

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.

```
[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._libs.tslibs.np_datetime', 'pandas._libs.tslibs.nattype',
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 'pandas.core.shared_docs', 'pandas._libs.window',
 'pandas._libs.window.aggregations', 'pandas.core.util.numba_',
 'pandas.core.window.common', 'pandas._libs.window.indexers',
 'pandas.core.window.indexers', 'pandas.core.window.numba_',
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 'pandas.plotting._core', 'pandas.plotting._misc', 'pandas.plotting',
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 'pandas._libs.groupby', 'pandas.core.groupby.numba_',
 'pandas.core.groupby.categorical', 'pandas.core.groupby.grouper',
 'pandas.core.groupby.ops', 'pandas.core.groupby.groupby',
 'pandas.core.groupby.generic', 'pandas.core.groupby', 'pandas.core.api',
 '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',
'pandas.core.computation.eval', 'pandas.core.computation.api',
'pandas.core.reshape.merge', 'pandas.core.reshape.pivot',
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'pandas.util._print_versions', 'pandas.io.clipboards', 'pandas._libs.parsers',
'pandas.io.excel._util', 'pandas.io.date_converters', 'pandas.io.parsers',
'pandas.io.excel._odfreader', 'pandas.io.excel._openpyxl',
'pandas.io.excel._pyxlsb', 'pandas.io.excel._xlrd', 'pandas.io.excel._base',
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'pandas', 'matplotlib', 'matplotlib.cbook.deprecation', 'matplotlib.cbook',
'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_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': 1.5042623721789243}
DEBUG:root:1|p_pre_y_births output (exec time: 0.00s): {'add_to_pre_y_population':
10.680904437681438}
DEBUG:root:2|p_predator_births output (exec time: 0.00s):
{'add_to_predator_population': 1.4819887064157913}
DEBUG:root:2|p_pre_y_births output (exec time: 0.00s): {'add_to_pre_y_population':
10.225390657102785}
DEBUG:root:3|p_predator_births output (exec time: 0.00s):
{'add_to_predator_population': 1.5693548855510455}
DEBUG:root:3|p_pre_y_births output (exec time: 0.00s): {'add_to_pre_y_population':
10.404024805902122}
DEBUG:root:4|p_predator_births output (exec time: 0.00s):
{'add_to_predator_population': 1.6613484658378668}
DEBUG:root:4|p_pre_y_births output (exec time: 0.00s): {'add_to_pre_y_population':
11.028804613488827}
DEBUG:root:5|p_predator_births output (exec time: 0.00s):
{'add_to_predator_population': 1.6623531223862338}
DEBUG:root:5|p_pre_y_births output (exec time: 0.00s): {'add_to_pre_y_population':
11.718057034236708}
DEBUG:root:6|p_predator_births output (exec time: 0.00s):
{'add_to_predator_population': 1.7774363834156384}
DEBUG:root:6|p_pre_y_births output (exec time: 0.00s): {'add_to_pre_y_population':
12.59804898341515}
DEBUG:root:7|p_predator_births output (exec time: 0.00s):
{'add_to_predator_population': 1.7394817771635136}
DEBUG:root:7|p_pre_y_births output (exec time: 0.00s): {'add_to_pre_y_population':
11.467917463619502}
DEBUG:root:8|p_predator_births output (exec time: 0.00s):
{'add_to_predator_population': 1.6042402627080776}
DEBUG:root:8|p_pre_y_births output (exec time: 0.00s): {'add_to_pre_y_population':
10.31073732577051}
DEBUG:root:9|p_predator_births output (exec time: 0.00s):
{'add_to_predator_population': 1.6729941961493608}
DEBUG:root:9|p_pre_y_births output (exec time: 0.00s): {'add_to_pre_y_population':
10.74712875428761}
DEBUG:root:10|p_predator_births output (exec time: 0.00s):
{'add_to_predator_population': 1.7608077964997024}
DEBUG:root:10|p_pre_y_births output (exec time: 0.00s):
{'add_to_pre_y_population': 11.140103677851137}
DEBUG:root:11|p_predator_births output (exec time: 0.00s):
{'add_to_predator_population': 1.7227937936664348}
DEBUG:root:11|p_pre_y_births output (exec time: 0.00s):
{'add_to_pre_y_population': 10.746699631658029}
DEBUG:root:12|p_predator_births output (exec time: 0.00s):
{'add_to_predator_population': 1.5567970605025947}
DEBUG:root:12|p_pre_y_births output (exec time: 0.00s):
{'add_to_pre_y_population': 10.506272195723994}
DEBUG:root:13|p_predator_births output (exec time: 0.00s):

