DEBUG:root:7|p_predator_births output (exec time: 0.00s):
{'add_to_predator_population': 1.5358113252610877}
DEBUG:root:7|p_predator_deaths output (exec time: 0.00s):
{'add_to_predator_population': -1.5115088785276063}
DEBUG:root:8|p_predator_births output (exec time: 0.00s):
{'add_to_predator_population': 1.5157149819879674}
DEBUG:root:8|p_predator_deaths output (exec time: 0.00s):
{'add_to_predator_population': -1.5170443928352777}
DEBUG:root:9|p_predator_births output (exec time: 0.00s):
{'add_to_predator_population': 1.53035293814797}
DEBUG:root:9|p_predator_deaths output (exec time: 0.00s):
{'add_to_predator_population': -1.5180379552951866}
DEBUG:root:10|p_predator_births output (exec time: 0.00s):
{'add_to_predator_population': 1.5161492192556654}
DEBUG:root:10|p_predator_deaths output (exec time: 0.00s):
{'add_to_predator_population': -1.5170057402987662}

```

```
DEBUG:root:11|p_predator_births output (exec time: 0.00s):
{'add_to_predator_population': 1.5148424207312203}
DEBUG:root:11|p_predator_deaths output (exec time: 0.00s):
{'add_to_predator_population': -1.5138167817597352}
DEBUG:root:12|p_predator_births output (exec time: 0.00s):
{'add_to_predator_population': 1.5402137037873793}
DEBUG:root:12|p_predator_deaths output (exec time: 0.00s):
{'add_to_predator_population': -1.5159706583474235}
DEBUG:root:13|p_predator_births output (exec time: 0.00s):
{'add_to_predator_population': 1.5415304468647877}
DEBUG:root:13|p_predator_deaths output (exec time: 0.00s):
{'add_to_predator_population': -1.5174213780072954}
DEBUG:root:14|p_predator_births output (exec time: 0.00s):
{'add_to_predator_population': 1.5313074142730858}
DEBUG:root:14|p_predator_deaths output (exec time: 0.00s):
{'add_to_predator_population': -1.5188286807878315}
DEBUG:root:15|p_predator_births output (exec time: 0.00s):
{'add_to_predator_population': 1.541022250779982}
DEBUG:root:15|p_predator_deaths output (exec time: 0.00s):
{'add_to_predator_population': -1.5182054433068108}
DEBUG:root:16|p_predator_births output (exec time: 0.00s):
{'add_to_predator_population': 1.5215538404169626}
DEBUG:root:16|p_predator_deaths output (exec time: 0.00s):
{'add_to_predator_population': -1.5205107004575413}
DEBUG:root:17|p_predator_births output (exec time: 0.00s):
{'add_to_predator_population': 1.5443687577481846}
DEBUG:root:17|p_predator_deaths output (exec time: 0.00s):
{'add_to_predator_population': -1.5218491112465014}
DEBUG:root:18|p_predator_births output (exec time: 0.00s):
{'add_to_predator_population': 1.523466816970825}
DEBUG:root:18|p_predator_deaths output (exec time: 0.00s):
{'add_to_predator_population': -1.529436665757035}
DEBUG:root:19|p_predator_births output (exec time: 0.00s):
{'add_to_predator_population': 1.5417532803182787}
DEBUG:root:19|p_predator_deaths output (exec time: 0.00s):
{'add_to_predator_population': -1.5283021811217457}
DEBUG:root:20|p_predator_births output (exec time: 0.00s):
{'add_to_predator_population': 1.536854000310659}
DEBUG:root:20|p_predator_deaths output (exec time: 0.00s):
{'add_to_predator_population': -1.5295215644226838}
DEBUG:root:21|p_predator_births output (exec time: 0.00s):
{'add_to_predator_population': 1.536414643443426}
DEBUG:root:21|p_predator_deaths output (exec time: 0.00s):
{'add_to_predator_population': -1.530020198710203}
DEBUG:root:22|p_predator_births output (exec time: 0.00s):
{'add_to_predator_population': 1.5291235902884286}
DEBUG:root:22|p_predator_deaths output (exec time: 0.00s):
{'add_to_predator_population': -1.525761725493824}
```

by cadCAD

SubsetIDs: [0]


```
Ns      : [0]
ExpIDs   : [0]
Execution Mode: single_threaded
Total execution time: 0.06s
```

1.2.6 Results

```
[9]: import plotly.express as px
```

```
[10]: df = pd.DataFrame(records)

fig = px.line(df,
               x=df.prey_population,
               y=df.predator_population,
               color=df.run.astype(str))

fig.show()
```