execution_time_decorator

March 29, 2021

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
```

DEBUG:matplotlib:matplotlib data path: /github/home/.local/lib/python3.9/site-
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DEBUG:matplotlib:matplotlib version 3.4.0
DEBUG:matplotlib:interactive is False
DEBUG:matplotlib:platform is linux
DEBUG:matplotlib:loaded modules: ['sys', 'builtins', '_frozen_importlib',
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'pandas.core.arrays.categorical', 'pandas.tseries',
```

```
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'pandas.core.arrays._ranges', 'pandas.tseries.offsets',
'pandas.core.arrays.datetimes', 'pandas.core.tools',
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'pandas.core.shared_docs', 'pandas._libs.window',
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'pandas.core.window.common', 'pandas._libs.window.indexers',
'pandas.core.window.indexers', 'pandas.core.window.numba_',
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'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.util._print_versions', 'pandas.io.clipboards', 'pandas._libs.parsers',
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'pandas.io.excel._pyxlsb', 'pandas.io.excel.xlrd', 'pandas.io.excel._base',
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'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',
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'PIL._version', 'PIL', 'xml.etree', 'xml.etree.ElementPath', 'pyexpat.errors',
'pyexpat.model', 'pyexpat', '_elementtree', 'xml.etree.ElementTree',
'PIL.ImageMode', 'PIL.TiffTags', 'PIL._binary', 'PIL._util', 'PIL._imaging',
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'PIL.ImageFile', 'PIL.GimpGradientFile', 'PIL.GimpPaletteFile',
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'PIL.PngImagePlugin', 'matplotlib._path', 'matplotlib.bezier',
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'matplotlib.scale', 'matplotlib._color_data', 'matplotlib.colors', 'pyparsing',
'matplotlib.fontconfig_pattern', 'matplotlib._enums', 'cycler',
'matplotlib.rcsetup', 'matplotlib._version', 'matplotlib.ft2font', 'kiwisolver',
'dateutil.rrule', 'matplotlib.units', 'matplotlib.dates']
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

```
[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

```
[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

```
[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': 1.5291515777951366}
DEBUG:root:1|p_prey_births output (exec time: 0.00s): {'add_to_prey_population':
10.65342658639591}
DEBUG:root:2|p_predator_births output (exec time: 0.00s):
{'add_to_predator_population': 1.547973142880819}
DEBUG:root:2|p_prey_births output (exec time: 0.00s): {'add_to_prey_population':
11.134988404031738}
DEBUG:root:3|p_predator_births output (exec time: 0.00s):
{'add_to_predator_population': 1.5325542790522675}
DEBUG:root:3|p_prey_births output (exec time: 0.00s): {'add_to_prey_population':
10.650341323433052}
DEBUG:root:4|p_predator_births output (exec time: 0.00s):
{'add_to_predator_population': 1.4207919734333432}
DEBUG:root:4|p_prey_births output (exec time: 0.00s): {'add_to_prey_population':
9.614791931842705}
DEBUG:root:5|p_predator_births output (exec time: 0.00s):
{'add_to_predator_population': 1.3192106531780532}
DEBUG:root:5|p_prey_births output (exec time: 0.00s): {'add_to_prey_population':
8.970586216244987}
DEBUG:root:6|p_predator_births output (exec time: 0.00s):
{'add_to_predator_population': 1.3763480655485172}
DEBUG:root:6|p_prey_births output (exec time: 0.00s): {'add_to_prey_population':
9.97763041713634}
DEBUG:root:7|p_predator_births output (exec time: 0.00s):
{'add_to_predator_population': 1.3321806550169704}
DEBUG:root:7|p_prey_births output (exec time: 0.00s): {'add_to_prey_population':
9.455577236546658}
DEBUG:root:8|p_predator_births output (exec time: 0.00s):
{'add_to_predator_population': 1.2389359406597023}
DEBUG:root:8|p_prey_births output (exec time: 0.00s): {'add_to_prey_population':
9.267774286651136}
```

