ML in Applications

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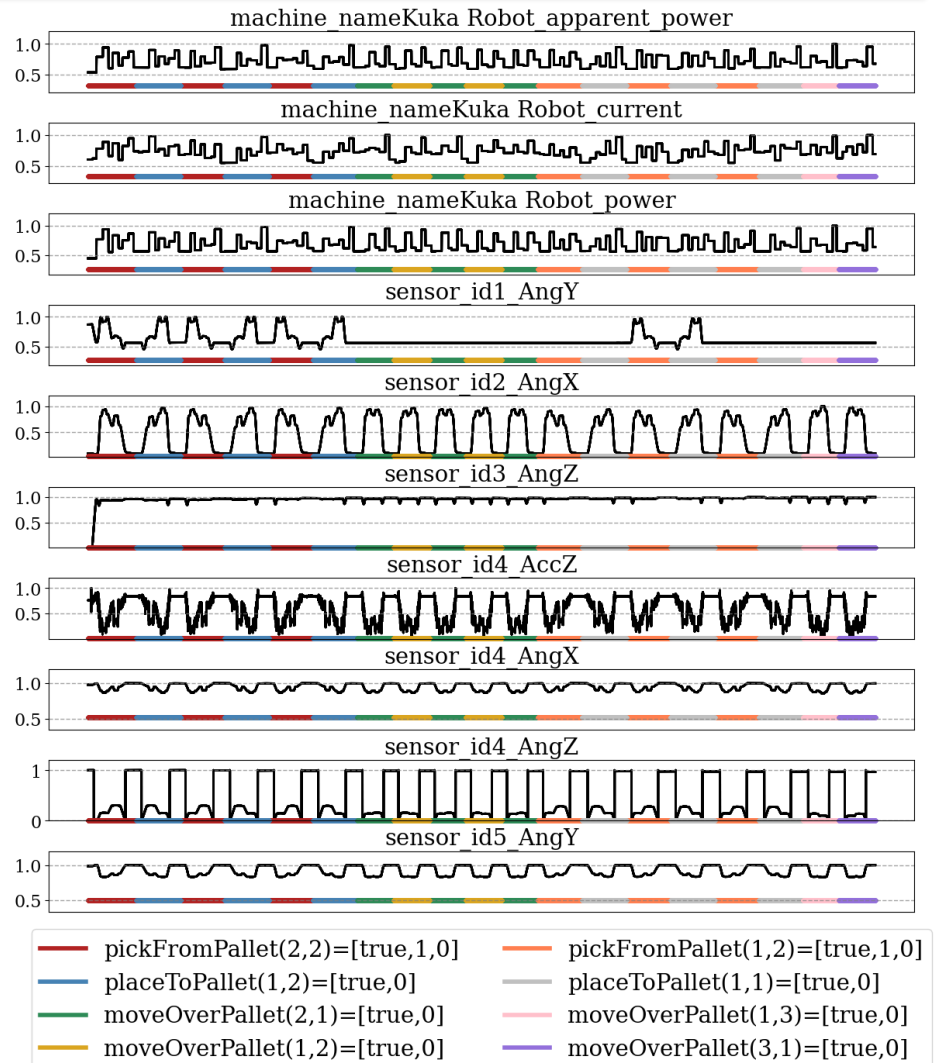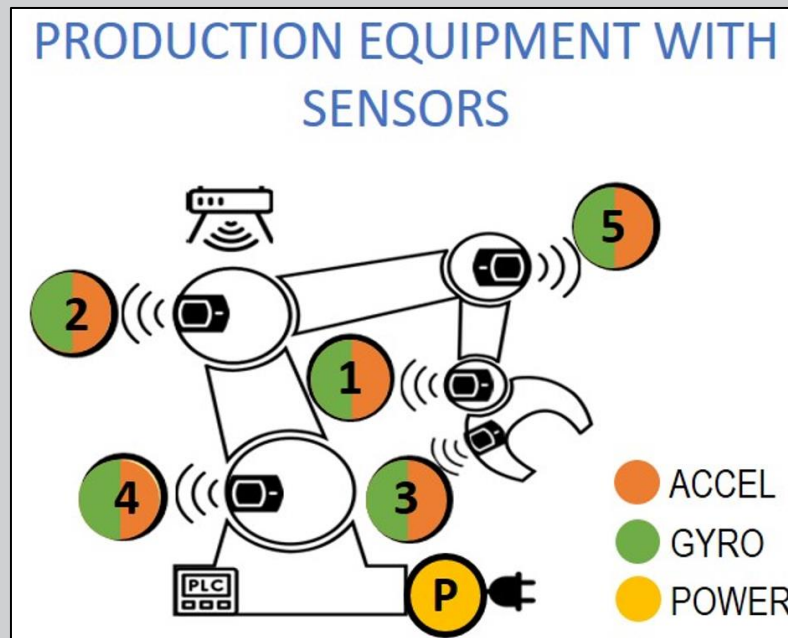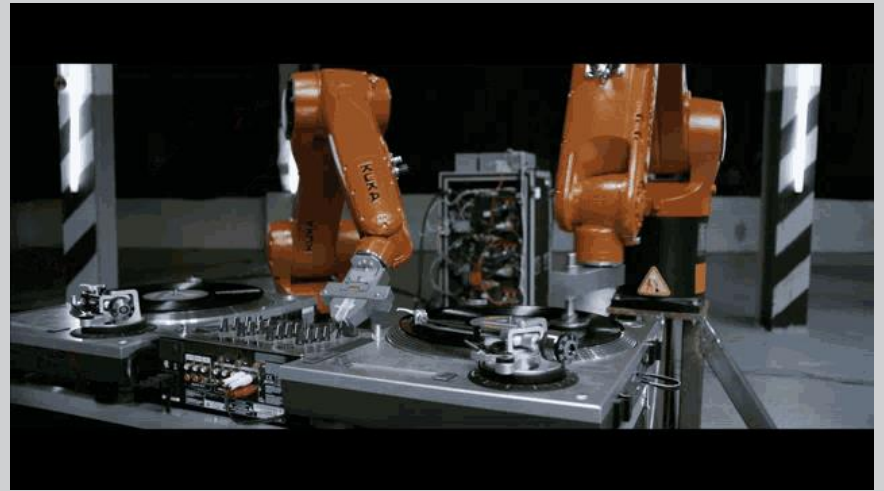
Lab 1

