# 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 sinlge 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_1 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
```