

execution_time_decorator

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1 Detailed execution time for cadCAD models

Danilo Lessa Bernardineli

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.

```
[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 Dependencies

```
[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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DEBUG:matplotlib:interactive is False
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DEBUG:matplotlib:loaded modules: ['sys', 'builtins', '_frozen_importlib',
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 'pandas.compat._optional', 'pandas.core.missing', 'pandas.core.sorting',
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 'pandas.core.groupby.base', 'pandas.core.window.rolling',
 'pandas.core.window.ewm', 'pandas.core.window.expanding', 'pandas.core.window',
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 'pandas.tseries.api', 'pandas.core.computation',
 'pandas.core.computation.common', 'pandas.core.computation.align',
 'pandas.compat.chainmap', 'pandas.core.computation.scope',

```

'pandas.core.computation.ops', 'pandas.core.computation.engines',
'pandas.core.computation.parsing', 'pandas.core.computation.expr',
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'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.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_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_preyn_population(params, step, sL, s, _input):
    y = 'preyn_population'
    x = s['preyn_population'] + _input['add_to_preyn_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 = [
    {
        'policies': {
            'predator_births': p_predator_births,
            'preyn_births': p_preyn_births,
            'predator_deaths': p_predator_deaths,
            'preyn_deaths': p_preyn_deaths,
        },
        'variables': {
            'predator_population': s_preyn_population,
            'preyn_population': s_predator_population
        }
    }
]
```

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': 1.5288938316002145}
DEBUG:root:1|p_pre_y_births output (exec time: 0.00s): {'add_to_pre_y_population':
10.94256475563537}
DEBUG:root:2|p_predator_births output (exec time: 0.00s):
{'add_to_predator_population': 1.5057822418462237}
DEBUG:root:2|p_pre_y_births output (exec time: 0.00s): {'add_to_pre_y_population':
10.710864548915925}
DEBUG:root:3|p_predator_births output (exec time: 0.00s):
{'add_to_predator_population': 1.540998072806123}
DEBUG:root:3|p_pre_y_births output (exec time: 0.00s): {'add_to_pre_y_population':
10.75366679773807}
DEBUG:root:4|p_predator_births output (exec time: 0.00s):
{'add_to_predator_population': 1.6181740086034417}
DEBUG:root:4|p_pre_y_births output (exec time: 0.00s): {'add_to_pre_y_population':
11.024305976556143}
DEBUG:root:5|p_predator_births output (exec time: 0.00s):
{'add_to_predator_population': 1.706871807673052}
DEBUG:root:5|p_pre_y_births output (exec time: 0.00s): {'add_to_pre_y_population':
11.507184680711887}
DEBUG:root:6|p_predator_births output (exec time: 0.00s):
{'add_to_predator_population': 1.6223244534611165}
DEBUG:root:6|p_pre_y_births output (exec time: 0.00s): {'add_to_pre_y_population':
11.075167739105334}
DEBUG:root:7|p_predator_births output (exec time: 0.00s):
{'add_to_predator_population': 1.7225592502269007}
DEBUG:root:7|p_pre_y_births output (exec time: 0.00s): {'add_to_pre_y_population':
12.03609169134419}
DEBUG:root:8|p_predator_births output (exec time: 0.00s):
{'add_to_predator_population': 1.8370162418810112}
DEBUG:root:8|p_pre_y_births output (exec time: 0.00s): {'add_to_pre_y_population':
12.535555386881946}
DEBUG:root:9|p_predator_births output (exec time: 0.00s):
{'add_to_predator_population': 1.9217643841266476}
DEBUG:root:9|p_pre_y_births output (exec time: 0.00s): {'add_to_pre_y_population':
12.67737104530233}
DEBUG:root:10|p_predator_births output (exec time: 0.00s):
{'add_to_predator_population': 1.8348390666836583}
DEBUG:root:10|p_pre_y_births output (exec time: 0.00s):
{'add_to_pre_y_population': 12.033101710660091}
DEBUG:root:11|p_predator_births output (exec time: 0.00s):
{'add_to_predator_population': 1.6973348686516343}
DEBUG:root:11|p_pre_y_births output (exec time: 0.00s):
{'add_to_pre_y_population': 11.131219698431666}
DEBUG:root:12|p_predator_births output (exec time: 0.00s):
{'add_to_predator_population': 1.6887452413555057}
DEBUG:root:12|p_pre_y_births output (exec time: 0.00s):
{'add_to_pre_y_population': 10.441885888531978}
DEBUG:root:13|p_predator_births output (exec time: 0.00s):

```