Time series classification

Time series

- Data series: **ordered sequence of data points**

- Describes property based on a **continuous measure** (e.g., temperature, position, speed, etc.)

- **If the order is based on time**: **time series**

- Only one variable, the time series is called **univariate**; otherwise, it is **multivariate**

Kuka robot

PRODUCTION EQUIPMENT WITH SENSORS

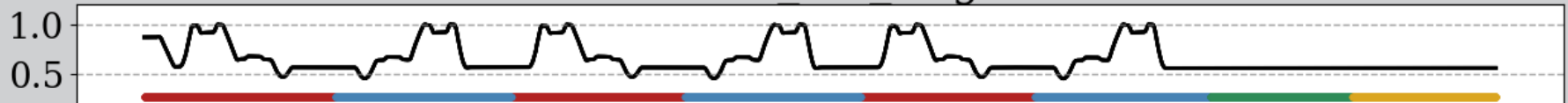source: https://www.kuka.com/en-us/products/robotics-systems/software/simulation-planning-optimization/kuka_sim

Dataset
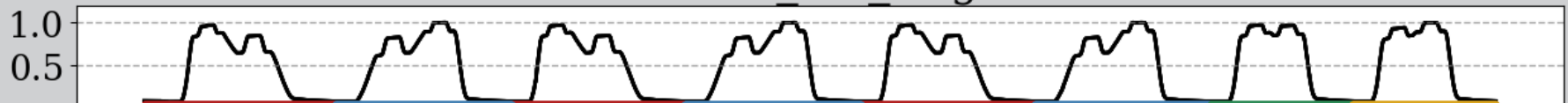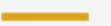

machine_nameKuka Robot_current

sensor_id1_AngY

sensor_id2_AngX

pickFromPallet(2,2)=[true,1,0]   moveOverPallet(2,1)=[true,0]
placeToPallet(1,2)=[true,0]   moveOverPallet(1,2)=[true,0]

source: https://www.kuka.com/en-us/products/robotics-systems/software/simulation-planning-optimization/kuka_sim

Dataset - .csv

75 columns: some of them will be dropped

n rows depending on sampling frequency (1, 10, 100, 200 Hz)

