psub_metadata

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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.

```python
[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

```python
[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',
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```

```
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```

```
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'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

```python
[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_prey_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_prey_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_prey_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_prey_population': -1.0 * deaths}
```

1.2.3 State update functions

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

```python
    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
            }
        }
    ]

    # Mantain 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)
```

```python
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': 1.5141620764656747}
DEBUG:root:1|p_predator_deaths output (exec time: 0.00s):
{'add_to_predator_population': -1.5068742193498208}
DEBUG:root:2|p_predator_births output (exec time: 0.00s):
{'add_to_predator_population': 1.5114903859444992}
DEBUG:root:2|p_predator_deaths output (exec time: 0.00s):
{'add_to_predator_population': -1.5024240504610173}
DEBUG:root:3|p_predator_births output (exec time: 0.00s):
{'add_to_predator_population': 1.5109080889467847}
DEBUG:root:3|p_predator_deaths output (exec time: 0.00s):
{'add_to_predator_population': -1.5025966741161743}
DEBUG:root:4|p_predator_births output (exec time: 0.00s):
{'add_to_predator_population': 1.5282834561357428}
DEBUG:root:4|p_predator_deaths output (exec time: 0.00s):
{'add_to_predator_population': -1.503936085127922}
DEBUG:root:5|p_predator_births output (exec time: 0.00s):
{'add_to_predator_population': 1.5320290529654788}
DEBUG:root:5|p_predator_deaths output (exec time: 0.00s):
{'add_to_predator_population': -1.5099815905095937}
DEBUG:root:6|p_predator_births output (exec time: 0.00s):
{'add_to_predator_population': 1.5223048626566233}
DEBUG:root:6|p_predator_deaths output (exec time: 0.00s):
{'add_to_predator_population': -1.5131090885005616}
DEBUG:root:7|p_predator_births output (exec time: 0.00s):
{'add_to_predator_population': 1.5302784772192002}
DEBUG:root:7|p_predator_deaths output (exec time: 0.00s):
{'add_to_predator_population': -1.5101615468563179}
DEBUG:root:8|p_predator_births output (exec time: 0.00s):
{'add_to_predator_population': 1.5330947325674884}
DEBUG:root:8|p_predator_deaths output (exec time: 0.00s):
{'add_to_predator_population': -1.5102758288757254}
DEBUG:root:9|p_predator_births output (exec time: 0.00s):
{'add_to_predator_population': 1.5358018990145712}
DEBUG:root:9|p_predator_deaths output (exec time: 0.00s):
{'add_to_predator_population': -1.5132140419169633}
DEBUG:root:10|p_predator_births output (exec time: 0.00s):
{'add_to_predator_population': 1.5312366241712452}
DEBUG:root:10|p_predator_deaths output (exec time: 0.00s):
{'add_to_predator_population': -1.521351762340259}
```

```
DEBUG:root:11|p_predator_births output (exec time: 0.00s):
{'add_to_predator_population': 1.5363329654941014}
DEBUG:root:11|p_predator_deaths output (exec time: 0.00s):
{'add_to_predator_population': -1.5219976943753348}
DEBUG:root:12|p_predator_births output (exec time: 0.00s):
{'add_to_predator_population': 1.528763053535106}
DEBUG:root:12|p_predator_deaths output (exec time: 0.00s):
{'add_to_predator_population': -1.5191863882988434}
DEBUG:root:13|p_predator_births output (exec time: 0.00s):
{'add_to_predator_population': 1.522228580245792}
DEBUG:root:13|p_predator_deaths output (exec time: 0.00s):
{'add_to_predator_population': -1.5211706114384766}
DEBUG:root:14|p_predator_births output (exec time: 0.00s):
{'add_to_predator_population': 1.5342506949304031}
DEBUG:root:14|p_predator_deaths output (exec time: 0.00s):
{'add_to_predator_population': -1.5230454330675358}
