In [1]:!pip install scikit-survival
!pip install scikit-learn
!pip install pycox
!pip install captum

```
Requirement already satisfied: scikit-survival in /home/jskrajny/PycharmProjects/xai_team/venv/lib/python3.8/site-packages (0.19.0.post1)
Requirement already satisfied: numexpr in /home/jskrajny/PycharmProjects/xai_team/venv/lib/python3.8/site-packages (from scikit-survival) (2.8.4)
Requirement already satisfied: joblib in /home/jskrajny/PycharmProjects/xai_team/venv/lib/python3.8/site-packages (from scikit-survival) (1.2.0)
Requirement already satisfied: ecos in /home/jskrajny/PycharmProjects/xai_team/venv/lib/python3.8/site-packages (from scikit-survival) (2.0.12)
Requirement already satisfied: pandas>=1.0.5 in /home/jskrajny/PycharmProjects/xai_team/venv/lib/python3.8/site-packages (from scikit-survival) (1.5.3)
Requirement already satisfied: scipy>=1.3.2 in /home/jskrajny/PycharmProjects/xai_team/venv/lib/python3.8/site-packages (from scikit-survival) (1.10.0)
Requirement already satisfied: numpy in /home/jskrajny/PycharmProjects/xai_team/venv/lib/python3.8/site-packages (from scikit-survival) (1.23.5)
Requirement already satisfied: osqp!=0.6.0,!=0.6.1 in /home/jskrajny/PycharmProjects/xai_team/venv/lib/python3.8/site-packages (from scikit-survival) (0.6.2.
post8)
Requirement already satisfied: scikit-learn<1.2,>=1.1.2 in /home/jskrajny/PycharmProjects/xai_team/venv/lib/python3.8/site-packages (from scikit-survival) (1.
1.3)
Requirement already satisfied: qdldl in /home/jskrajny/PycharmProjects/xai_team/venv/lib/python3.8/site-packages (from osqp!=0.6.0,!=0.6.1->scikit-survival)
(0.1.5.post3)
Requirement already satisfied: python-dateutil>=2.8.1 in /home/jskrajny/PycharmProjects/xai_team/venv/lib/python3.8/site-packages (from pandas>=1.0.5->s
cikit-survival) (2.8.2)
Requirement already satisfied: pytz>=2020.1 in /home/jskrajny/PycharmProjects/xai_team/venv/lib/python3.8/site-packages (from pandas>=1.0.5->scikit-surv
ival) (2022.7.1)
Requirement already satisfied: six>=1.5 in /home/jskrajny/PycharmProjects/xai_team/venv/lib/python3.8/site-packages (from python-dateutil>=2.8.1->pandas
>=1.0.5->scikit-survival) (1.16.0)
Requirement already satisfied: threadpoolctl>=2.0.0 in /home/jskrajny/PycharmProjects/xai_team/venv/lib/python3.8/site-packages (from scikit-learn<1.2,>=1.
1.2->scikit-survival) (3.1.0)
WARNING: You are using pip version 21.1.2; however, version 22.3.1 is available.
You should consider upgrading via the '/home/jskrajny/PycharmProjects/xai_team/venv/bin/python -m pip install --upgrade pip' command.
Requirement already satisfied: scikit-learn in /home/jskrajny/PycharmProjects/xai_team/venv/lib/python3.8/site-packages (1.1.3)
Requirement already satisfied: joblib>=1.0.0 in /home/jskrajny/PycharmProjects/xai_team/venv/lib/python3.8/site-packages (from scikit-learn) (1.2.0)
Requirement already satisfied: threadpoolctl>=2.0.0 in /home/jskrajny/PycharmProjects/xai_team/venv/lib/python3.8/site-packages (from scikit-learn) (3.1.0)
Requirement already satisfied: numpy>=1.17.3 in /home/jskrajny/PycharmProjects/xai_team/venv/lib/python3.8/site-packages (from scikit-learn) (1.23.5)
Requirement already satisfied: scipy>=1.3.2 in /home/jskrajny/PycharmProjects/xai_team/venv/lib/python3.8/site-packages (from scikit-learn) (1.10.0)
WARNING: You are using pip version 21.1.2; however, version 22.3.1 is available.
You should consider upgrading via the '/home/jskrajny/PycharmProjects/xai_team/venv/bin/python -m pip install --upgrade pip' command.
Requirement already satisfied: pycox in /home/jskrajny/PycharmProjects/xai_team/venv/lib/python3.8/site-packages (0.2.3)
Requirement already satisfied: h5py>=2.9.0 in /home/jskrajny/PycharmProjects/xai_team/venv/lib/python3.8/site-packages (from pycox) (3.8.0)
Requirement already satisfied: torchtuples>=0.2.0 in /home/jskrajny/PycharmProjects/xai_team/venv/lib/python3.8/site-packages (from pycox) (0.2.2)
Requirement already satisfied: requests>=2.22.0 in /home/jskrajny/PycharmProjects/xai_team/venv/lib/python3.8/site-packages (from pycox) (2.28.2)
Requirement already satisfied: feather-format>=0.4.0 in /home/jskrajny/PycharmProjects/xai_team/venv/lib/python3.8/site-packages (from pycox) (0.4.1)
Requirement already satisfied: numba>=0.44 in /home/jskrajny/PycharmProjects/xai_team/venv/lib/python3.8/site-packages (from pycox) (0.56.4)
Requirement already satisfied: scikit-learn>=0.21.2 in /home/jskrajny/PycharmProjects/xai_team/venv/lib/python3.8/site-packages (from pycox) (1.1.3)
Requirement already satisfied: py7zr>=0.11.3 in /home/jskrajny/PycharmProjects/xai_team/venv/lib/python3.8/site-packages (from pycox) (0.20.2)
Requirement already satisfied: pyarrow>=0.4.0 in /home/jskrajny/PycharmProjects/xai_team/venv/lib/python3.8/site-packages (from feather-format>=0.4.0->p
ycox) (10.0.1)
Requirement already satisfied: numpy>=1.14.5 in /home/jskrajny/PycharmProjects/xai_team/venv/lib/python3.8/site-packages (from h5py>=2.9.0->pycox) (1.
23.5)
Requirement already satisfied: setuptools in /home/jskrajny/PycharmProjects/xai_team/venv/lib/python3.8/site-packages (from numba>=0.44->pycox) (57.0.0
)
Requirement already satisfied: importlib-metadata in /home/jskrajny/PycharmProjects/xai_team/venv/lib/python3.8/site-packages (from numba>=0.44->pycox)
(6.0.0)
Requirement already satisfied: llvmlite<0.40,>=0.39.0dev0 in /home/jskrajny/PycharmProjects/xai_team/venv/lib/python3.8/site-packages (from numba>=0.44
->pycox) (0.39.1)
Requirement already satisfied: psutil in /home/jskrajny/PycharmProjects/xai_team/venv/lib/python3.8/site-packages (from py7zr>=0.11.3->pycox) (5.9.4)
Requirement already satisfied: pycryptodomex>=3.6.6 in /home/jskrajny/PycharmProjects/xai_team/venv/lib/python3.8/site-packages (from py7zr>=0.11.3->p
ycox) (3.16.0)
Requirement already satisfied: brotli>=1.0.9 in /home/jskrajny/PycharmProjects/xai_team/venv/lib/python3.8/site-packages (from py7zr>=0.11.3->pycox) (1.0.
9)
Requirement already satisfied: multivolumefile>=0.2.3 in /home/jskrajny/PycharmProjects/xai_team/venv/lib/python3.8/site-packages (from py7zr>=0.11.3->p
ycox) (0.2.3)
Requirement already satisfied: pyzstd>=0.14.4 in /home/jskrajny/PycharmProjects/xai_team/venv/lib/python3.8/site-packages (from py7zr>=0.11.3->pycox) (0
.15.3)
Requirement already satisfied: texttable in /home/jskrajny/PycharmProjects/xai_team/venv/lib/python3.8/site-packages (from py7zr>=0.11.3->pycox) (1.6.7)
Requirement already satisfied: inflate64>=0.3.1 in /home/jskrajny/PycharmProjects/xai_team/venv/lib/python3.8/site-packages (from py7zr>=0.11.3->pycox) (
0.3.1)
Requirement already satisfied: pybcj>=0.6.0 in /home/jskrajny/PycharmProjects/xai_team/venv/lib/python3.8/site-packages (from py7zr>=0.11.3->pycox) (1.0.
1)
Requirement already satisfied: pyppmd<1.1.0,>=0.18.1 in /home/jskrajny/PycharmProjects/xai_team/venv/lib/python3.8/site-packages (from py7zr>=0.11.3->
pycox) (1.0.0)
Requirement already satisfied: charset-normalizer<4,>=2 in /home/jskrajny/PycharmProjects/xai_team/venv/lib/python3.8/site-packages (from requests>=2.2
2.0->pycox) (3.0.1)
Requirement already satisfied: urllib3<1.27,>=1.21.1 in /home/jskrajny/PycharmProjects/xai_team/venv/lib/python3.8/site-packages (from requests>=2.22.0->
pycox) (1.26.14)
Requirement already satisfied: idna<4,>=2.5 in /home/jskrajny/PycharmProjects/xai_team/venv/lib/python3.8/site-packages (from requests>=2.22.0->pycox) (
3.4)
Requirement already satisfied: certifi>=2017.4.17 in /home/jskrajny/PycharmProjects/xai_team/venv/lib/python3.8/site-packages (from requests>=2.22.0->pyc
ox) (2022.12.7)
Requirement already satisfied: scipy>=1.3.2 in /home/jskrajny/PycharmProjects/xai_team/venv/lib/python3.8/site-packages (from scikit-learn>=0.21.2->pycox)
(1.10.0)
```

```
Requirement already satisfied: threadpoolctl>=2.0.0 in /home/jskrajny/PycharmProjects/xai_team/venv/lib/python3.8/site-packages (from scikit-learn>=0.21.2->pycox) (3.1.0)
Requirement already satisfied: joblib>=1.0.0 in /home/jskrajny/PycharmProjects/xai_team/venv/lib/python3.8/site-packages (from scikit-learn>=0.21.2->pycox) (1.2.0)
Requirement already satisfied: pandas>=0.24.2 in /home/jskrajny/PycharmProjects/xai_team/venv/lib/python3.8/site-packages (from torchtuples>=0.2.0->pycox) (1.5.3)
Requirement already satisfied: matplotlib>=3.0.3 in /home/jskrajny/PycharmProjects/xai_team/venv/lib/python3.8/site-packages (from torchtuples>=0.2.0->pycox) (3.6.3)
Requirement already satisfied: python-dateutil>=2.7 in /home/jskrajny/PycharmProjects/xai_team/venv/lib/python3.8/site-packages (from matplotlib>=3.0.3->torchtuples>=0.2.0->pycox) (2.8.2)
Requirement already satisfied: pillow>=6.2.0 in /home/jskrajny/PycharmProjects/xai_team/venv/lib/python3.8/site-packages (from matplotlib>=3.0.3->torchtuples>=0.2.0->pycox) (9.4.0)
Requirement already satisfied: cycler>=0.10 in /home/jskrajny/PycharmProjects/xai_team/venv/lib/python3.8/site-packages (from matplotlib>=3.0.3->torchtuples>=0.2.0->pycox) (0.11.0)
Requirement already satisfied: packaging>=20.0 in /home/jskrajny/PycharmProjects/xai_team/venv/lib/python3.8/site-packages (from matplotlib>=3.0.3->torchtuples>=0.2.0->pycox) (23.0)
Requirement already satisfied: fonttools>=4.22.0 in /home/jskrajny/PycharmProjects/xai_team/venv/lib/python3.8/site-packages (from matplotlib>=3.0.3->torchtuples>=0.2.0->pycox) (4.38.0)
Requirement already satisfied: pyparsing>=2.2.1 in /home/jskrajny/PycharmProjects/xai_team/venv/lib/python3.8/site-packages (from matplotlib>=3.0.3->torchtuples>=0.2.0->pycox) (3.0.9)
Requirement already satisfied: contourpy>=1.0.1 in /home/jskrajny/PycharmProjects/xai_team/venv/lib/python3.8/site-packages (from matplotlib>=3.0.3->torchtuples>=0.2.0->pycox) (1.0.7)
Requirement already satisfied: kiwisolver>=1.0.1 in /home/jskrajny/PycharmProjects/xai_team/venv/lib/python3.8/site-packages (from matplotlib>=3.0.3->torchtuples>=0.2.0->pycox) (1.4.4)
Requirement already satisfied: pytz>=2020.1 in /home/jskrajny/PycharmProjects/xai_team/venv/lib/python3.8/site-packages (from pandas>=0.24.2->torchtuples>=0.2.0->pycox) (2022.7.1)
Requirement already satisfied: six>=1.5 in /home/jskrajny/PycharmProjects/xai_team/venv/lib/python3.8/site-packages (from python-dateutil>=2.7->matplotlib>=3.0.3->torchtuples>=0.2.0->pycox) (1.16.0)
Requirement already satisfied: zipp>=0.5 in /home/jskrajny/PycharmProjects/xai_team/venv/lib/python3.8/site-packages (from importlib-metadata->numba>=0.44->pycox) (3.11.0)
WARNING: You are using pip version 21.1.2; however, version 22.3.1 is available.
You should consider upgrading via the '/home/jskrajny/PycharmProjects/xai_team/venv/bin/python -m pip install --upgrade pip' command.
Requirement already satisfied: captum in /home/jskrajny/PycharmProjects/xai_team/venv/lib/python3.8/site-packages (0.6.0)
Requirement already satisfied: matplotlib in /home/jskrajny/PycharmProjects/xai_team/venv/lib/python3.8/site-packages (from captum) (3.6.3)
Requirement already satisfied: numpy in /home/jskrajny/PycharmProjects/xai_team/venv/lib/python3.8/site-packages (from captum) (1.23.5)
Requirement already satisfied: torch>=1.6 in /home/jskrajny/PycharmProjects/xai_team/venv/lib/python3.8/site-packages (from captum) (1.13.1)
Requirement already satisfied: nvidia-cuda-runtime-cu11==11.7.99 in /home/jskrajny/PycharmProjects/xai_team/venv/lib/python3.8/site-packages (from torch>=1.6->captum) (11.7.99)
Requirement already satisfied: nvidia-cudnn-cu11==8.5.0.96 in /home/jskrajny/PycharmProjects/xai_team/venv/lib/python3.8/site-packages (from torch>=1.6->captum) (8.5.0.96)
Requirement already satisfied: typing-extensions in /home/jskrajny/PycharmProjects/xai_team/venv/lib/python3.8/site-packages (from torch>=1.6->captum) (4.4.0)
Requirement already satisfied: nvidia-cublas-cu11==11.10.3.66 in /home/jskrajny/PycharmProjects/xai_team/venv/lib/python3.8/site-packages (from torch>=1.6->captum) (11.10.3.66)
Requirement already satisfied: nvidia-cuda-nvrtc-cu11==11.7.99 in /home/jskrajny/PycharmProjects/xai_team/venv/lib/python3.8/site-packages (from torch>=1.6->captum) (11.7.99)
Requirement already satisfied: setuptools in /home/jskrajny/PycharmProjects/xai_team/venv/lib/python3.8/site-packages (from nvidia-cublas-cu11==11.10.3.66->torch>=1.6->captum) (57.0.0)
Requirement already satisfied: wheel in /home/jskrajny/PycharmProjects/xai_team/venv/lib/python3.8/site-packages (from nvidia-cublas-cu11==11.10.3.66->torch>=1.6->captum) (0.36.2)
Requirement already satisfied: fonttools>=4.22.0 in /home/jskrajny/PycharmProjects/xai_team/venv/lib/python3.8/site-packages (from matplotlib->captum) (4.38.0)
Requirement already satisfied: packaging>=20.0 in /home/jskrajny/PycharmProjects/xai_team/venv/lib/python3.8/site-packages (from matplotlib->captum) (23.0)
Requirement already satisfied: cycler>=0.10 in /home/jskrajny/PycharmProjects/xai_team/venv/lib/python3.8/site-packages (from matplotlib->captum) (0.11.0)
Requirement already satisfied: python-dateutil>=2.7 in /home/jskrajny/PycharmProjects/xai_team/venv/lib/python3.8/site-packages (from matplotlib->captum) (2.8.2)
Requirement already satisfied: pyparsing>=2.2.1 in /home/jskrajny/PycharmProjects/xai_team/venv/lib/python3.8/site-packages (from matplotlib->captum) (3.0.9)
Requirement already satisfied: contourpy>=1.0.1 in /home/jskrajny/PycharmProjects/xai_team/venv/lib/python3.8/site-packages (from matplotlib->captum) (1.0.7)
Requirement already satisfied: pillow>=6.2.0 in /home/jskrajny/PycharmProjects/xai_team/venv/lib/python3.8/site-packages (from matplotlib->captum) (9.4.0)
Requirement already satisfied: kiwisolver>=1.0.1 in /home/jskrajny/PycharmProjects/xai_team/venv/lib/python3.8/site-packages (from matplotlib->captum) (1.4.4)
Requirement already satisfied: six>=1.5 in /home/jskrajny/PycharmProjects/xai_team/venv/lib/python3.8/site-packages (from python-dateutil>=2.7->matplotlib->captum) (1.16.0)
WARNING: You are using pip version 21.1.2; however, version 22.3.1 is available.
You should consider upgrading via the '/home/jskrajny/PycharmProjects/xai_team/venv/bin/python -m pip install --upgrade pip' command.
In [2]:import numpy as np
        import pandas as pd
        import sklearn.model_selection as model_selection

        import torch
        import torchtuples

        import sksurv.datasets as datasets
        import sksurv.linear_model as linear_model
```

```
import sksurv.ensemble as ensemble
import sksurv.functions as functions

import pycox
from pycox.datasets import metabric, nwtco
import pycox.evaluation as evaluation

import captum.attr as attr
import survshap

import matplotlib.pyplot as plt

import torchtuples as tt
```