	A	B	C	D	E	F	G	H	I	J	K
1	time	sensor_id	sensor_id	sensor_id	sensor_id	sensor_id	machine_	sensor_id	sensor_id	sensor_id	sensor_id
2	2022-08-11T13:08:45.619094+00:00	5.94	0.63	304.19	1.72	1.33	0.0	304.28	0.18	0.44	307.0
3	2022-08-11T13:08:46.619094+00:00	5.96	0.67	304.21	1.74	1.32	0.0	304.29	0.19	0.46	307.03
4	2022-08-11T13:08:47.619094+00:00	5.97	0.68	304.2	1.73	1.34	0.0	304.27	0.19	0.43	307.02
5	2022-08-11T13:08:48.619094+00:00	5.97	0.64	304.2	1.76	1.33	0.0	304.31	0.18	0.44	307.05
6	2022-08-11T13:08:49.619094+00:00	5.92	0.64	304.23	1.73	1.33	0.0	304.3	0.18	0.43	306.99
7	2022-08-11T13:08:50.619094+00:00	5.95	0.59	304.22	1.72	1.33	0.0	304.3	0.17	0.41	307.0
8	2022-08-11T13:08:51.619094+00:00	5.91	0.65	304.23	1.74	1.34	0.0	304.32	0.16	0.44	307.0
9	2022-08-11T13:08:52.619094+00:00	5.93	0.64	304.2	1.76	1.33	0.0	304.29	0.22	0.42	307.02
10	2022-08-11T13:08:53.619094+00:00	5.93	0.61	304.22	1.75	1.35	0.0	304.31	0.19	0.43	307.02
11	2022-08-11T13:08:54.619094+00:00	5.91	0.63	304.21	1.74	1.35	0.0	304.3	0.21	0.45	30
12	2022-08-11T13:08:55.619094+00:00	5.95	0.63	304.23	1.74	1.33	0.0	304.31	0.2	0.42	30
13	2022-08-11T13:08:56.619094+00:00	5.92	0.64	304.23	1.75	1.33	0.0	304.29	0.19	0.43	307.01
14	2022-08-11T13:08:57.619094+00:00	5.94	0.63	304.22	1.74	1.35	0.0	304.29	0.16	0.45	307.03
15	2022-08-11T13:08:58.619094+00:00	5.94	0.64	304.21	1.76	1.33	0.0	304.32	0.19	0.44	307.0
16	2022-08-11T13:08:59.619094+00:00	5.92	0.61	304.24	1.73	1.34	0.0	304.32	0.17	0.45	307.03
17	2022-08-11T13:09:00.619094+00:00	5.95	0.64	304.2	1.72	1.35	0.0	304.29	0.19	0.44	307.0
18	2022-08-11T13:09:01.619094+00:00	5.95	0.59	304.22	1.75	1.34	0.0	304.31	0.16	0.45	307.01
19	2022-08-11T13:09:02.619094+00:00	5.92	0.63	304.21	1.74	1.34	0.0	304.3	0.19	0.43	307.02
20	2022-08-11T13:09:03.619094+00:00	5.95	0.63	304.19	1.77	1.33	0.0	304.29	0.19	0.44	307.01

[...]