DEBUG:root:15|p_predator_births output (exec time: 0.00s):
{'add_to_predator_population': 1.5241312215502691}
DEBUG:root:15|p_predator_deaths output (exec time: 0.00s):
{'add_to_predator_population': -1.5233460795538158}
DEBUG:root:16|p_predator_births output (exec time: 0.00s):
{'add_to_predator_population': 1.5272550955813042}
DEBUG:root:16|p_predator_deaths output (exec time: 0.00s):
{'add_to_predator_population': -1.5231511817223766}
DEBUG:root:17|p_predator_births output (exec time: 0.00s):
{'add_to_predator_population': 1.5408309709737757}
DEBUG:root:17|p_predator_deaths output (exec time: 0.00s):
{'add_to_predator_population': -1.521417973647167}
DEBUG:root:18|p_predator_births output (exec time: 0.00s):
{'add_to_predator_population': 1.5256782987771202}
DEBUG:root:18|p_predator_deaths output (exec time: 0.00s):
{'add_to_predator_population': -1.523274771146401}
DEBUG:root:19|p_predator_births output (exec time: 0.00s):
{'add_to_predator_population': 1.5444702975887479}
DEBUG:root:19|p_predator_deaths output (exec time: 0.00s):
{'add_to_predator_population': -1.5251725678415824}
DEBUG:root:20|p_predator_births output (exec time: 0.00s):
{'add_to_predator_population': 1.548884152046816}
DEBUG:root:20|p_predator_deaths output (exec time: 0.00s):
{'add_to_predator_population': -1.5297139731236842}
DEBUG:root:21|p_predator_births output (exec time: 0.00s):
{'add_to_predator_population': 1.5480819287798635}
DEBUG:root:21|p_predator_deaths output (exec time: 0.00s):
{'add_to_predator_population': -1.5328315329337867}
DEBUG:root:22|p_predator_births output (exec time: 0.00s):
{'add_to_predator_population': 1.5432644944074239}
DEBUG:root:22|p_predator_deaths output (exec time: 0.00s):
{'add_to_predator_population': -1.5286162338161302}
```

```
DEBUG:root:23|p_predator_births output (exec time: 0.00s):
{'add_to_predator_population': 1.5443400974214678}
DEBUG:root:23|p_predator_deaths output (exec time: 0.00s):
{'add_to_predator_population': -1.5315169433172597}
DEBUG:root:24|p_predator_births output (exec time: 0.00s):
{'add_to_predator_population': 1.545991275188196}
DEBUG:root:24|p_predator_deaths output (exec time: 0.00s):
{'add_to_predator_population': -1.53033320912569554}
DEBUG:root:25|p_predator_births output (exec time: 0.00s):
{'add_to_predator_population': 1.5481227319961381}
DEBUG:root:25|p_predator_deaths output (exec time: 0.00s):
{'add_to_predator_population': -1.5332330180006655}
DEBUG:root:26|p_predator_births output (exec time: 0.00s):
{'add_to_predator_population': 1.559743225561519}
DEBUG:root:26|p_predator_deaths output (exec time: 0.00s):
{'add_to_predator_population': -1.5353458530243786}
DEBUG:root:27|p_predator_births output (exec time: 0.00s):
{'add_to_predator_population': 1.5498555018055982}
DEBUG:root:27|p_predator_deaths output (exec time: 0.00s):
{'add_to_predator_population': -1.538069621605674}
DEBUG:root:28|p_predator_births output (exec time: 0.00s):
{'add_to_predator_population': 1.537921125482658}
DEBUG:root:28|p_predator_deaths output (exec time: 0.00s):
{'add_to_predator_population': -1.5388967494521875}
DEBUG:root:29|p_predator_births output (exec time: 0.00s):
{'add_to_predator_population': 1.5491716293224842}
DEBUG:root:29|p_predator_deaths output (exec time: 0.00s):
{'add_to_predator_population': -1.5383873149874763}
DEBUG:root:30|p_predator_births output (exec time: 0.00s):
{'add_to_predator_population': 1.5522995408352158}
DEBUG:root:30|p_predator_deaths output (exec time: 0.00s):
{'add_to_predator_population': -1.5418042666876683}


            _____     ____
   _____ __ ___/ / ___/   |  / __ \
  / ___/ __`/ __  / /   / /| | / / / /
 / /__/ /_/ / /_/ / /___/ ___ |/ /_/ /
 \___/\__,_/\__,_/\____/_/  |_/_____/
by cadCAD

Execution Mode: local_proc
Configuration Count: 1
Dimensions of the first simulation: (Timesteps, Params, Runs, Vars) = (30, 5, 1,
2)
Execution Method: local_simulations
SimIDs   : [0]
SubsetIDs: [0]
```

```
Ns         : [0]
ExpIDs     : [0]
Execution Mode: single_threaded
Total execution time: 0.03s
```

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()
```