

psub_metadata

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1 Detailed execution time for cadCAD models

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This notebook shows how you can use metadata on PSUBs in order to do pre-processing on the simulations. We use two keys for flagging them: the `ignore` which indicates which PSUBs we want to skip, and the `debug`, which informs us what are the ones which we want to monitor the policies execution time.

```
[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-
packages/matplotlib/mpl-data
DEBUG:matplotlib:CONFIGDIR=/github/home/.config/matplotlib
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',
'_imp', '_thread', '_warnings', '_weakref', '_frozen_importlib_external',
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 'pandas._config', 'pandas._config.localization', 'pandas._libs.tslibs.strptime',
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 'dateutil.easter', 'pandas._libs.properties', 'pandas._libs.tslibs.offsets',
 'pandas._libs.tslibs.parsing', 'pandas._libs.tslibs.conversion',
 'pandas._libs.tslibs.period', 'pandas._libs.tslibs.vectorized',
 'pandas._libs.tslibs', 'pandas._libs.ops_dispatch', 'pandas._libs.missing',
 'pandas._libs.hashtable', 'pandas._libs.algos', 'pandas._libs.interval',
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 'pandas.core.config_init', 'pandas.core.dtypes', 'pandas.errors',
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 'pandas.compat.numpy.function', 'pandas._libs.ops', 'pandas.core.ops.roperator',
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 'pandas.core.arrays.string_', 'pandas.core.arrays.timedeltas',
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 'pandas.core.indexes.range', 'pandas.core.indexes.api',
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 'pandas.core.shared_docs', 'pandas._libs.window',
 'pandas._libs.window.aggregations', 'pandas.core.util.numba_',
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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.core.groupby.categorical', 'pandas.core.groupby.grouper',
 'pandas.core.groupby.ops', 'pandas.core.groupby.groupby',
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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',
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 'pandas.core.computation.eval', 'pandas.core.computation.api',
 'pandas.core.reshape.merge', 'pandas.core.reshape.pivot',
 'pandas.core.reshape.reshape', 'pandas.core.reshape.tile',
 'pandas.core.reshape.api', 'pandas.api.extensions', 'pandas.api.indexers',

```

'pandas.core.dtypes.api', 'pandas.api.types', 'pandas.api',
'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',
'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',
'pandas.compat.pickle_compat', 'pandas.io.pickle',
'pandas.core.computation.pytables', 'pandas.io.pytables',
'pandas.io.sas.sasreader', 'pandas.io.sas', 'pandas.io.spss', 'pandas.io.sql',
'pandas.io.stata', 'pandas.io.api', 'pandas.util._tester', 'cmath',
'pandas._libs.testing', 'pandas._testing', 'pandas.testing', 'pandas._version',
'pandas', 'matplotlib', 'matplotlib.api.deprecation', 'matplotlib.api',
'matplotlib._c_internal_utils', 'matplotlib.cbook', 'matplotlib.docstring',
'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',
'cffi.lock', 'cffi.error', 'cffi.model', 'cffi.api', 'cffi', 'PIL.Image',
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'PIL.ImageFile', 'PIL.GimpGradientFile', 'PIL.GimpPaletteFile',
'PIL.ImageColor', 'PIL.PaletteFile', 'PIL.ImagePalette', 'PIL.ImageSequence',
'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]: 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}

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_preyn_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 = [
    {
        'label': 'Predator dynamics',
        'ignore': False,
        'debug': True,
        'policies': {
            'predator_births': p_predator_births,
            'predator_deaths': p_predator_deaths
        },
        'variables': {
            'predator_population': s_predator_population
        }
    },
    {
        'label': 'Prey dynamics',
        'ignore': True,
        'debug': True,
        'policies': {
            'prey_births': p_preyn_births,
            'prey_deaths': p_preyn_deaths
        },
        'variables': {
            'preyn_population': s_preyn_population
        }
    }
]

# Mantain only PSUBs which doesn't have the ignore flag
partial_state_update_blocks = [psub
```

```

        for psub in partial_state_update_blocks
        if psub.get('ignore', False) == False]