Dataset - metadata

|	A	B	C	D	E	F
1	id	state_id	str_repr	init_timestamp	running_timestamp	completed_timestamp
2	RBTC_un	69793226882	pickFromPallet(2,2)=[true,1,0]	2022-08-11T13:09:50.231007+00:00	2022-08-11T13:09:50.277217+00:00	2022-08-11T13:10:02.283485+00:00
3	RBTC_un	1073750083	placeToPallet(1,2)=[true,0]	2022-08-11T13:10:02.283485+00:00	2022-08-11T13:10:02.301121+00:00	2022-08-11T13:10:13.331343+00:00
4	RBTC_un	69793226882	pickFromPallet(2,2)=[true,1,0]	2022-08-11T13:10:13.331343+00:00	2022-08-11T13:10:13.349625+00:00	2022-08-11T13:10:24.298139+00:00
5	RBTC_un	1073750083	placeToPallet(1,2)=[true,0]	2022-08-11T13:10:24.298139+00:00	2022-08-11T13:10:24.314347+00:00	2022-08-11T13:10:35.322945+00:00
6	RBTC_un	69793226882	pickFromPallet(2,2)=[true,1,0]	2022-08-11T13:10:35.322945+00:00	2022-08-11T13:10:35.345241+00:00	2022-08-11T13:10:46.332618+00:00
7	RBTC_un	1073750083	placeToPallet(1,2)=[true,0]	2022-08-11T13:10:46.332618+00:00	2022-08-11T13:10:46.454070+00:00	2022-08-11T13:10:57.353299+00:00
8	RBTC_un	1073746052	moveOverPallet(2,1)=[true,0]	2022-08-11T13:10:57.353299+00:00	2022-08-11T13:10:57.380528+00:00	2022-08-11T13:11:06.327109+00:00
9	RBTC_un	1073750084	moveOverPallet(1,2)=[true,0]	2022-08-11T13:11:06.327109+00:00	2022-08-11T13:11:06.351813+00:00	2022-08-11T13:11:15.332241+00:00
10	RBTC_un	1073746052	moveOverPallet(2,1)=[true,0]	2022-08-11T13:11:15.332241+00:00	2022-08-11T13:11:15.348973+00:00	2022-08-11T13:11:24.345620+00:00
11	RBTC_un	1073750084	moveOverPallet(1,2)=[true,0]	2022-08-11T13:11:24.345620+00:00	2022-08-11T13:11:24.362739+00:00	2022-08-11T13:11:33.349554+00:00
12	RBTC_un	1073746052	moveOverPallet(2,1)=[true,0]	2022-08-11T13:11:33.349554+00:00	2022-08-11T13:11:33.371687+00:00	2022-08-11T13:11:42.350004+00:00
13	RBTC_un	69793226818	pickFromPallet(1,2)=[true,1,0]	2022-08-11T13:11:42.350004+00:00	2022-08-11T13:11:42.364573+00:00	2022-08-11T13:11:53.426915+00:00
14	RBTC_un	1073745987	placeToPallet(1,1)=[true,0]	2022-08-11T13:11:53.426915+00:00	2022-08-11T13:11:53.451568+00:00	2022-08-11T13:12:04.363651+00:00
15	RBTC_un	69793226818	pickFromPallet(1,2)=[true,1,0]	2022-08-11T13:12:04.363651+00:00	2022-08-11T13:12:04.381865+00:00	2022-08-11T13:12:15.369142+00:00
16	RBTC_un	1073745987	placeToPallet(1,1)=[true,0]	2022-08-11T13:12:15.369142+00:00	2022-08-11T13:12:15.385292+00:00	2022-08-11T13:12:26.383050+00:00
17	RBTC_un	69793226818	pickFromPallet(1,2)=[true,1,0]	2022-08-11T13:12:26.383050+00:00	2022-08-11T13:12:26.417124+00:00	2022-08-11T13:12:37.390505+00:00
18	RBTC_un	1073745987	placeToPallet(1,1)=[true,0]	2022-08-11T13:12:37.390505+00:00	2022-08-11T13:12:37.414624+00:00	2022-08-11T13:12:48.387199+00:00
19	RBTC_un	1073754180	moveOverPallet(1,3)=[true,0]	2022-08-11T13:12:48.387199+00:00	2022-08-11T13:12:48.404136+00:00	2022-08-11T13:12:57.402798+00:00
20	RBTC_un	1073746116	moveOverPallet(3,1)=[true,0]	2022-08-11T13:12:57.402798+00:00	2022-08-11T13:12:57.425880+00:00	2022-08-11T13:13:06.405615+00:00