In [3]:
```
class DeepHitSingleWrapper:
    def __init__(self, net, optim):
        self.net = net
        self.optim = optim

    def fit(self, train_data, train_target, val_data, val_target, callbacks, epochs=10):
        cuts = self.net.net[-1].out_features
        lt = pycox.models.DeepHitSingle.label_transform(cuts)

        train_data = train_data.values
        train_target = lt.fit_transform(train_target["duration"], train_target["event"])

        val_data = val_data.values
        val_target = lt.transform(val_target["duration"], val_target["event"])

        self.model = pycox.models.DeepHitSingle(self.net, self.optim, device='cpu', duration_index=lt.cuts)
        log = self.model.fit(train_data, train_target, 256, epochs=epochs, callbacks=callbacks, val_data=(val_data, val_target))

        self.event_times_ = lt.cuts

        return log

    def predict_surv_df(self, data):
        return self.model.predict_surv_df(data.values)

    def score(self, data, target):
        surv_df = self.predict_surv_df(data)
        eval_surv = evaluation.EvalSurv(surv_df, target["duration"], target["event"])

        return eval_surv.concordance_td()

    def predict_survival_function(self, data):
        surv_df = self.predict_surv_df(data)
        ret = [functions.StepFunction(surv_df.index.values, values) for values in surv_df.T.values]

        return np.array(ret)
```