```

{'add_to_predator_population': 1.7328716846220165}
DEBUG:root:13|p_pre_y_births output (exec time: 0.00s):
{'add_to_pre_y_population': 11.252848499942539}
DEBUG:root:14|p_predator_births output (exec time: 0.00s):
{'add_to_predator_population': 1.5475216361826885}
DEBUG:root:14|p_pre_y_births output (exec time: 0.00s):
{'add_to_pre_y_population': 10.018707728837649}
DEBUG:root:15|p_predator_births output (exec time: 0.00s):
{'add_to_predator_population': 1.461080496911466}
DEBUG:root:15|p_pre_y_births output (exec time: 0.00s):
{'add_to_pre_y_population': 9.387113235450219}
DEBUG:root:16|p_predator_births output (exec time: 0.00s):
{'add_to_predator_population': 1.352764301153822}
DEBUG:root:16|p_pre_y_births output (exec time: 0.00s):
{'add_to_pre_y_population': 8.482191876245432}
DEBUG:root:17|p_predator_births output (exec time: 0.00s):
{'add_to_predator_population': 1.3226246679888496}
DEBUG:root:17|p_pre_y_births output (exec time: 0.00s):
{'add_to_pre_y_population': 8.19913157515624}
DEBUG:root:18|p_predator_births output (exec time: 0.00s):
{'add_to_predator_population': 1.358514233335447}
DEBUG:root:18|p_pre_y_births output (exec time: 0.00s):
{'add_to_pre_y_population': 8.774366781374747}
DEBUG:root:19|p_predator_births output (exec time: 0.00s):
{'add_to_predator_population': 1.3191460633091407}
DEBUG:root:19|p_pre_y_births output (exec time: 0.00s):
{'add_to_pre_y_population': 9.173107321864379}
DEBUG:root:20|p_predator_births output (exec time: 0.00s):
{'add_to_predator_population': 1.2039698333326334}
DEBUG:root:20|p_pre_y_births output (exec time: 0.00s):
{'add_to_pre_y_population': 8.52610770985367}
DEBUG:root:21|p_predator_births output (exec time: 0.00s):
{'add_to_predator_population': 1.2579572979276419}
DEBUG:root:21|p_pre_y_births output (exec time: 0.00s):
{'add_to_pre_y_population': 8.528957850542504}
DEBUG:root:22|p_predator_births output (exec time: 0.00s):
{'add_to_predator_population': 1.3048726928495782}
DEBUG:root:22|p_pre_y_births output (exec time: 0.00s):
{'add_to_pre_y_population': 9.362649867668102}
DEBUG:root:23|p_predator_births output (exec time: 0.00s):
{'add_to_predator_population': 1.2958488830123878}
DEBUG:root:23|p_pre_y_births output (exec time: 0.00s):
{'add_to_pre_y_population': 9.506362604205489}
DEBUG:root:24|p_predator_births output (exec time: 0.00s):
{'add_to_predator_population': 1.237191108221634}
DEBUG:root:24|p_pre_y_births output (exec time: 0.00s):
{'add_to_pre_y_population': 9.170150310436304}
DEBUG:root:25|p_predator_births output (exec time: 0.00s):

```

by cadCAD

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()
```