

Automatic Classification of Sport Exercises for Training Support

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Goals in Sports



muscle size



[1]

body weight



[2]

performance



[3]



training



Training Schedule

coach

training schedule

athlete

Monday

Wednesday

Friday

week 1



5.6 km/h



5.6 km/h



8.3 km/h

week 2



50 watt



100 watt



100 watt

Feedback



coach

training schedule

athlete

feedback

Monday

Wednesday

Friday

week 1



week 2



self
reports



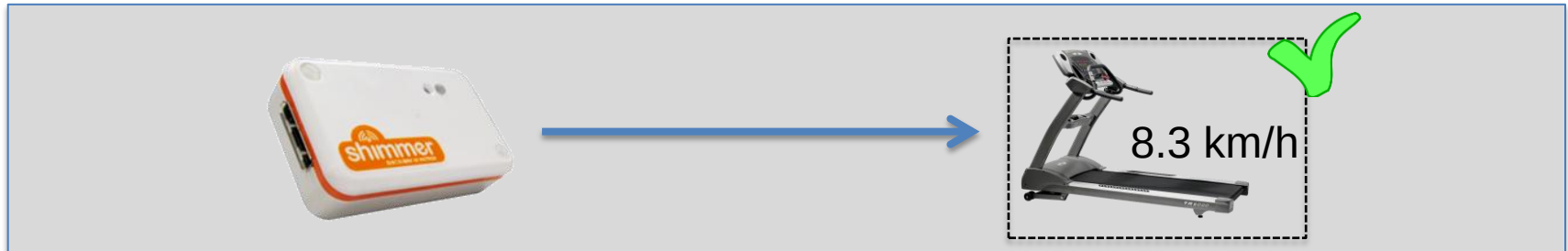
sensors

- physiological
- motion



[6]

automatic classification of sport exercises for training support





Pattern Recognition Pipeline





Data Acquisition

data
acquisition



preprocessing



feature
extraction



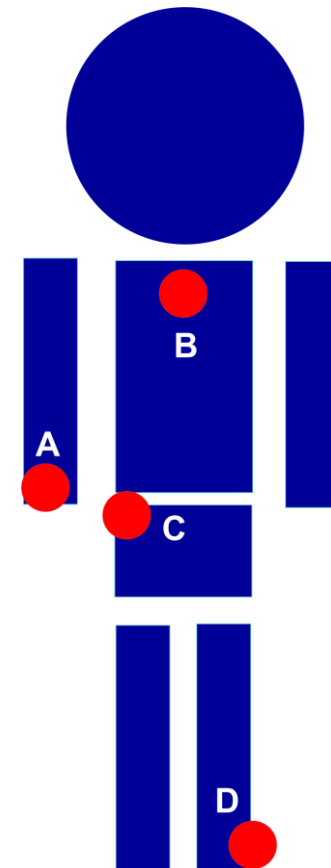
feature
selection



classification



3-D accelerometer	6g
3-D gyroscope	500 deg/s 2000 deg/s
sampling rate	200 Hz
storage	SD card





Data Acquisition

data
acquisition



preprocessing



feature
extraction



feature
selection



classification

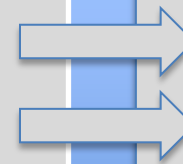


[7]

20

treadmill

- 5.6 km/h
- 8.3 km/h



120 s

bicycling

- 50 watt (70 rev. / min)
- 100 watt (70 rev. / min)