In [4]:
```
import time


class Wrapper:
    def __init__(self, model, data, explainer):
        self.model = model
        self.baseline = torch.zeros(data.values.shape)
        self.explainer = explainer(self.model.net)

    def __call__(self, observation):
        data = torch.tensor(observation.values)

        attributions = []
        st = time.time()
        for i in range(len(self.model.event_times_)):
            attribution = self.explainer.attribute(data, self.baseline, i).detach().numpy()
            attributions.append(attribution)
        attributions = np.stack(attributions, axis=2)

        print(f"Explainer working time in seconds = {time.time() - st}")

        step_functions = {}
        for i, column in enumerate(observation.columns):
            step_functions[column] = [
                functions.StepFunction(self.model.event_times_, np.cumsum(attributions[j, i])) \
                for j in range(len(observation))
            ]

        return pd.DataFrame(step_functions)
```

In [5]:
```
class DeepLiftShapWrapper(Wrapper):
    def __init__(self, model, data):
        super(DeepLiftShapWrapper, self).__init__(model, data, attr.DeepLiftShap)

        self.model = model
        self.baseline = torch.randn(data.values.shape) * 0.001
        self.explainer = attr.DeepLiftShap(self.model.net)
```

In [6]:
```
class DeepLiftWrapper(Wrapper):
    def __init__(self, model, data):
        super(DeepLiftWrapper, self).__init__(model, data, attr.DeepLift)

        self.model = model
        self.baseline = torch.zeros((1, data.values.shape[1]))
        self.explainer = attr.DeepLift(self.model.net)
```

In [7]:
```
class IntegratedGradientsWrapper(Wrapper):
    def __init__(self, model, data):
        super(IntegratedGradientsWrapper, self).__init__(model, data, attr.DeepLiftShap)

        self.model = model
        self.baseline = torch.zeros((1, data.values.shape[1]))
        self.explainer = attr.IntegratedGradients(self.model.net)
```

In [8]:
```
class SurvShapWrapper:
    def __init__(self, model, data, target):
        self.model = model
        self.explainer = survshap.SurvivalModelExplainer(self.model, data, target)

    def __call__(self, observation):
        surv_shap = survshap.PredictSurvSHAP()
        st = time.time()
        surv_shap.fit(self.explainer, observation, self.model.event_times_)
        print(f"Explainer working time in seconds = {time.time() - st}")
        result = surv_shap.result

        step_functions = {}
        for name, group in result.groupby(by="variable_name"):
            step_functions[name] = [
                functions.StepFunction(self.model.event_times_, attributions)
                for attributions in group.iloc[:, 5:].values
            ]

        return pd.DataFrame(step_functions)
```

In [9]:
```
def plot(results):
    Xs = [result.x for result in results]
    Ys = [result.y for result in results]
    labels = list(results.index)

    plt.plot(np.array(Xs).T, np.array(Ys).T, label=labels)
    plt.legend(bbox_to_anchor=(1, 1))
```

METABRIC EXPERIMENT - The Molecular Taxonomy of Breast Cancer International Consortium

x0 - MKI67 x1 - EGFR x2 - PGR x3 - ERBB2 x4 - hormone treatment indicator x5 - radiotherapy indicator x6 - chemotherapy indicator x7 - ER-positive indicator x8 - age at diagnosis

In [24]:
```
df = metabric.read_df()

data, target = datasets.get_x_y(df, attr_labels=["event", "duration"], pos_label=1)
train_data, test_data, train_target, test_target = model_selection.train_test_split(data, target)

for feature_name in train_data.columns:
    max_value = train_data[feature_name].max()
    min_value = train_data[feature_name].min()
    train_data[feature_name] = (train_data[feature_name] - min_value) / (max_value - min_value)
    test_data[feature_name] = (test_data[feature_name] - min_value) / (max_value - min_value)
train_data, train_target
```

Out[24]:(x0   x1   x2   x3   x4   x5   x6   x7   x8
          493   0.024114 0.094836 0.668063 0.499578 1.0 0.0 0.0 1.0 0.571140
          507   0.063961 0.802279 0.503265 0.203685 1.0 1.0 0.0 1.0 0.567375
          405   0.211244 0.365733 0.555867 0.240377 0.0 0.0 0.0 1.0 0.243545
          67   0.226682 0.117200 0.416762 0.232201 1.0 0.0 0.0 1.0 0.399274
          1112 0.091678 0.414578 0.517204 0.225913 0.0 1.0 0.0 1.0 0.550968
          ...   .
          525   0.239324 0.218224 0.487622 0.127104 1.0 0.0 0.0 1.0 0.651156
          354   0.348225 0.127246 0.498213 0.751849 1.0 0.0 1.0 0.0 0.422539
          1680 0.073574 0.390495 0.634369 0.523202 1.0 1.0 0.0 1.0 0.528376
          1155 0.069091 0.313804 0.643573 0.655238 1.0 1.0 0.0 1.0 0.675632
          996   0.086551 0.132912 0.485925 0.384221 1.0 1.0 1.0 1.0 0.410167

          [1428 rows x 9 columns],
          array([(False, 111.6333313), (True, 199.2666626),
                 (False, 197.43333435), ..., (True, 87.23332977),
                 (True, 163.19999695), (True, 18.93333244)],
                dtype=[('event', '?'), ('duration', '<f8')]))

TRAINING

METABRIC - RANDOM FOREST

In [11]:
```
random_survival_forest = ensemble.RandomSurvivalForest()
random_survival_forest.fit(train_data, train_target)

print(f"Train score = {random_survival_forest.score(train_data, train_target)}")
print(f"Test score = {random_survival_forest.score(test_data, test_target)}")
```

Train score = 0.8902796057049234
Test score = 0.6239168334732356

METABRIC - COXPH

In [12]:
```
CoxPH_survival_analysis = linear_model.CoxPHSurvivalAnalysis()
CoxPH_survival_analysis.fit(train_data, train_target)

print(f"Train score = {CoxPH_survival_analysis.score(train_data, train_target)}")
print(f"Test score = {CoxPH_survival_analysis.score(test_data, test_target)}")
```