```
DEBUG:root:9|p_predator_births output (exec time: 0.00s):
{'add_to_predator_population': 1.2455928494596988}
DEBUG:root:9|p_prey_births output (exec time: 0.00s): {'add_to_prey_population':
8.97967914659}
DEBUG:root:10|p_predator_births output (exec time: 0.00s):
{'add_to_predator_population': 1.2100005755305798}
DEBUG:root:10|p_prey_births output (exec time: 0.00s):
{'add_to_prey_population': 8.758995099299522}
DEBUG:root:11|p_predator_births output (exec time: 0.00s):
{'add_to_predator_population': 1.2474727106052752}
DEBUG:root:11|p_prey_births output (exec time: 0.00s):
{'add_to_prey_population': 9.130191150308615}
DEBUG:root:12|p_predator_births output (exec time: 0.00s):
{'add_to_predator_population': 1.1792566310488979}
DEBUG:root:12|p_prey_births output (exec time: 0.00s):
{'add_to_prey_population': 8.574696865412122}
DEBUG:root:13|p_predator_births output (exec time: 0.00s):
{'add_to_predator_population': 1.1002465443429517}
DEBUG:root:13|p_prey_births output (exec time: 0.00s):
{'add_to_prey_population': 8.209016868843307}
DEBUG:root:14|p_predator_births output (exec time: 0.00s):
{'add_to_predator_population': 1.0280277237513635}
DEBUG:root:14|p_prey_births output (exec time: 0.00s):
{'add_to_prey_population': 8.348821769428755}
DEBUG:root:15|p_predator_births output (exec time: 0.00s):
{'add_to_predator_population': 1.033974754547649}
DEBUG:root:15|p_prey_births output (exec time: 0.00s):
{'add_to_prey_population': 8.21187647368765}
DEBUG:root:16|p_predator_births output (exec time: 0.00s):
{'add_to_predator_population': 1.0605254922262357}
DEBUG:root:16|p_prey_births output (exec time: 0.00s):
{'add_to_prey_population': 8.498332189303076}
DEBUG:root:17|p_predator_births output (exec time: 0.00s):
{'add_to_predator_population': 1.0845077228176976}
DEBUG:root:17|p_prey_births output (exec time: 0.00s):
{'add_to_prey_population': 8.63047386431708}
DEBUG:root:18|p_predator_births output (exec time: 0.00s):
{'add_to_predator_population': 1.0891223482412826}
DEBUG:root:18|p_prey_births output (exec time: 0.00s):
{'add_to_prey_population': 9.10222810387678}
DEBUG:root:19|p_predator_births output (exec time: 0.00s):
{'add_to_predator_population': 1.0977092820176915}
DEBUG:root:19|p_prey_births output (exec time: 0.00s):
{'add_to_prey_population': 9.086919829694711}
DEBUG:root:20|p_predator_births output (exec time: 0.00s):
{'add_to_predator_population': 1.1500208972752064}
DEBUG:root:20|p_prey_births output (exec time: 0.00s):
{'add_to_prey_population': 9.778285302772607}
```

```
DEBUG:root:21|p_predator_births output (exec time: 0.00s):
{'add_to_predator_population': 1.1078624221097044}
DEBUG:root:21|p_prey_births output (exec time: 0.00s):
{'add_to_prey_population': 9.288235873506702}
DEBUG:root:22|p_predator_births output (exec time: 0.00s):
{'add_to_predator_population': 1.050602333153013}
DEBUG:root:22|p_prey_births output (exec time: 0.00s):
{'add_to_prey_population': 8.931670501108249}
DEBUG:root:23|p_predator_births output (exec time: 0.00s):
{'add_to_predator_population': 0.9857792842705184}
DEBUG:root:23|p_prey_births output (exec time: 0.00s):
{'add_to_prey_population': 9.05187491860262}
DEBUG:root:24|p_predator_births output (exec time: 0.00s):
{'add_to_predator_population': 1.0134355119090335}
DEBUG:root:24|p_prey_births output (exec time: 0.00s):
{'add_to_prey_population': 9.343067214462769}
DEBUG:root:25|p_predator_births output (exec time: 0.00s):
{'add_to_predator_population': 1.0255620705325477}
DEBUG:root:25|p_prey_births output (exec time: 0.00s):
{'add_to_prey_population': 9.029047432973046}
DEBUG:root:26|p_predator_births output (exec time: 0.00s):
{'add_to_predator_population': 0.9770207613304042}
DEBUG:root:26|p_prey_births output (exec time: 0.00s):
{'add_to_prey_population': 9.429730862170288}
DEBUG:root:27|p_predator_births output (exec time: 0.00s):
{'add_to_predator_population': 1.0012796433128226}
DEBUG:root:27|p_prey_births output (exec time: 0.00s):
{'add_to_prey_population': 9.305106422557218}
DEBUG:root:28|p_predator_births output (exec time: 0.00s):
{'add_to_predator_population': 1.0466102014582506}
DEBUG:root:28|p_prey_births output (exec time: 0.00s):
{'add_to_prey_population': 9.947312933914485}
DEBUG:root:29|p_predator_births output (exec time: 0.00s):
{'add_to_predator_population': 1.1210053980551073}
DEBUG:root:29|p_prey_births output (exec time: 0.00s):
{'add_to_prey_population': 10.940076879615853}
DEBUG:root:30|p_predator_births output (exec time: 0.00s):
{'add_to_predator_population': 1.1016287903284954}
DEBUG:root:30|p_prey_births output (exec time: 0.00s):
{'add_to_prey_population': 10.4459794049004}
```

```
             _____      ____
   _____ __ ___/ / ____/   |  / __ \
  / ___/ __`/ __  / /   / /|  | / / / /
 / /__/ /_/ / /_/ / /___/ ___ |/ /_/ /
 \___/\__,_/\__,_/\____/_/  |_/_____/
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()
```