Preprocessing

data
acquisition



preprocessing



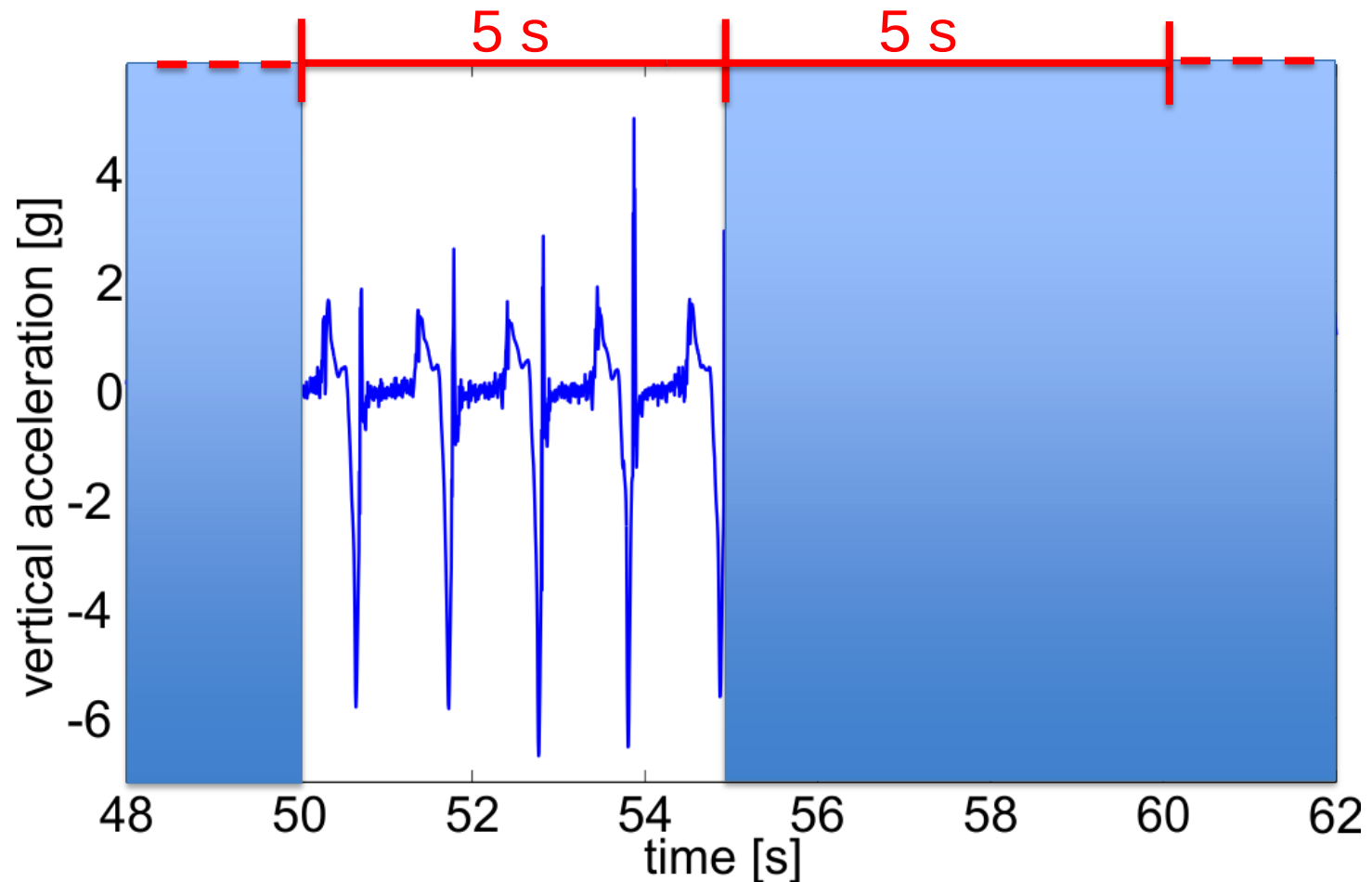
feature
extraction



feature
selection

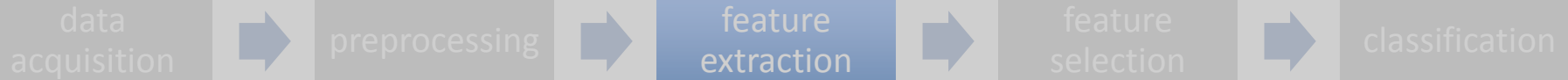


classification





Feature Extraction



4 sensors

X

6 axes

X

7 features

=

168

5 LPC
coefficients

} time

spectral
centroid

bandwidth

} frequency

LPC: linear predictive coding

Feature Extraction (Spectral Centroid)