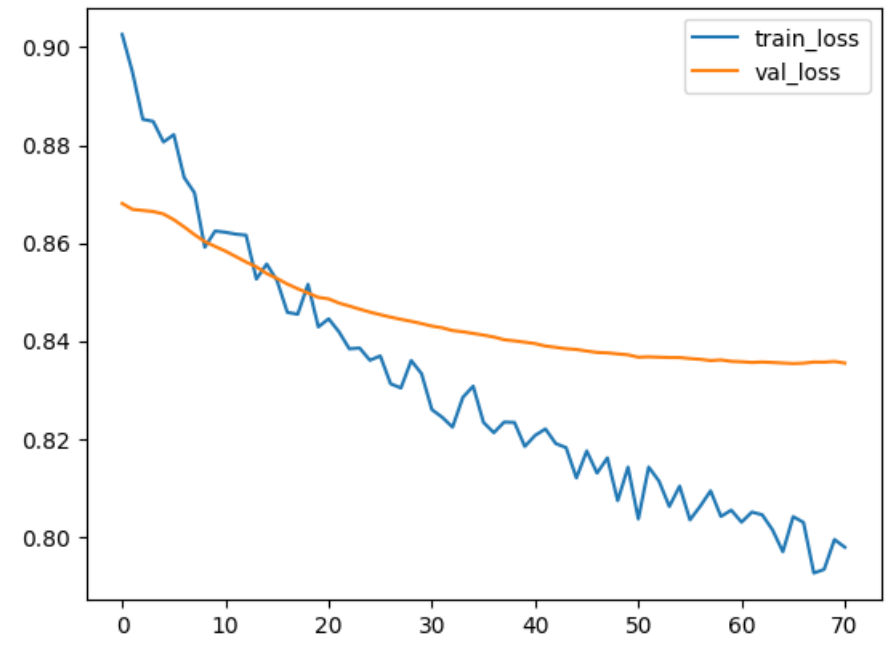
Train score = 0.650540226099077
Test score = 0.6033318266933557

METABRIC - DEEPHIT

In [26]:
```
net = torchtuples.practical.MLPVanilla(train_data.shape[1], [16, 16], 100)
optim = torch.optim.Adam(net.parameters(), lr=5e-4)

deep_hit_single = DeepHitSingleWrapper(net, optim)
log = deep_hit_single.fit(train_data, train_target, test_data, test_target, [tt.callbacks.EarlyStopping(patience=5)], epochs=100)

print(f"Train score = {deep_hit_single.score(train_data, train_target)}")
print(f"Test score = {deep_hit_single.score(test_data, test_target)}")

_ = log.plot()
```

0: [0s / 0s], train_loss: 0.9026, val_loss: 0.8681
1: [0s / 0s], train_loss: 0.8949, val_loss: 0.8669
2: [0s / 0s], train_loss: 0.8853, val_loss: 0.8666
3: [0s / 0s], train_loss: 0.8848, val_loss: 0.8664
4: [0s / 0s], train_loss: 0.8806, val_loss: 0.8659
5: [0s / 0s], train_loss: 0.8821, val_loss: 0.8648
6: [0s / 0s], train_loss: 0.8734, val_loss: 0.8633
7: [0s / 0s], train_loss: 0.8703, val_loss: 0.8617
8: [0s / 0s], train_loss: 0.8591, val_loss: 0.8603
9: [0s / 0s], train_loss: 0.8624, val_loss: 0.8593
10: [0s / 1s], train_loss: 0.8622, val_loss: 0.8583
11: [0s / 1s], train_loss: 0.8618, val_loss: 0.8572
12: [0s / 1s], train_loss: 0.8616, val_loss: 0.8561
13: [0s / 1s], train_loss: 0.8526, val_loss: 0.8551
14: [0s / 1s], train_loss: 0.8557, val_loss: 0.8538
15: [0s / 1s], train_loss: 0.8523, val_loss: 0.8527
16: [0s / 1s], train_loss: 0.8458, val_loss: 0.8516
17: [0s / 1s], train_loss: 0.8455, val_loss: 0.8507
18: [0s / 1s], train_loss: 0.8516, val_loss: 0.8498
19: [0s / 1s], train_loss: 0.8429, val_loss: 0.8489
20: [0s / 1s], train_loss: 0.8445, val_loss: 0.8486
21: [0s / 1s], train_loss: 0.8419, val_loss: 0.8477
22: [0s / 1s], train_loss: 0.8384, val_loss: 0.8471
23: [0s / 1s], train_loss: 0.8385, val_loss: 0.8465
24: [0s / 1s], train_loss: 0.8360, val_loss: 0.8459

25: [0s / 1s], train_loss: 0.8369, val_loss: 0.8454
26: [0s / 2s], train_loss: 0.8312, val_loss: 0.8449
27: [0s / 2s], train_loss: 0.8304, val_loss: 0.8444
28: [0s / 2s], train_loss: 0.8360, val_loss: 0.8440
29: [0s / 2s], train_loss: 0.8333, val_loss: 0.8435
30: [0s / 2s], train_loss: 0.8260, val_loss: 0.8430
31: [0s / 2s], train_loss: 0.8244, val_loss: 0.8427
32: [0s / 2s], train_loss: 0.8224, val_loss: 0.8421
33: [0s / 2s], train_loss: 0.8285, val_loss: 0.8419
34: [0s / 2s], train_loss: 0.8307, val_loss: 0.8415
35: [0s / 2s], train_loss: 0.8234, val_loss: 0.8412
36: [0s / 2s], train_loss: 0.8212, val_loss: 0.8408
37: [0s / 2s], train_loss: 0.8234, val_loss: 0.8402
38: [0s / 2s], train_loss: 0.8233, val_loss: 0.8400
39: [0s / 2s], train_loss: 0.8184, val_loss: 0.8397
40: [0s / 2s], train_loss: 0.8207, val_loss: 0.8394
41: [0s / 2s], train_loss: 0.8220, val_loss: 0.8389
42: [0s / 2s], train_loss: 0.8190, val_loss: 0.8387
43: [0s / 2s], train_loss: 0.8182, val_loss: 0.8384
44: [0s / 2s], train_loss: 0.8120, val_loss: 0.8382
45: [0s / 2s], train_loss: 0.8175, val_loss: 0.8379
46: [0s / 2s], train_loss: 0.8130, val_loss: 0.8376
47: [0s / 2s], train_loss: 0.8161, val_loss: 0.8376
48: [0s / 2s], train_loss: 0.8074, val_loss: 0.8373
49: [0s / 2s], train_loss: 0.8142, val_loss: 0.8372
50: [0s / 2s], train_loss: 0.8036, val_loss: 0.8367
51: [0s / 2s], train_loss: 0.8142, val_loss: 0.8367
52: [0s / 2s], train_loss: 0.8114, val_loss: 0.8367
53: [0s / 2s], train_loss: 0.8062, val_loss: 0.8366
54: [0s / 2s], train_loss: 0.8103, val_loss: 0.8366
55: [0s / 2s], train_loss: 0.8034, val_loss: 0.8364
56: [0s / 2s], train_loss: 0.8062, val_loss: 0.8362
57: [0s / 2s], train_loss: 0.8094, val_loss: 0.8360
58: [0s / 2s], train_loss: 0.8041, val_loss: 0.8361
59: [0s / 2s], train_loss: 0.8054, val_loss: 0.8358
60: [0s / 2s], train_loss: 0.8030, val_loss: 0.8357
61: [0s / 3s], train_loss: 0.8050, val_loss: 0.8356
62: [0s / 3s], train_loss: 0.8045, val_loss: 0.8357
63: [0s / 3s], train_loss: 0.8014, val_loss: 0.8356
64: [0s / 3s], train_loss: 0.7969, val_loss: 0.8355
65: [0s / 3s], train_loss: 0.8041, val_loss: 0.8354
66: [0s / 3s], train_loss: 0.8029, val_loss: 0.8355
67: [0s / 3s], train_loss: 0.7926, val_loss: 0.8357
68: [0s / 3s], train_loss: 0.7933, val_loss: 0.8357
69: [0s / 3s], train_loss: 0.7994, val_loss: 0.8358
70: [0s / 3s], train_loss: 0.7979, val_loss: 0.8355
Train score = 0.6844028757915686
Test score = 0.6570948804394517
/home/jskrajny/PycharmProjects/xai_team/venv/lib/python3.8/site-packages/pycox/evaluation/eval_surv.py:36: FutureWarning: is_monotonic is deprecated and will be removed in a future version. Use is_monotonic_increasing instead.
  assert pd.Series(self.index_surv).is_monotonic
/home/jskrajny/PycharmProjects/xai_team/venv/lib/python3.8/site-packages/pycox/evaluation/eval_surv.py:36: FutureWarning: is_monotonic is deprecated and will be removed in a future version. Use is_monotonic_increasing instead.
  assert pd.Series(self.index_surv).is_monotonic

