

Definition of the NPS function in python

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Code function

This document presents a python implementation of the multivariate categorical sampling function mentioned in the “A Fast Nonparametric Sampling (NPS) Method for Time-to-Event in Individual-Level Simulation Models.” manuscript, and used in the R examples provided in the Appendix.

```
def nps_nhpp(a_probs, correction, a_categories=None):
    """
    Generate samples from different probability distributions using a
    multivariate categorical distribution.

    Parameters:
    -----
    a_probs (array): Array filled with independent and equally-length
    probability distributions.
    correction (str): String defining whether to a random variable between 0
    and 1 to approximate continous time ("uniform") or no modification at all
    after performing the sample ("none").
    a_categories (array): (Optional) Array defining the names of the
    categories to sample.

    Returns:
    -----
    numpy.array: Array filled with the sampled categories for all the
```

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probability distributions.

Example:

```
import numpy as np
import scipy.stats as stats

# Number of samples
n_samp = 100

# Create an array filled with categories between 1 and 101
a_categories = np.arange(1, 101)

# Parameters of normal distribution
## First distribution
norm_mean_1, norm_var_1 = 30, 10
## second distribution
norm_mean_2, norm_var_2 = 60, 10

# Get PDF from distributions
v_disc_PDF_norm_1 = stats.norm.pdf(a_categories, loc = norm_mean_1,
    scale = norm_var_1)
v_disc_PDF_norm_2 = stats.norm.pdf(a_categories, loc = norm_mean_2,
    scale = norm_var_2)

# normalize values
## First version
v_norm_PDF_norm_1 = v_disc_PDF_norm_1/sum(v_disc_PDF_norm_1)
## Second version
v_norm_PDF_norm_2 = v_disc_PDF_norm_2/sum(v_disc_PDF_norm_2)

# Join v_norm_PDF_norm_1 and v_norm_PDF_norm_2 into a single array
a_PDF_1_2 = np.array([v_norm_PDF_norm_1, v_norm_PDF_norm_2])

# Randomly sample 0s and 1s
a_choice = np.random.choice(a = [0, 1], size = n_samp, replace = True,
    p = [0.5, 0.5])

# Use values present in a_choice to extract either v_norm_PDF_norm_1 or
# v_norm_PDF_norm_2 and stack them into an array
a_probs = np.stack(arrays = a_PDF_1_2[a_choice], axis = 0)
```

```

# Run the nps_nhpp function to sample times to events from the arrays
# of probabilities present in a_probs
nps_nhpp(a_probs= a_probs, correction="uniform")
-----
"""
valid_correction = {'none', 'uniform'}

if correction not in valid_correction:
    print("Warning: correction argument only accepts: 'none' and uniform")

    corresponding_values = None

if a_categories is None:
    # Get number of categories
    a_categories = np.arange(0, a_probs.shape[1])

# Check that all PDF's sum up to 1
if not all(np.isclose(a_probs.sum(axis = 1), 1)):
    a_probs = a_probs/a_probs.sum(axis=1, keepdims=True)

# Get number of elements to draw
a_samp_size = a_probs.shape[0]

# Obtain array filled with random numbers following a uniform distribution
a_unif_probs = np.vstack(np.random.uniform(size = a_samp_size))

# Get cumulative probabilities array from `a_probs`
# Every row is a CDF
a_cum_probs = np.cumsum(a_probs, axis = 1)

# Compare uniform probabilities against cumulative probs
comparison_result = a_cum_probs >= a_unif_probs

# Getting positions where values are greater than or equal
positions = np.argmax(comparison_result, axis = 1)

corresponding_values = a_categories[positions]

if correction == "uniform":

    unif_corr = np.vstack(np.random.uniform(size = a_samp_size))

```

```
corresponding_values = corresponding_values + unif_corr  
return corresponding_values
```