data
acquisition



preprocessing



feature
extraction



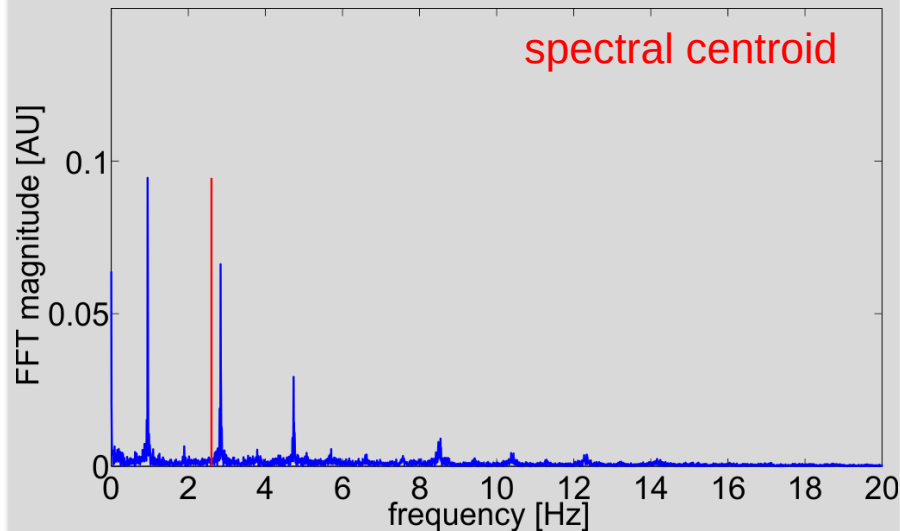
feature
selection



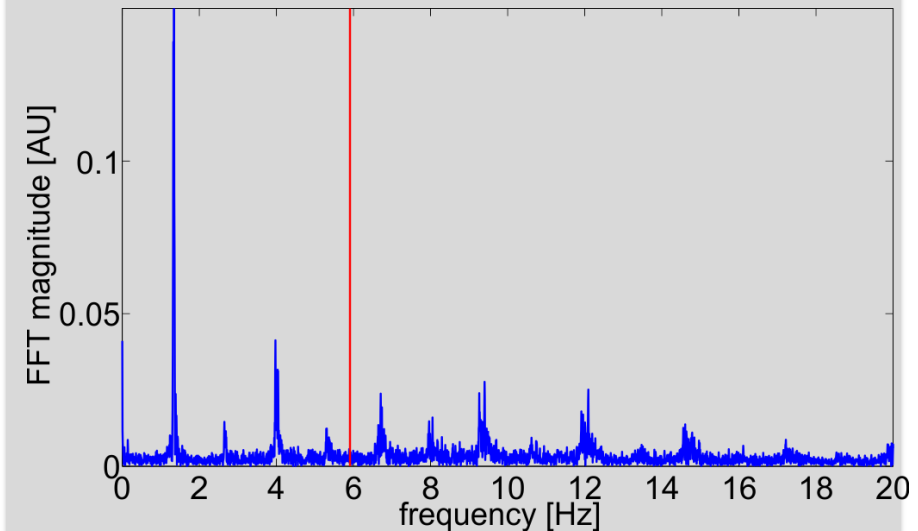
classification

treadmill

5.6 km/h



8.3 km/h





Feature Selection

data
acquisition



preprocessing



feature
extraction



feature
selection



classification

- reduction of number of features
- sequential forward selection
- leave-one-subject-out cross-validation