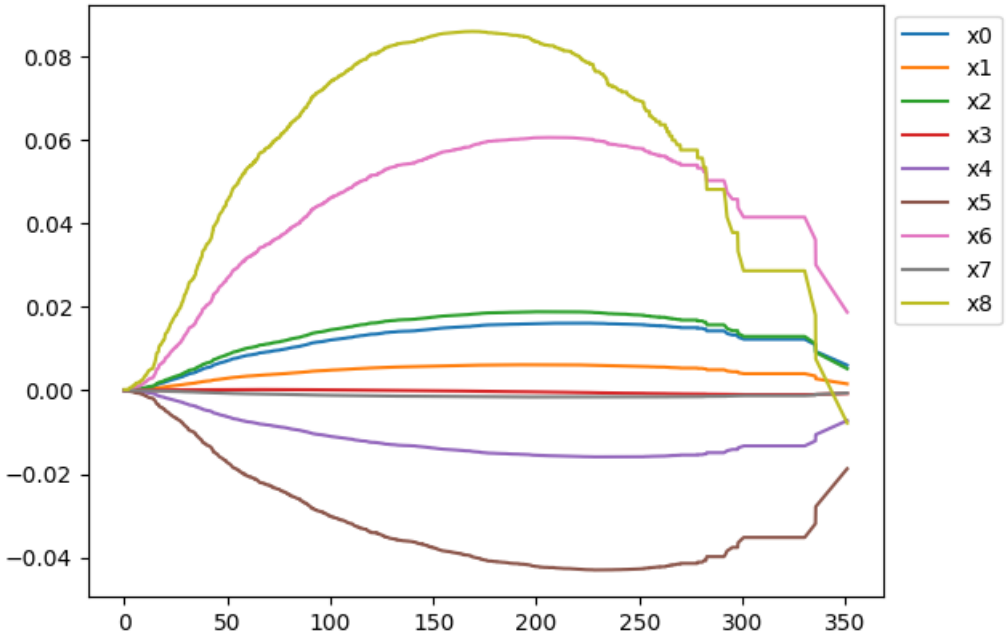


EXPLAINING

METABRIC - SURVSHAP - COXPH

In [14]:
```
surv_shap_wrapper = SurvShapWrapper(CoxPH_survival_analysis, test_data, test_target)
surv_shap_results = surv_shap_wrapper(test_data.iloc[[0]]).iloc[0]

plot(surv_shap_results)
```

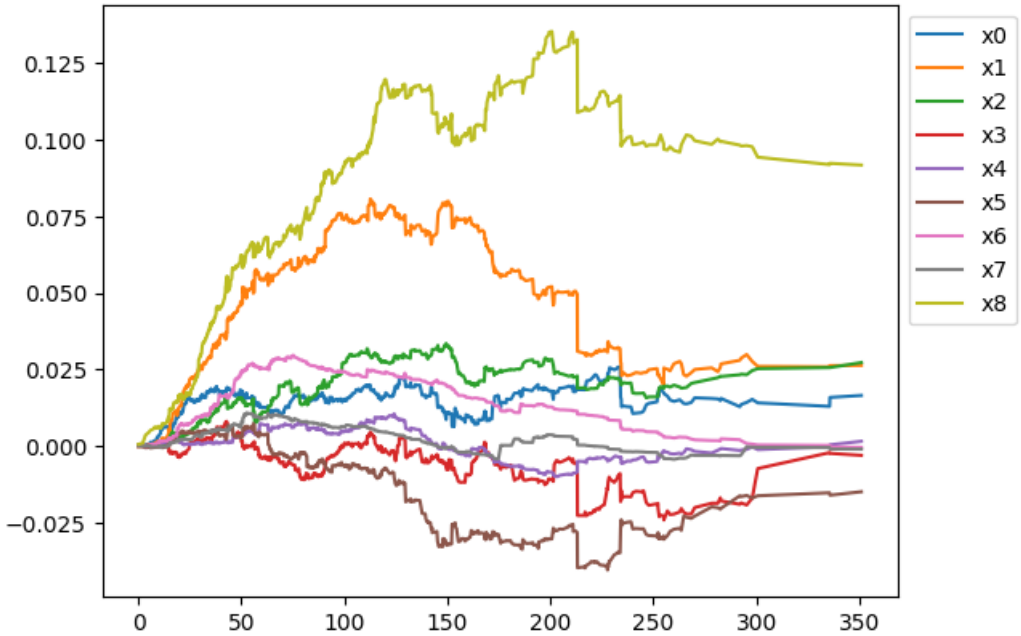
Explainer working time in seconds = 24.846624612808228



METABRIC - SURVSHAP - RANDOM FOREST

In [15]:
```
surv_shap_wrapper = SurvShapWrapper(random_survival_forest, test_data, test_target)
surv_shap_results = surv_shap_wrapper(test_data.iloc[[0]]).iloc[0]

plot(surv_shap_results)
```

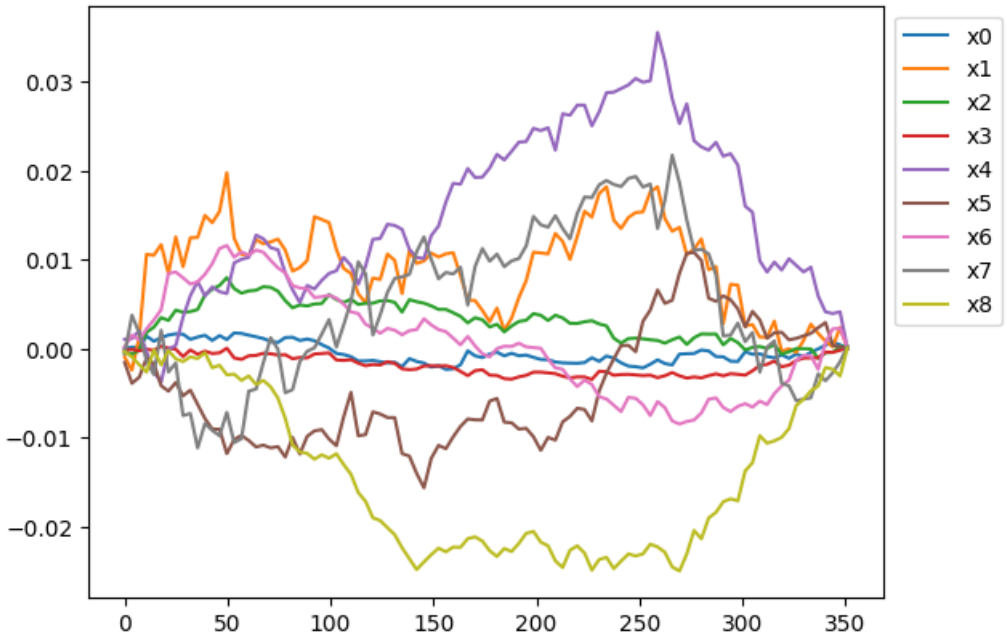
Explainer working time in seconds = 67.68577146530151



METABRIC - SURVSHAP - DEEPHIT

In [27]:
```
surv_shap_wrapper = SurvShapWrapper(deep_hit_single, test_data, test_target)
surv_shap_results = surv_shap_wrapper(test_data.iloc[[0]]).iloc[0]

plot(surv_shap_results)
```