# Only check the execution time for the PSUBs with the debug flag
for psub in partial_state_update_blocks:
    psub['policies'] = {label: print_time(f) for label, f in psub['policies'].
    ↪items()}

```

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': 1.5006910078779974}
DEBUG:root:1|p_predator_deaths output (exec time: 0.00s):
{'add_to_predator_population': -1.5012629682756096}
DEBUG:root:2|p_predator_births output (exec time: 0.00s):
{'add_to_predator_population': 1.5293304480964505}
DEBUG:root:2|p_predator_deaths output (exec time: 0.00s):
{'add_to_predator_population': -1.5008016605642156}
DEBUG:root:3|p_predator_births output (exec time: 0.00s):
{'add_to_predator_population': 1.5089675063961907}
DEBUG:root:3|p_predator_deaths output (exec time: 0.00s):
{'add_to_predator_population': -1.5065369332476217}
DEBUG:root:4|p_predator_births output (exec time: 0.00s):
{'add_to_predator_population': 1.5278463692567037}
DEBUG:root:4|p_predator_deaths output (exec time: 0.00s):
{'add_to_predator_population': -1.505808020952818}
DEBUG:root:5|p_predator_births output (exec time: 0.00s):
{'add_to_predator_population': 1.5147218947163685}
DEBUG:root:5|p_predator_deaths output (exec time: 0.00s):
{'add_to_predator_population': -1.5113046626360704}
DEBUG:root:6|p_predator_births output (exec time: 0.00s):
{'add_to_predator_population': 1.5201727277562411}

```

DEBUG:root:6|p_predator_deaths output (exec time: 0.00s):
{'add_to_predator_population': -1.5089612389798868}
DEBUG:root:7|p_predator_births output (exec time: 0.00s):
{'add_to_predator_population': 1.5111432892976269}
DEBUG:root:7|p_predator_deaths output (exec time: 0.00s):
{'add_to_predator_population': -1.5140016023596299}
DEBUG:root:8|p_predator_births output (exec time: 0.00s):
{'add_to_predator_population': 1.513641971219224}
DEBUG:root:8|p_predator_deaths output (exec time: 0.00s):
{'add_to_predator_population': -1.5135024273823505}
DEBUG:root:9|p_predator_births output (exec time: 0.00s):
{'add_to_predator_population': 1.528672000131766}
DEBUG:root:9|p_predator_deaths output (exec time: 0.00s):
{'add_to_predator_population': -1.5096542272377111}
DEBUG:root:10|p_predator_births output (exec time: 0.00s):
{'add_to_predator_population': 1.5133183363457787}
DEBUG:root:10|p_predator_deaths output (exec time: 0.00s):
{'add_to_predator_population': -1.5146101893363972}
DEBUG:root:11|p_predator_births output (exec time: 0.00s):
{'add_to_predator_population': 1.5203399095365433}
DEBUG:root:11|p_predator_deaths output (exec time: 0.00s):
{'add_to_predator_population': -1.5132980349139977}
DEBUG:root:12|p_predator_births output (exec time: 0.00s):
{'add_to_predator_population': 1.5329382961190294}
DEBUG:root:12|p_predator_deaths output (exec time: 0.00s):
{'add_to_predator_population': -1.5122267801084828}
DEBUG:root:13|p_predator_births output (exec time: 0.00s):
{'add_to_predator_population': 1.5390461761728083}
DEBUG:root:13|p_predator_deaths output (exec time: 0.00s):
{'add_to_predator_population': -1.5183902643615261}
DEBUG:root:14|p_predator_births output (exec time: 0.00s):
{'add_to_predator_population': 1.5338015554922404}
DEBUG:root:14|p_predator_deaths output (exec time: 0.00s):
{'add_to_predator_population': -1.5187668249270336}
DEBUG:root:15|p_predator_births output (exec time: 0.00s):
{'add_to_predator_population': 1.5425124252095757}
DEBUG:root:15|p_predator_deaths output (exec time: 0.00s):
{'add_to_predator_population': -1.5200959929000533}
DEBUG:root:16|p_predator_births output (exec time: 0.00s):
{'add_to_predator_population': 1.5290787896475884}
DEBUG:root:16|p_predator_deaths output (exec time: 0.00s):
{'add_to_predator_population': -1.5229382173252566}
DEBUG:root:17|p_predator_births output (exec time: 0.00s):
{'add_to_predator_population': 1.5470176884788975}
DEBUG:root:17|p_predator_deaths output (exec time: 0.00s):
{'add_to_predator_population': -1.5240317120075568}
DEBUG:root:18|p_predator_births output (exec time: 0.00s):
{'add_to_predator_population': 1.5255018012827215}