Classification

data
acquisition



preprocessing



feature
extraction



feature
selection



classification

level 1

feature 2



feature 1

level 2

5.6 km/h

8.3 km/h

50 watt

100 watt



Classification

data
acquisition



preprocessing



feature
extraction



feature
selection



classification

algorithms

- Support Vector Machine (SVM)
 - linear kernel
 - cost parameter: $C = 1$

performance
assessment

- classification rate
 - class dependent mean
 - overall mean



Classification Rates

level 1

	class rate
treadmill	97.3 %
bicycling	99.0 %
mean	98.2 %



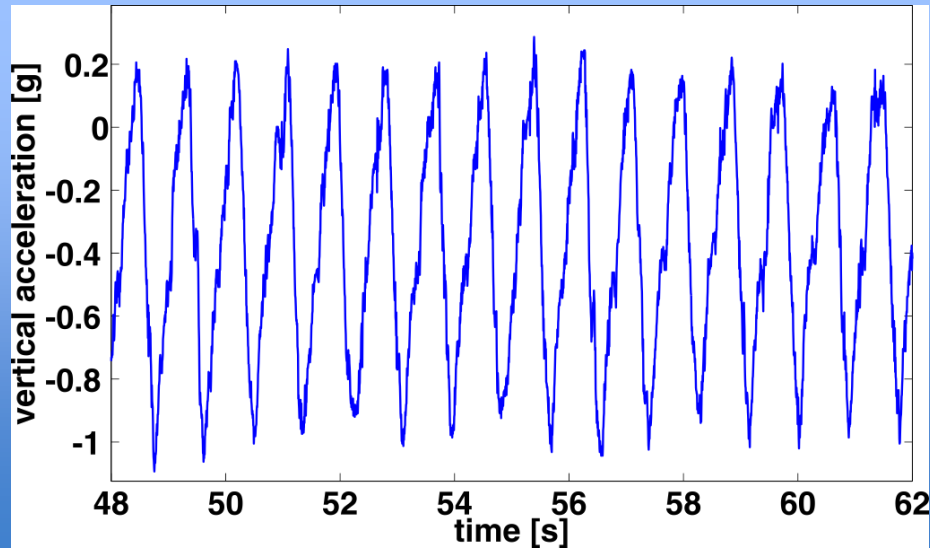
level 2

	class rate
5.6 km/h	99.6 %
8.3 km/h	98.3 %
mean	99.0 %

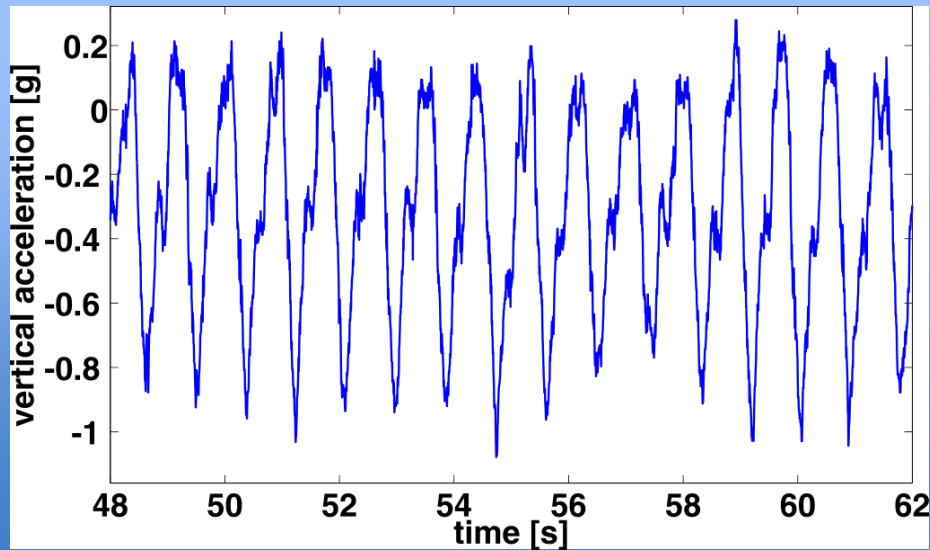
	class rate
50 watt	60.5 %
100 watt	61.6 %
mean	61.1 %