Explainer working time in seconds = 11.042371273040771

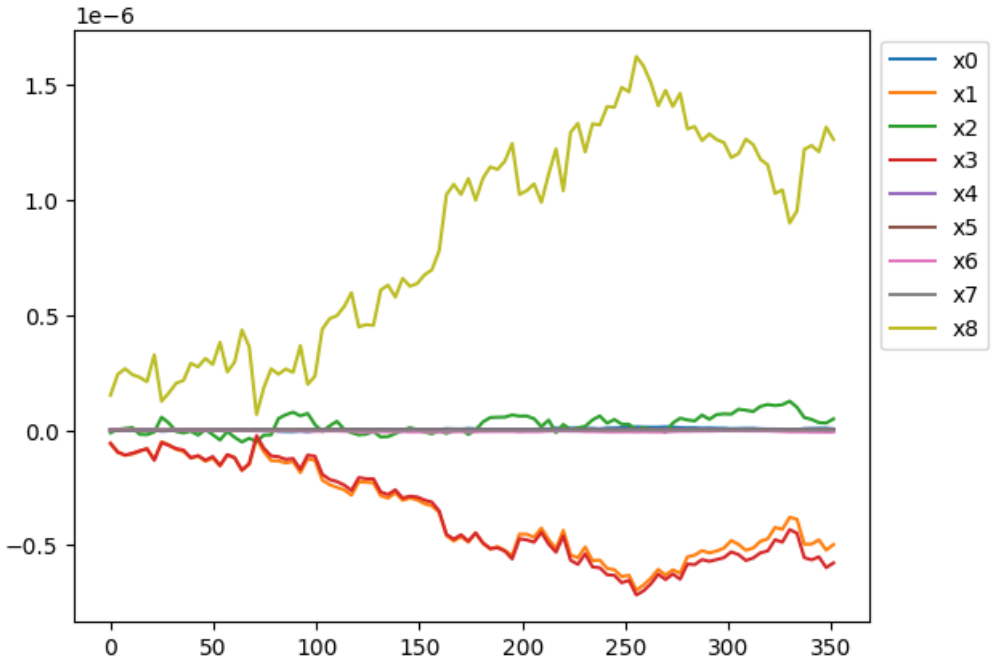


METABRIC - DEEPLIFT - DEEPHIT

In [28]:
```
deep_lift_shap_wrapper = DeepLiftShapWrapper(deep_hit_single, test_data)
deep_lift_shap_results = deep_lift_shap_wrapper(test_data.iloc[[0]]).iloc[0]

plot(deep_lift_shap_results)
```

```
/home/jskrajny/PycharmProjects/xai_team/venv/lib/python3.8/site-packages/captum/attr/_core/deep_lift.py:304: UserWarning: Setting forward, backward hooks and attributes on non-linear
    activations. The hooks and attributes will be removed
    after the attribution is finished
  warnings.warn(
```

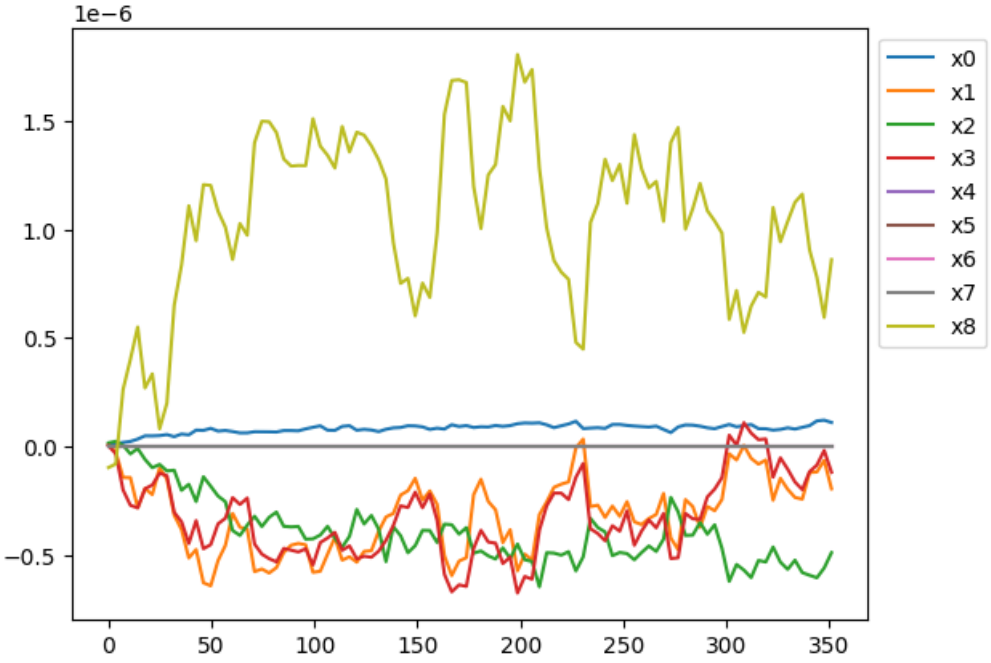
Explainer working time in seconds = 0.8885498046875



METABRIC - INTEGRATED GRADIENT - DEEPHIT

In [29]:
```
integrated_gradient_wrapper = IntegratedGradientsWrapper(deep_hit_single, test_data)
integrated_gradient_results = integrated_gradient_wrapper(test_data.iloc[[0]]).iloc[0]

plot(integrated_gradient_results)
```

Explainer working time in seconds = 1.3948235511779785



SUPPORT EXPERIMENT - Study to Understand Prognoses Preferences Outcomes and Risks of Treatment

x0 - age x1 - sex x2 - race x3 - number of comorbidities x4 - presence of diabetes x5 - presence of dementia x6 - presence of cancer x7 - mean arterial blood pressure x8 - heart rate x9 - respiration rate x10 - temperature x11 - white blood cell count x12 - serum's sodium x13 - and serum's creatinine

In [30]:
```
from pycox.datasets import support

    df = support.read_df()
    data, target = datasets.get_x_y(df, attr_labels=["event", "duration"], pos_label=1)
    train_data, test_data, train_target, test_target = model_selection.train_test_split(data, target)

    for feature_name in train_data.columns:
        max_value = train_data[feature_name].max()
        min_value = train_data[feature_name].min()
        train_data[feature_name] = (train_data[feature_name] - min_value) / (max_value - min_value)
        test_data[feature_name] = (test_data[feature_name] - min_value) / (max_value - min_value)
    train_data, train_target
```

Out[30]:(

	x0	x1	x2	x3	x4	x5	x6	x7	x8	x9	x10	x11	x12	x13
3438	0.155251	1.0	0.222222	0.2	0.0	0.0	1.0	0.261538	0.536	0.133333	0.660024	0.548387	0.004500	0.088785
3219	0.529306	0.0	0.222222	0.2	0.0	0.0	0.0	0.369231	0.300	0.100000	0.509965	0.451613	0.103984	0.060744
7268	0.620719	0.0	0.444444	0.6	1.0	0.0	0.5	0.569231	0.320	0.177778	0.420086	0.370968	0.036997	0.121482
141	0.722872	1.0	0.555556	0.2	0.0	0.0	0.5	0.333333	0.400	0.311111	0.480266	0.387097	0.028999	0.032707
4305	0.550999	1.0	0.222222	0.2	0.0	0.0	0.0	0.312821	0.404	0.244444	0.470106	0.435484	0.053994	0.023364
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
3269	0.475169	0.0	0.111111	0.2	0.0	0.0	0.5	0.384615	0.248	0.466667	0.470106	0.564516	0.070996	0.032707
4067	0.644297	1.0	0.333333	0.2	0.0	0.0	0.5	0.466667	0.384	0.244444	0.470106	0.370968	0.047500	0.037379
2458	0.155025	1.0	0.111111	0.2	0.0	0.0	1.0	0.564103	0.496	0.355556	0.730364	0.564516	0.057998	0.065421
4351	0.442964	0.0	0.222222	0.2	0.0	0.0	0.5	0.271795	0.468	0.322222	0.749902	0.596774	0.092988	0.056066
5779	0.553027	1.0	0.000000	0.2	0.0	0.0	0.5	0.512821	0.520	0.266667	0.570145	0.483871	0.035000	0.028036

[6654 rows x 14 columns],
array([(False, 1305.), (True, 4.), (True, 266.), ...,
(True, 47.), (True, 30.), (True, 6.)],
dtype=[('event', '?'), ('duration', '<f8')]))

TRAINING

SUPPORT - RANDOM FOREST

In [31]:
```
random_survival_forest = ensemble.RandomSurvivalForest()
random_survival_forest.fit(train_data, train_target)

print(f"Train score = {random_survival_forest.score(train_data, train_target)}")
print(f"Test score = {random_survival_forest.score(test_data, test_target)}")
```

```
Train score = 0.8389961262109014
Test score = 0.6139028974092138
```

SUPPORT - COXPH

In [39]:
```
CoxPH_survival_analysis = linear_model.CoxPHSurvivalAnalysis()
CoxPH_survival_analysis.fit(train_data, train_target)

print(f"Train score = {CoxPH_survival_analysis.score(train_data, train_target)}")
print(f"Test score = {CoxPH_survival_analysis.score(test_data, test_target)}")
```