DEBUG:root:18|p_predator_deaths output (exec time: 0.00s):
{'add_to_predator_population': -1.5207837440282574}
DEBUG:root:19|p_predator_births output (exec time: 0.00s):
{'add_to_predator_population': 1.5231114418025917}
DEBUG:root:19|p_predator_deaths output (exec time: 0.00s):
{'add_to_predator_population': -1.5209360905885896}
DEBUG:root:20|p_predator_births output (exec time: 0.00s):
{'add_to_predator_population': 1.5487781651206376}
DEBUG:root:20|p_predator_deaths output (exec time: 0.00s):
{'add_to_predator_population': -1.5262768648461165}
DEBUG:root:21|p_predator_births output (exec time: 0.00s):
{'add_to_predator_population': 1.548576570825423}
DEBUG:root:21|p_predator_deaths output (exec time: 0.00s):
{'add_to_predator_population': -1.526384300265004}
DEBUG:root:22|p_predator_births output (exec time: 0.00s):
{'add_to_predator_population': 1.5548892521854423}
DEBUG:root:22|p_predator_deaths output (exec time: 0.00s):
{'add_to_predator_population': -1.532090594534059}
DEBUG:root:23|p_predator_births output (exec time: 0.00s):
{'add_to_predator_population': 1.5547454832473}
DEBUG:root:23|p_predator_deaths output (exec time: 0.00s):
{'add_to_predator_population': -1.5281078301715776}
DEBUG:root:24|p_predator_births output (exec time: 0.00s):
{'add_to_predator_population': 1.541005697590992}
DEBUG:root:24|p_predator_deaths output (exec time: 0.00s):
{'add_to_predator_population': -1.5336484751423338}
DEBUG:root:25|p_predator_births output (exec time: 0.00s):
{'add_to_predator_population': 1.5376151901257888}
DEBUG:root:25|p_predator_deaths output (exec time: 0.00s):
{'add_to_predator_population': -1.5359864509593582}
DEBUG:root:26|p_predator_births output (exec time: 0.00s):
{'add_to_predator_population': 1.553539751417154}
DEBUG:root:26|p_predator_deaths output (exec time: 0.00s):
{'add_to_predator_population': -1.5314920759794504}
DEBUG:root:27|p_predator_births output (exec time: 0.00s):
{'add_to_predator_population': 1.5626139886995711}
DEBUG:root:27|p_predator_deaths output (exec time: 0.00s):
{'add_to_predator_population': -1.5380409223907134}
DEBUG:root:28|p_predator_births output (exec time: 0.00s):
{'add_to_predator_population': 1.5435720100958714}
DEBUG:root:28|p_predator_deaths output (exec time: 0.00s):
{'add_to_predator_population': -1.5394881619626082}
DEBUG:root:29|p_predator_births output (exec time: 0.00s):
{'add_to_predator_population': 1.5601025206213228}
DEBUG:root:29|p_predator_deaths output (exec time: 0.00s):
{'add_to_predator_population': -1.5378510053320347}
DEBUG:root:30|p_predator_births output (exec time: 0.00s):
{'add_to_predator_population': 1.5541514371095184}

```
DEBUG:root:30|p_predator_deaths output (exec time: 0.00s):
{'add_to_predator_population': -1.5455705965202835}
```

```

      -----
 /  -----  \  /  /  -----  \  /  /  -----  \
/  /  /  /  /  /  /  /  /  /  /  /  /  /  /  /  /  /
/  /  /  /  /  /  /  /  /  /  /  /  /  /  /  /  /  /
\  /  /  /  /  /  /  /  /  /  /  /  /  /  /  /  /  /
\  /  /  /  /  /  /  /  /  /  /  /  /  /  /  /  /  /
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()
```