```

```

{'add_to_predator_population': 1.4361158158766676}
DEBUG:root:13|p_pre_y_births output (exec time: 0.00s):
{'add_to_pre_y_population': 9.357015391578873}
DEBUG:root:14|p_predator_births output (exec time: 0.00s):
{'add_to_predator_population': 1.4892125614748906}
DEBUG:root:14|p_pre_y_births output (exec time: 0.00s):
{'add_to_pre_y_population': 9.920534522500912}
DEBUG:root:15|p_predator_births output (exec time: 0.00s):
{'add_to_predator_population': 1.4040607794880604}
DEBUG:root:15|p_pre_y_births output (exec time: 0.00s):
{'add_to_pre_y_population': 8.857823063855708}
DEBUG:root:16|p_predator_births output (exec time: 0.00s):
{'add_to_predator_population': 1.3684467184320086}
DEBUG:root:16|p_pre_y_births output (exec time: 0.00s):
{'add_to_pre_y_population': 9.064957825421883}
DEBUG:root:17|p_predator_births output (exec time: 0.00s):
{'add_to_predator_population': 1.3763035516675097}
DEBUG:root:17|p_pre_y_births output (exec time: 0.00s):
{'add_to_pre_y_population': 9.323908196586542}
DEBUG:root:18|p_predator_births output (exec time: 0.00s):
{'add_to_predator_population': 1.336991537125594}
DEBUG:root:18|p_pre_y_births output (exec time: 0.00s):
{'add_to_pre_y_population': 8.774319176944138}
DEBUG:root:19|p_predator_births output (exec time: 0.00s):
{'add_to_predator_population': 1.3723609707163356}
DEBUG:root:19|p_pre_y_births output (exec time: 0.00s):
{'add_to_pre_y_population': 9.776852176750234}
DEBUG:root:20|p_predator_births output (exec time: 0.00s):
{'add_to_predator_population': 1.2965801964625863}
DEBUG:root:20|p_pre_y_births output (exec time: 0.00s):
{'add_to_pre_y_population': 8.80883388252079}
DEBUG:root:21|p_predator_births output (exec time: 0.00s):
{'add_to_predator_population': 1.1545765733946067}
DEBUG:root:21|p_pre_y_births output (exec time: 0.00s):
{'add_to_pre_y_population': 8.544494811264228}
DEBUG:root:22|p_predator_births output (exec time: 0.00s):
{'add_to_predator_population': 1.1119593277690398}
DEBUG:root:22|p_pre_y_births output (exec time: 0.00s):
{'add_to_pre_y_population': 7.8474351496328545}
DEBUG:root:23|p_predator_births output (exec time: 0.00s):
{'add_to_predator_population': 1.030638298119835}
DEBUG:root:23|p_pre_y_births output (exec time: 0.00s):
{'add_to_pre_y_population': 7.903810113845362}
DEBUG:root:24|p_predator_births output (exec time: 0.00s):
{'add_to_predator_population': 0.9581179531473704}
DEBUG:root:24|p_pre_y_births output (exec time: 0.00s):
{'add_to_pre_y_population': 7.088670098703739}
DEBUG:root:25|p_predator_births output (exec time: 0.00s):

```

```

{'add_to_predator_population': 0.9431560963100596}
DEBUG:root:25|p_pre_y_births output (exec time: 0.00s):
{'add_to_pre_y_population': 7.668662023549128}
DEBUG:root:26|p_predator_births output (exec time: 0.00s):
{'add_to_predator_population': 0.9532049144881513}
DEBUG:root:26|p_pre_y_births output (exec time: 0.00s):
{'add_to_pre_y_population': 8.000958228294463}
DEBUG:root:27|p_predator_births output (exec time: 0.00s):
{'add_to_predator_population': 0.9009316014807942}
DEBUG:root:27|p_pre_y_births output (exec time: 0.00s):
{'add_to_pre_y_population': 7.851616273271613}
DEBUG:root:28|p_predator_births output (exec time: 0.00s):
{'add_to_predator_population': 0.8825088707011782}
DEBUG:root:28|p_pre_y_births output (exec time: 0.00s):
{'add_to_pre_y_population': 7.362150120996666}
DEBUG:root:29|p_predator_births output (exec time: 0.00s):
{'add_to_predator_population': 0.8684268338550745}
DEBUG:root:29|p_pre_y_births output (exec time: 0.00s):
{'add_to_pre_y_population': 7.537129846228499}
DEBUG:root:30|p_predator_births output (exec time: 0.00s):
{'add_to_predator_population': 0.8688356411787078}
DEBUG:root:30|p_pre_y_births output (exec time: 0.00s):
{'add_to_pre_y_population': 7.953209609464889}

```

```

      -----
  -----  --  ---/ /  ---/  |  /  --  \
 /  ---/  --  /  --  / /  /  /  |  /  /  /
/  /  /  /  /  /  /  /  /  /  /  |  /  /  /
\  --  \  --  /  --  /  /  /  /  |  /  /  /
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: 0.05s

```

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()
```