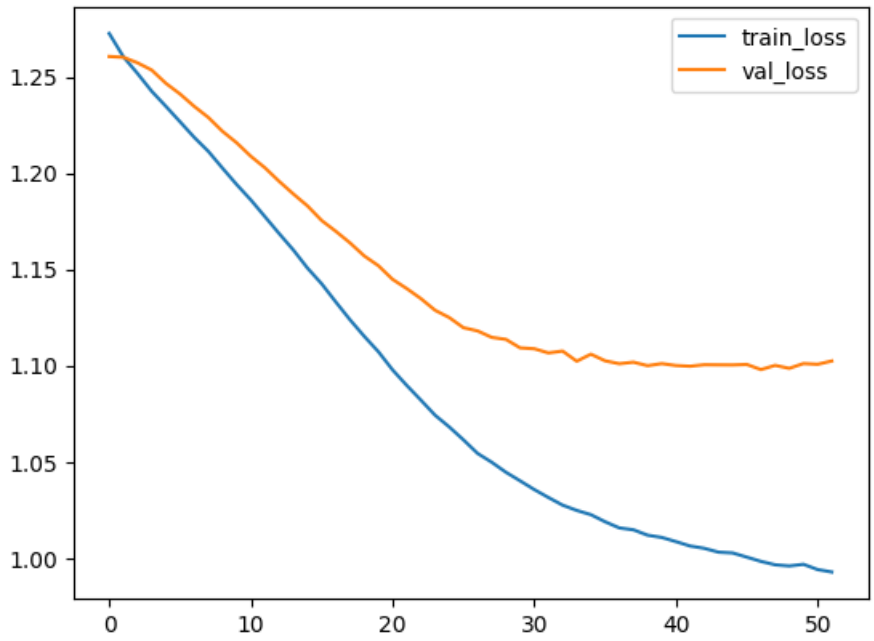
```
Train score = 0.5733937411854154
Test score = 0.5654284451862205
```

SUPPORT - DEEPHIT

In [33]:
```
net = torchtuples.practical.MLPVanilla(train_data.shape[1], [32, 32], 500)
optim = torch.optim.Adam(net.parameters(), lr=5e-4)

deep_hit_single = DeepHitSingleWrapper(net, optim)
log = deep_hit_single.fit(train_data, train_target, test_data, test_target, [tt.callbacks.EarlyStopping(patience=5)], epochs=100)

print(f"Train score = {deep_hit_single.score(train_data, train_target)}")
print(f"Test score = {deep_hit_single.score(test_data, test_target)}")

_ = log.plot()
```

```
0: [0s / 0s],  train_loss: 1.2725, val_loss: 1.2605
1: [0s / 0s],  train_loss: 1.2604, val_loss: 1.2601
2: [0s / 0s],  train_loss: 1.2517, val_loss: 1.2572
3: [0s / 1s],  train_loss: 1.2425, val_loss: 1.2535
4: [0s / 1s],  train_loss: 1.2346, val_loss: 1.2466
5: [0s / 2s],  train_loss: 1.2266, val_loss: 1.2411
6: [0s / 2s],  train_loss: 1.2185, val_loss: 1.2346
7: [0s / 2s],  train_loss: 1.2112, val_loss: 1.2289
8: [0s / 3s],  train_loss: 1.2025, val_loss: 1.2216
9: [0s / 3s],  train_loss: 1.1940, val_loss: 1.2157
10: [0s / 3s],  train_loss: 1.1860, val_loss: 1.2087
11: [0s / 4s],  train_loss: 1.1772, val_loss: 1.2027
12: [0s / 4s],  train_loss: 1.1685, val_loss: 1.1956
13: [0s / 4s],  train_loss: 1.1600, val_loss: 1.1891
14: [0s / 4s],  train_loss: 1.1506, val_loss: 1.1829
15: [0s / 5s],  train_loss: 1.1424, val_loss: 1.1753
16: [0s / 5s],  train_loss: 1.1329, val_loss: 1.1697
17: [0s / 5s],  train_loss: 1.1237, val_loss: 1.1637
18: [0s / 5s],  train_loss: 1.1152, val_loss: 1.1569
19: [0s / 6s],  train_loss: 1.1072, val_loss: 1.1518
20: [0s / 6s],  train_loss: 1.0977, val_loss: 1.1448
21: [0s / 6s],  train_loss: 1.0897, val_loss: 1.1400
22: [0s / 6s],  train_loss: 1.0820, val_loss: 1.1347
23: [0s / 7s],  train_loss: 1.0742, val_loss: 1.1287
24: [0s / 7s],  train_loss: 1.0681, val_loss: 1.1249
25: [1s / 9s],  train_loss: 1.0614, val_loss: 1.1196
26: [6s / 15s],  train_loss: 1.0543, val_loss: 1.1180
27: [2s / 18s],  train_loss: 1.0497, val_loss: 1.1146
28: [1s / 19s],  train_loss: 1.0445, val_loss: 1.1136
29: [1s / 21s],  train_loss: 1.0401, val_loss: 1.1092
30: [2s / 23s],  train_loss: 1.0356, val_loss: 1.1087
31: [2s / 25s],  train_loss: 1.0314, val_loss: 1.1065
32: [1s / 27s],  train_loss: 1.0275, val_loss: 1.1075
33: [1s / 28s],  train_loss: 1.0247, val_loss: 1.1022
34: [1s / 30s],  train_loss: 1.0225, val_loss: 1.1059
35: [0s / 31s],  train_loss: 1.0188, val_loss: 1.1024
36: [0s / 32s],  train_loss: 1.0156, val_loss: 1.1009
37: [1s / 33s],  train_loss: 1.0146, val_loss: 1.1017
38: [1s / 35s],  train_loss: 1.0118, val_loss: 1.0999
39: [1s / 36s],  train_loss: 1.0107, val_loss: 1.1010
40: [0s / 37s],  train_loss: 1.0085, val_loss: 1.1000
41: [0s / 38s],  train_loss: 1.0062, val_loss: 1.0996
42: [0s / 39s],  train_loss: 1.0050, val_loss: 1.1004
```

43: [0s / 40s], train_loss: 1.0030, val_loss: 1.1003
44: [1s / 41s], train_loss: 1.0026, val_loss: 1.1003
45: [1s / 42s], train_loss: 1.0004, val_loss: 1.1005
46: [1s / 43s], train_loss: 0.9982, val_loss: 1.0979
47: [0s / 44s], train_loss: 0.9965, val_loss: 1.1001
48: [1s / 45s], train_loss: 0.9959, val_loss: 1.0985
49: [1s / 47s], train_loss: 0.9967, val_loss: 1.1010
50: [1s / 48s], train_loss: 0.9940, val_loss: 1.1006
51: [0s / 49s], train_loss: 0.9927, val_loss: 1.1023
/home/jskrajny/PycharmProjects/xai_team/venv/lib/python3.8/site-packages/pycox/evaluation/eval_surv.py:36: FutureWarning: is_monotonic is deprecated and will be removed in a future version. Use is_monotonic_increasing instead.
  assert pd.Series(self.index_surv).is_monotonic
Train score = 0.6316960621973184
Test score = 0.6061618142280903
/home/jskrajny/PycharmProjects/xai_team/venv/lib/python3.8/site-packages/pycox/evaluation/eval_surv.py:36: FutureWarning: is_monotonic is deprecated and will be removed in a future version. Use is_monotonic_increasing instead.
  assert pd.Series(self.index_surv).is_monotonic



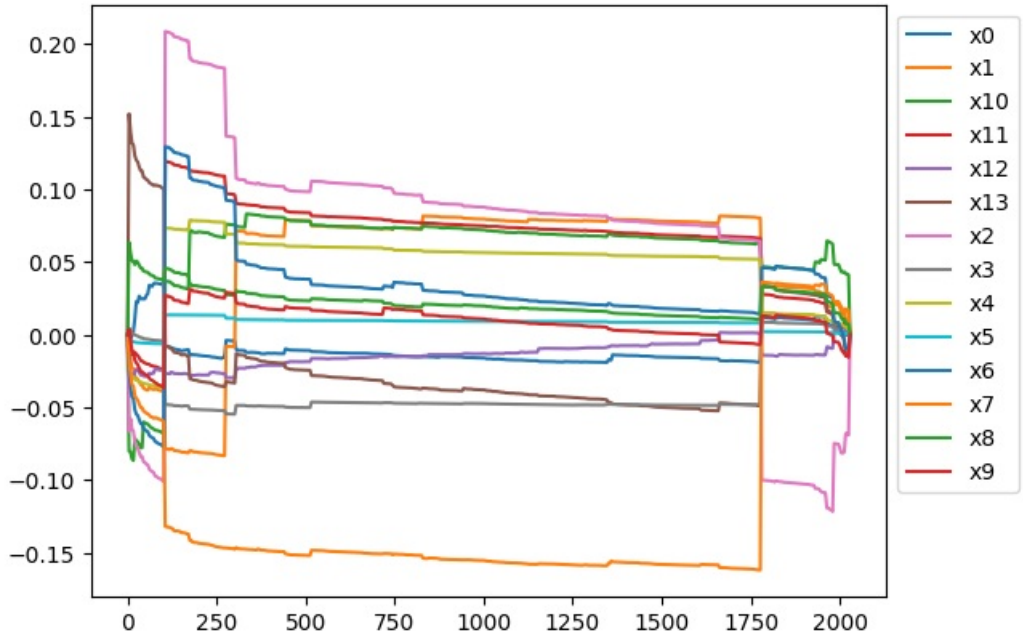
EXPLAINING

SUPPORT - SURVSHAP - COXPH

In [40]:urv_shap_wrapper = SurvShapWrapper(CoxPH_survival_analysis, test_data, test_target)
        surv_shap_results = surv_shap_wrapper(test_data.iloc[[0]]).iloc[0]

        plot(surv_shap_results)

