

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

```

'pandas.core.computation.ops', 'pandas.core.computation.engines',
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'pandas.io.excel._odfreader', 'pandas.io.excel._openpyxl',
'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',
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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': 1.524779116294149}
DEBUG:root:1|p_pre_y_births output (exec time: 0.00s): {'add_to_pre_y_population':
10.893730338730819}
DEBUG:root:2|p_predator_births output (exec time: 0.00s):
{'add_to_predator_population': 1.547555423986159}
DEBUG:root:2|p_pre_y_births output (exec time: 0.00s): {'add_to_pre_y_population':
10.435069484198143}
DEBUG:root:3|p_predator_births output (exec time: 0.00s):
{'add_to_predator_population': 1.3996171422734545}
DEBUG:root:3|p_pre_y_births output (exec time: 0.00s): {'add_to_pre_y_population':
9.315832416560296}
DEBUG:root:4|p_predator_births output (exec time: 0.00s):
{'add_to_predator_population': 1.3629072203432395}
DEBUG:root:4|p_pre_y_births output (exec time: 0.00s): {'add_to_pre_y_population':
9.909814642768232}
DEBUG:root:5|p_predator_births output (exec time: 0.00s):
{'add_to_predator_population': 1.2844965009121119}
DEBUG:root:5|p_pre_y_births output (exec time: 0.00s): {'add_to_pre_y_population':
8.631350086502307}
DEBUG:root:6|p_predator_births output (exec time: 0.00s):
{'add_to_predator_population': 1.3472447950060333}
DEBUG:root:6|p_pre_y_births output (exec time: 0.00s): {'add_to_pre_y_population':
9.863350068245715}
DEBUG:root:7|p_predator_births output (exec time: 0.00s):
{'add_to_predator_population': 1.3714139750749605}
DEBUG:root:7|p_pre_y_births output (exec time: 0.00s): {'add_to_pre_y_population':
9.993379348325353}
DEBUG:root:8|p_predator_births output (exec time: 0.00s):
{'add_to_predator_population': 1.2436661696571243}
DEBUG:root:8|p_pre_y_births output (exec time: 0.00s): {'add_to_pre_y_population':
9.307397349369749}
DEBUG:root:9|p_predator_births output (exec time: 0.00s):
{'add_to_predator_population': 1.2769793619846874}
DEBUG:root:9|p_pre_y_births output (exec time: 0.00s): {'add_to_pre_y_population':
9.543458363666527}
DEBUG:root:10|p_predator_births output (exec time: 0.00s):
{'add_to_predator_population': 1.209216429029329}
DEBUG:root:10|p_pre_y_births output (exec time: 0.00s):
{'add_to_pre_y_population': 9.304230581818432}
DEBUG:root:11|p_predator_births output (exec time: 0.00s):
{'add_to_predator_population': 1.1804840104836496}
DEBUG:root:11|p_pre_y_births output (exec time: 0.00s):
{'add_to_pre_y_population': 8.926254911507606}
DEBUG:root:12|p_predator_births output (exec time: 0.00s):
{'add_to_predator_population': 1.1287040259259087}
DEBUG:root:12|p_pre_y_births output (exec time: 0.00s):
{'add_to_pre_y_population': 8.484124366829866}
DEBUG:root:13|p_predator_births output (exec time: 0.00s):

```

```

{'add_to_predator_population': 1.1229993183658376}
DEBUG:root:13|p_pre_y_births output (exec time: 0.00s):
{'add_to_pre_y_population': 8.879818717244268}
DEBUG:root:14|p_predator_births output (exec time: 0.00s):
{'add_to_predator_population': 1.0883204863418503}
DEBUG:root:14|p_pre_y_births output (exec time: 0.00s):
{'add_to_pre_y_population': 8.386039823951206}
DEBUG:root:15|p_predator_births output (exec time: 0.00s):
{'add_to_predator_population': 1.1355417911207952}
DEBUG:root:15|p_pre_y_births output (exec time: 0.00s):
{'add_to_pre_y_population': 9.372621589908576}
DEBUG:root:16|p_predator_births output (exec time: 0.00s):
{'add_to_predator_population': 1.0813524822982865}
DEBUG:root:16|p_pre_y_births output (exec time: 0.00s):
{'add_to_pre_y_population': 8.497576688445088}
DEBUG:root:17|p_predator_births output (exec time: 0.00s):
{'add_to_predator_population': 1.104904225347095}
DEBUG:root:17|p_pre_y_births output (exec time: 0.00s):
{'add_to_pre_y_population': 8.64059548883094}
DEBUG:root:18|p_predator_births output (exec time: 0.00s):
{'add_to_predator_population': 1.092167180252727}
DEBUG:root:18|p_pre_y_births output (exec time: 0.00s):
{'add_to_pre_y_population': 9.136675610378985}
DEBUG:root:19|p_predator_births output (exec time: 0.00s):
{'add_to_predator_population': 1.1169307381322517}
DEBUG:root:19|p_pre_y_births output (exec time: 0.00s):
{'add_to_pre_y_population': 9.935879841493362}
DEBUG:root:20|p_predator_births output (exec time: 0.00s):
{'add_to_predator_population': 1.1160670884759372}
DEBUG:root:20|p_pre_y_births output (exec time: 0.00s):
{'add_to_pre_y_population': 9.342215483527294}
DEBUG:root:21|p_predator_births output (exec time: 0.00s):
{'add_to_predator_population': 1.0520597696299336}
DEBUG:root:21|p_pre_y_births output (exec time: 0.00s):
{'add_to_pre_y_population': 8.90517463704443}
DEBUG:root:22|p_predator_births output (exec time: 0.00s):
{'add_to_predator_population': 1.0245973881528356}
DEBUG:root:22|p_pre_y_births output (exec time: 0.00s):
{'add_to_pre_y_population': 8.562515873227001}
DEBUG:root:23|p_predator_births output (exec time: 0.00s):
{'add_to_predator_population': 0.9903748996650084}
DEBUG:root:23|p_pre_y_births output (exec time: 0.00s):
{'add_to_pre_y_population': 8.70270886675805}
DEBUG:root:24|p_predator_births output (exec time: 0.00s):
{'add_to_predator_population': 0.9214149488177267}
DEBUG:root:24|p_pre_y_births output (exec time: 0.00s):
{'add_to_pre_y_population': 8.279993368357056}
DEBUG:root:25|p_predator_births output (exec time: 0.00s):

```

by cadCAD

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### 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()
```