execution_time_decorator

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1 Detailed execution time for cadCAD models

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This notebook shows how you can get detailed info about the execution time by using Python decorators on the minimal P&P model. The strategy is to make use of the decorator as defined in the next block, and use in the most convenient way.

There are two options: one is to make use of the decorator on the function definition, like by wrapping the `p_predator_births` and the `p_prey_births` policies.

The other option is to update the `partial_state_update_blocks` by a list comprehension, like `partial_state_update_blocks = [print_time(psub) for psub in partial_state_update_blocks]`. This is useful if you want to check everyone at once.

```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

```
[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
```

```
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'pandas.compat.chainmap', 'pandas.core.computation.scope',
```

```
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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]: @print_time
     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}


     @print_time
     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

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

```python
[7]: partial_state_update_blocks = [
        {
            'policies': {
                'predator_births': p_predator_births,
                'prey_births': p_prey_births,
                'predator_deaths': p_predator_deaths,
                'prey_deaths': p_prey_deaths,
            },
            'variables': {
                'predator_population': s_prey_population,
                'prey_population': s_predator_population
            }
        }
    ]
```

1.2.5 Configuration and Execution

```python
[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': 1.5244312481645776}
DEBUG:root:1|p_prey_births output (exec time: 0.00s): {'add_to_prey_population':
10.828805896547038}
DEBUG:root:2|p_predator_births output (exec time: 0.00s):
{'add_to_predator_population': 1.572305910209828}
DEBUG:root:2|p_prey_births output (exec time: 0.00s): {'add_to_prey_population':
10.484855803992666}
DEBUG:root:3|p_predator_births output (exec time: 0.00s):
{'add_to_predator_population': 1.4246204052248972}
DEBUG:root:3|p_prey_births output (exec time: 0.00s): {'add_to_prey_population':
10.068686511567828}
DEBUG:root:4|p_predator_births output (exec time: 0.00s):
{'add_to_predator_population': 1.389857513015371}
DEBUG:root:4|p_prey_births output (exec time: 0.00s): {'add_to_prey_population':
9.593566929196228}
DEBUG:root:5|p_predator_births output (exec time: 0.00s):
{'add_to_predator_population': 1.361974607893156}
DEBUG:root:5|p_prey_births output (exec time: 0.00s): {'add_to_prey_population':
9.578671340595534}
DEBUG:root:6|p_predator_births output (exec time: 0.00s):
{'add_to_predator_population': 1.354074684116524}
DEBUG:root:6|p_prey_births output (exec time: 0.00s): {'add_to_prey_population':
9.849290501631373}
DEBUG:root:7|p_predator_births output (exec time: 0.00s):
{'add_to_predator_population': 1.4017373098916301}
DEBUG:root:7|p_prey_births output (exec time: 0.00s): {'add_to_prey_population':
10.35334249921899}
DEBUG:root:8|p_predator_births output (exec time: 0.00s):
{'add_to_predator_population': 1.3281430741763185}
DEBUG:root:8|p_prey_births output (exec time: 0.00s): {'add_to_prey_population':
9.977861322859304}
DEBUG:root:9|p_predator_births output (exec time: 0.00s):
{'add_to_predator_population': 1.3732761791213308}
DEBUG:root:9|p_prey_births output (exec time: 0.00s): {'add_to_prey_population':
10.10680317641411}
DEBUG:root:10|p_predator_births output (exec time: 0.00s):
{'add_to_predator_population': 1.4228325785085794}
DEBUG:root:10|p_prey_births output (exec time: 0.00s):
{'add_to_prey_population': 9.919713556101751}
DEBUG:root:11|p_predator_births output (exec time: 0.00s):
{'add_to_predator_population': 1.4024732483700204}
DEBUG:root:11|p_prey_births output (exec time: 0.00s):
{'add_to_prey_population': 10.582683153277642}
DEBUG:root:12|p_predator_births output (exec time: 0.00s):
{'add_to_predator_population': 1.4851400744991858}
DEBUG:root:12|p_prey_births output (exec time: 0.00s):
{'add_to_prey_population': 10.862602224989939}
DEBUG:root:13|p_predator_births output (exec time: 0.00s):