Explainer working time in seconds = 1387.2153100967407

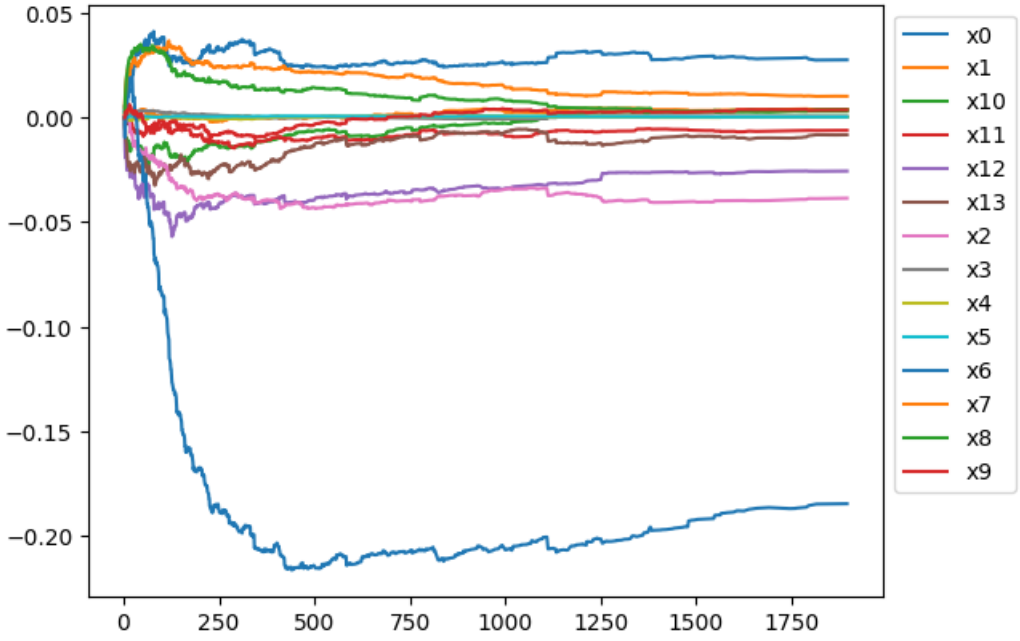


SUPPORT - SURVSHAP - RANDOM FOREST

In [41]:surv_shap_wrapper = SurvShapWrapper(random_survival_forest, test_data, test_target)

```
surv_shap_results = surv_shap_wrapper(test_data.iloc[[0]]).iloc[0]

plot(surv_shap_results)
```

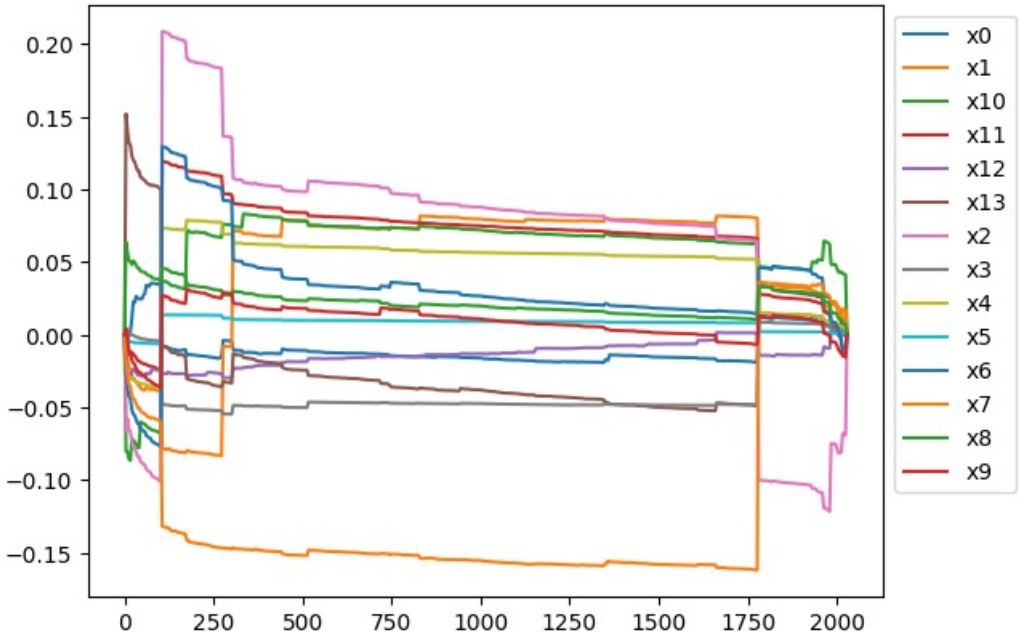
Explainer working time in seconds = 8662.64719581604



SUPPORT - SURVSHAP - DEEPHIT

In [42]:
```
surv_shap_wrapper = SurvShapWrapper(deep_hit_single, test_data, test_target)
surv_shap_results = surv_shap_wrapper(test_data.iloc[[0]]).iloc[0]

plot(surv_shap_results)
```

Explainer working time in seconds = 1276.2100977897644

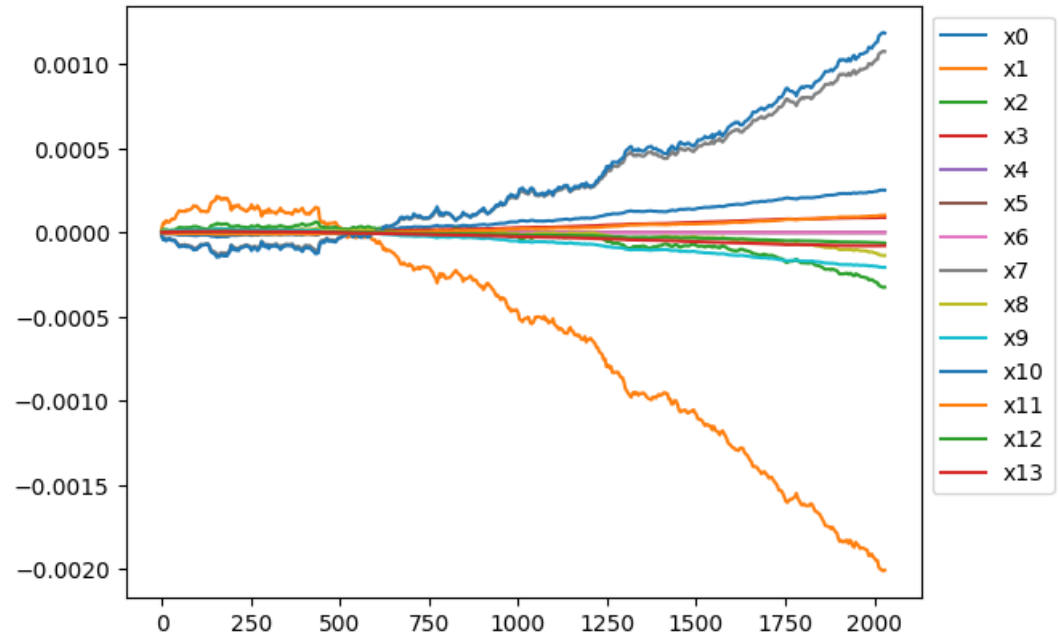


SUPPORT - DEEPLIFT - DEEPHIT

In [36]:
```
deep_lift_shap_wrapper = DeepLiftShapWrapper(deep_hit_single, test_data)
deep_lift_shap_results = deep_lift_shap_wrapper(test_data.iloc[[0]]).iloc[0]

plot(deep_lift_shap_results)
```

/home/jskrajny/PycharmProjects/xai_team/venv/lib/python3.8/site-packages/captum/attr/_core/deep_lift.py:304: UserWarning: Setting forward, backward hooks and attributes on non-linear
activations. The hooks and attributes will be removed
after the attribution is finished
warnings.warn(

Explainer working time in seconds = 37.401450872421265



SUPPORT - INTEGRATED GRADIENTS - DEEPHIT

In [37]:integrated_gradient_wrapper = IntegratedGradientsWrapper(deep_hit_single, test_data)
integrated_gradient_results = integrated_gradient_wrapper(test_data.iloc[[0]]).iloc[0]

plot(integrated_gradient_results)

Explainer working time in seconds = 4.688051462173462