label

Pipeline
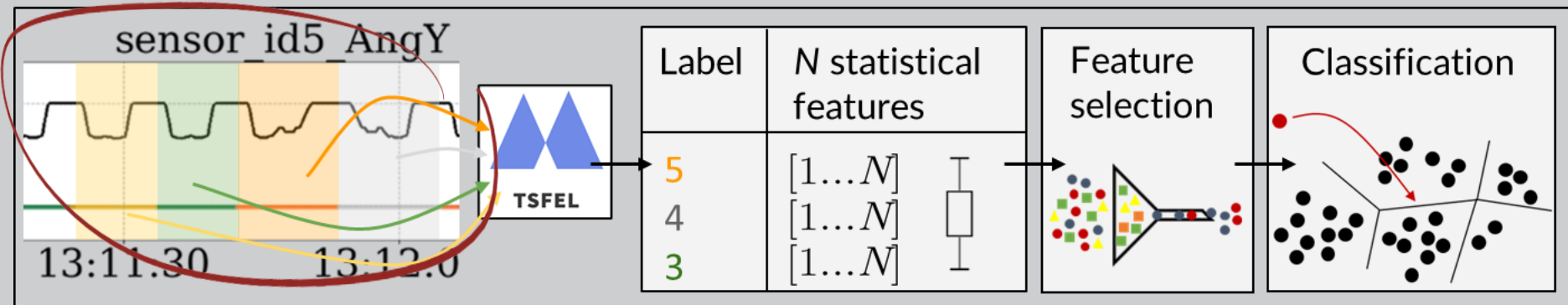
Signal windowing

Pipeline
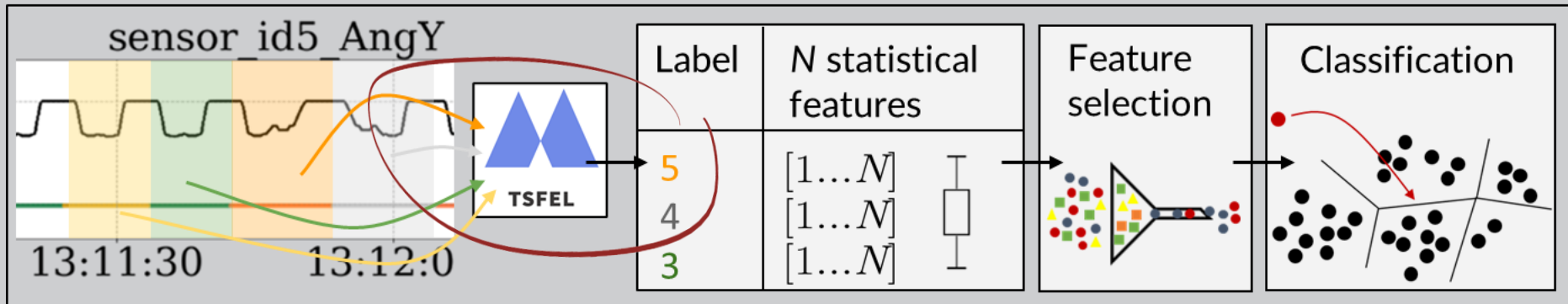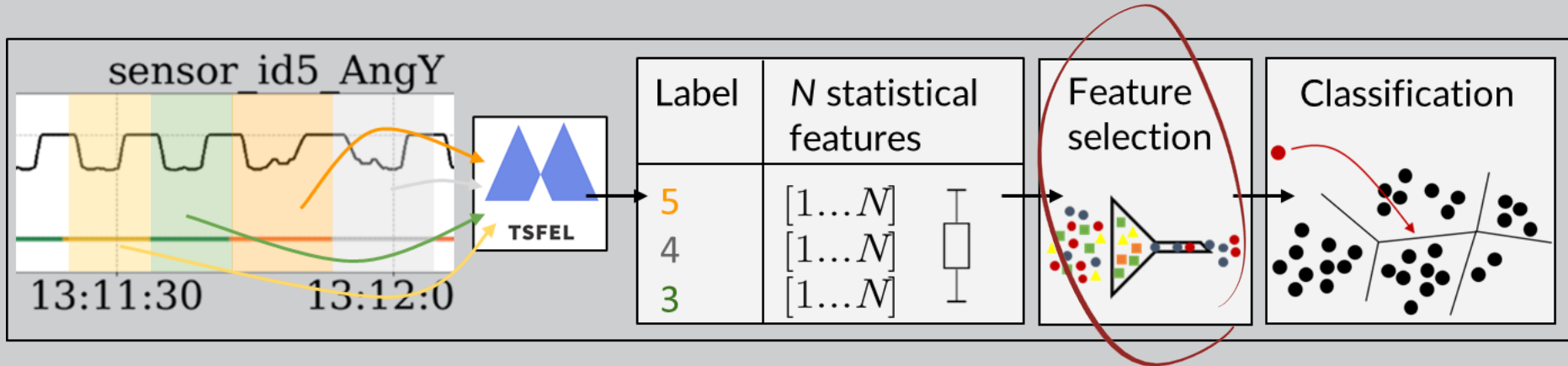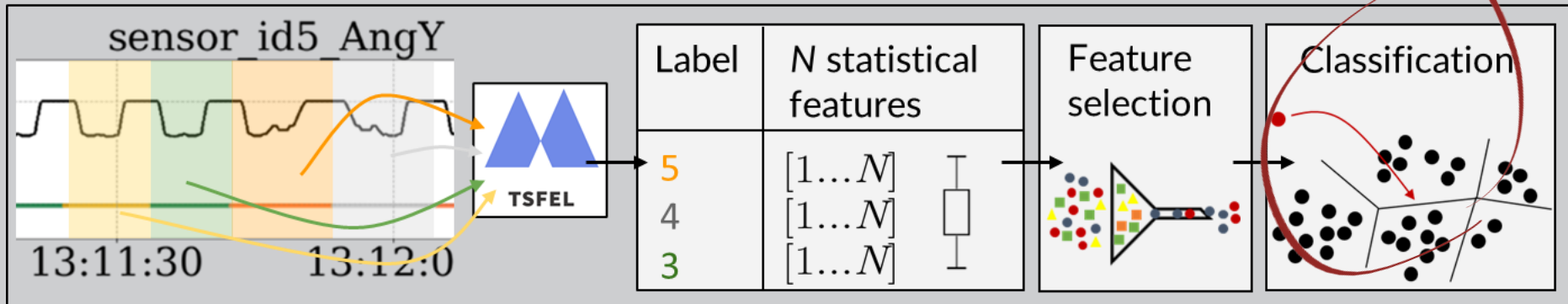

Features extraction leveraging TSFEL

Pipeline

Feature selection

Pipeline

Classification