Bicycling



50 watt

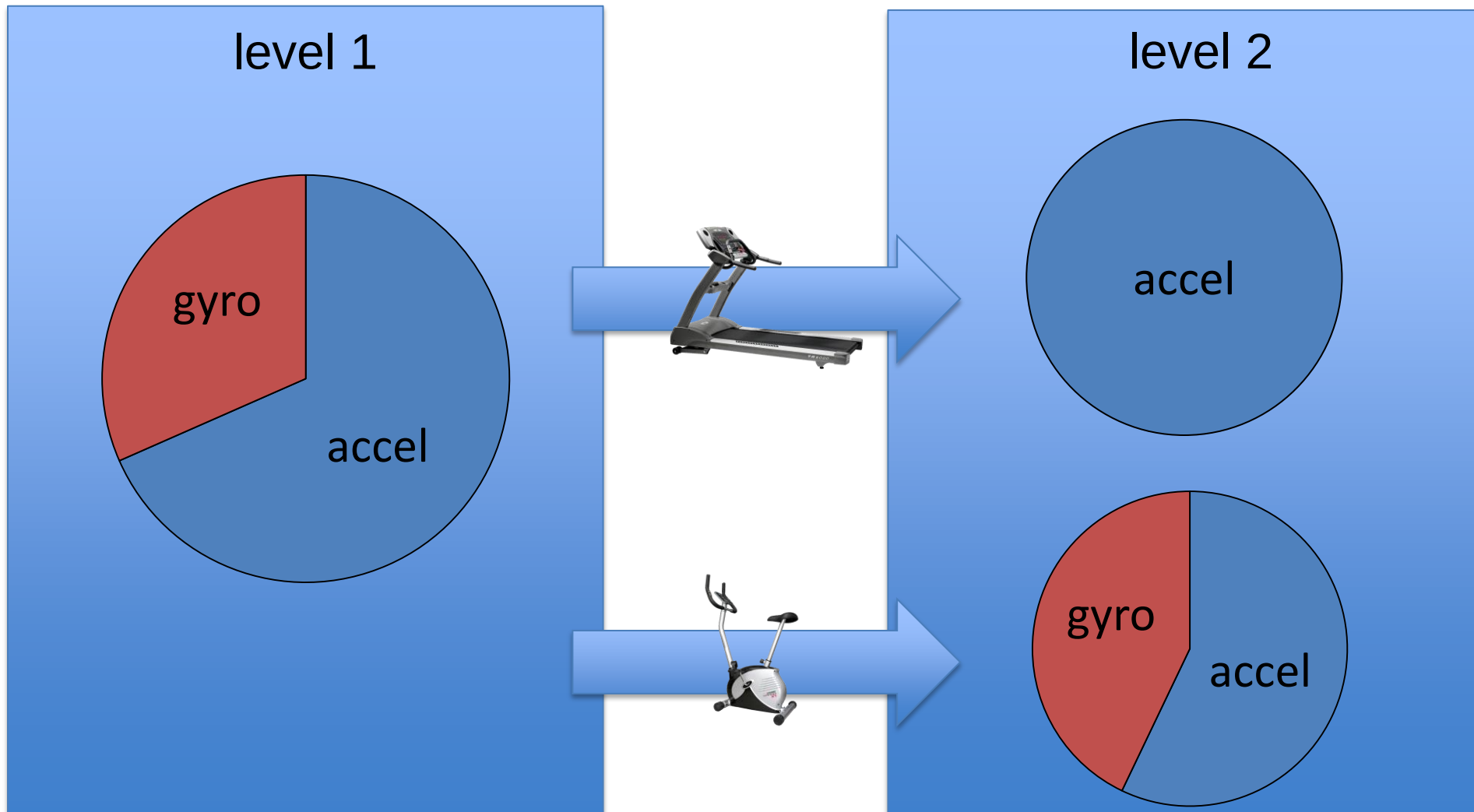


100 watt

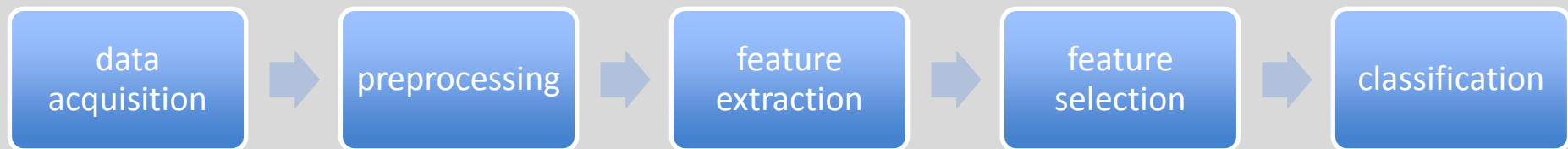
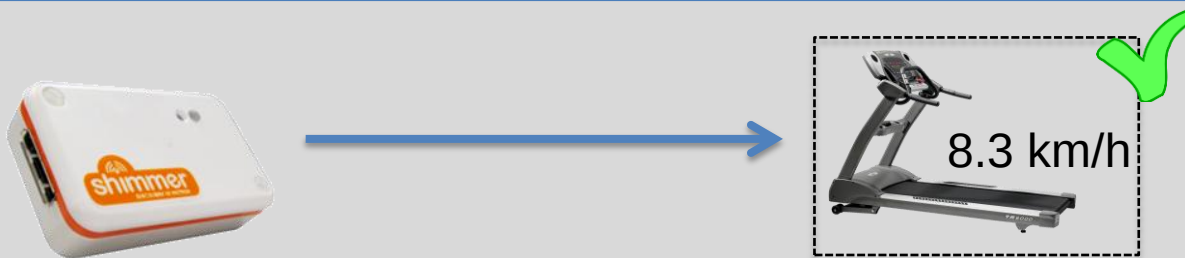
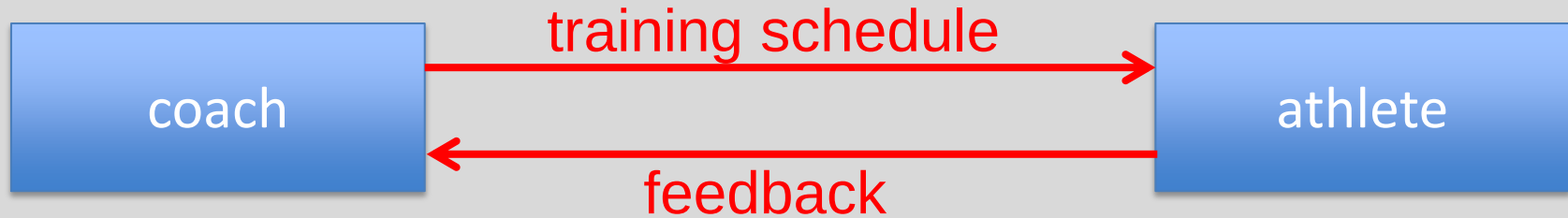




Feature Selection: Sensor Type



Summary



	treadmill / bicycling	two treadmill levels	two bicycling levels
class rate	98.2 %	99.0 %	61.1 %

additional elements

exercises



sensors



detail level increasement

number of steps



quality of exercise
execution



Thank you for your attention!



Bavarian Ministry of
Economic Affairs,
Infrastructure, Transport and
Technology



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