```
{'add_to_predator_population': 1.4442897431220283}
DEBUG:root:13|p_prey_births output (exec time: 0.00s):
{'add_to_prey_population': 10.425705779506703}
DEBUG:root:14|p_predator_births output (exec time: 0.00s):
{'add_to_predator_population': 1.4859193190868716}
DEBUG:root:14|p_prey_births output (exec time: 0.00s):
{'add_to_prey_population': 11.111841238269331}
DEBUG:root:15|p_predator_births output (exec time: 0.00s):
{'add_to_predator_population': 1.4178981636661279}
DEBUG:root:15|p_prey_births output (exec time: 0.00s):
{'add_to_prey_population': 10.510524117573334}
DEBUG:root:16|p_predator_births output (exec time: 0.00s):
{'add_to_predator_population': 1.4647612657242977}
DEBUG:root:16|p_prey_births output (exec time: 0.00s):
{'add_to_prey_population': 10.516154860469726}
DEBUG:root:17|p_predator_births output (exec time: 0.00s):
{'add_to_predator_population': 1.3822324886337432}
DEBUG:root:17|p_prey_births output (exec time: 0.00s):
{'add_to_prey_population': 9.80782657012155}
DEBUG:root:18|p_predator_births output (exec time: 0.00s):
{'add_to_predator_population': 1.270064537743668}
DEBUG:root:18|p_prey_births output (exec time: 0.00s):
{'add_to_prey_population': 9.439762835668267}
DEBUG:root:19|p_predator_births output (exec time: 0.00s):
{'add_to_predator_population': 1.2506447591821253}
DEBUG:root:19|p_prey_births output (exec time: 0.00s):
{'add_to_prey_population': 9.200766805657862}
DEBUG:root:20|p_predator_births output (exec time: 0.00s):
{'add_to_predator_population': 1.2345737752985364}
DEBUG:root:20|p_prey_births output (exec time: 0.00s):
{'add_to_prey_population': 8.934359144633717}
DEBUG:root:21|p_predator_births output (exec time: 0.00s):
{'add_to_predator_population': 1.2135951472735613}
DEBUG:root:21|p_prey_births output (exec time: 0.00s):
{'add_to_prey_population': 8.957705628796145}
DEBUG:root:22|p_predator_births output (exec time: 0.00s):
{'add_to_predator_population': 1.2605418287719177}
DEBUG:root:22|p_prey_births output (exec time: 0.00s):
{'add_to_prey_population': 9.953418990469256}
DEBUG:root:23|p_predator_births output (exec time: 0.00s):
{'add_to_predator_population': 1.30908165159046}
DEBUG:root:23|p_prey_births output (exec time: 0.00s):
{'add_to_prey_population': 10.077584664165908}
DEBUG:root:24|p_predator_births output (exec time: 0.00s):
{'add_to_predator_population': 1.2435268759896134}
DEBUG:root:24|p_prey_births output (exec time: 0.00s):
{'add_to_prey_population': 9.08991850608045}
DEBUG:root:25|p_predator_births output (exec time: 0.00s):
```

{'add_to_predator_population': 1.1822077379213052}
DEBUG:root:25|p_prey_births output (exec time: 0.00s):
{'add_to_prey_population': 9.540583190716113}
DEBUG:root:26|p_predator_births output (exec time: 0.00s):
{'add_to_predator_population': 1.1714561597388766}
DEBUG:root:26|p_prey_births output (exec time: 0.00s):
{'add_to_prey_population': 9.358301596282924}
DEBUG:root:27|p_predator_births output (exec time: 0.00s):
{'add_to_predator_population': 1.0857965310412765}
DEBUG:root:27|p_prey_births output (exec time: 0.00s):
{'add_to_prey_population': 8.396002906788988}
DEBUG:root:28|p_predator_births output (exec time: 0.00s):
{'add_to_predator_population': 1.0844549603306122}
DEBUG:root:28|p_prey_births output (exec time: 0.00s):
{'add_to_prey_population': 8.441061830716913}
DEBUG:root:29|p_predator_births output (exec time: 0.00s):
{'add_to_predator_population': 1.0866204149458503}
DEBUG:root:29|p_prey_births output (exec time: 0.00s):
{'add_to_prey_population': 9.23009605877071}
DEBUG:root:30|p_predator_births output (exec time: 0.00s):
{'add_to_predator_population': 1.1358604205747016}
DEBUG:root:30|p_prey_births output (exec time: 0.00s):
{'add_to_prey_population': 9.694925602031237}


```
              _____      ____
   _____ __ ___/ / ____/    |  / __ \
  / ___/ __`/ __  / /    / /| | / / / /
 / /__/ /_/ / /_/ / /___/ ___ |/ /_/ /
 \___/\__,_/\__,_/\____/_/  |_/_____/
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: 0.06s

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()
```