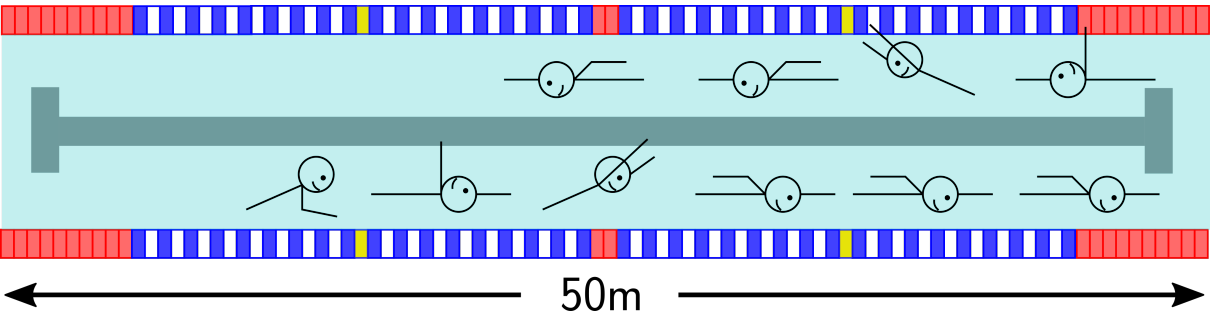


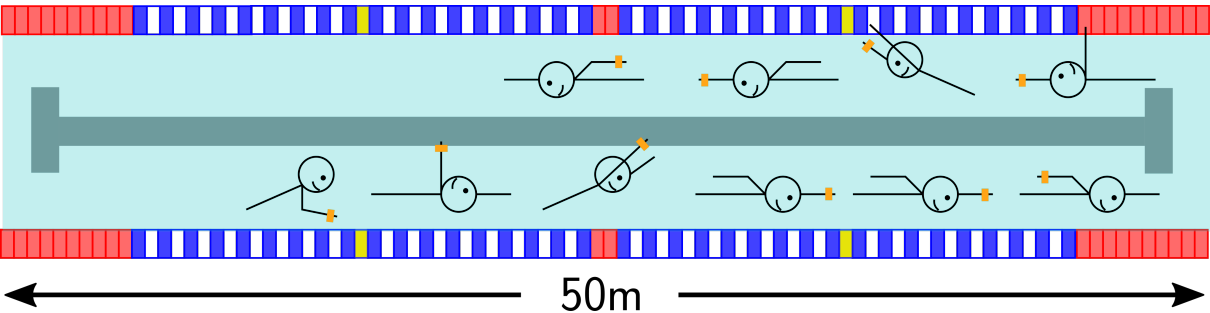
Swimming Style Recognition and Lap Counting Using a Smartwatch and Deep Learning



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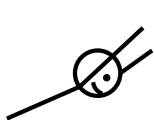
Swimming plan:	400m	Freestyle warm-up
	$4 \times 50\text{m}$	Backstroke
	100m	Individual Medley
	$\vdots$	$\vdots$



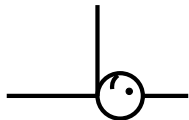
Swimming plan:	400m	Freestyle warm-up
	$4 \times 50\text{m}$	Backstroke
	100m	Individual Medley
	$\vdots$	$\vdots$

Swimming Plan

Style Recognition



Butterfly



Backstroke

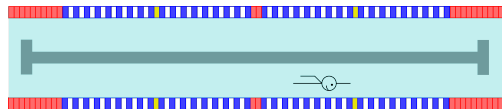


Breaststroke



Freestyle

Lap Counting



50m

100m

150m

200m

Smartwatch: Nixon The Mission



Accelerometer

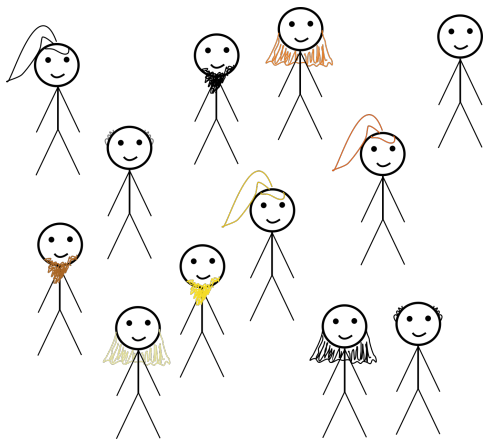
Barometer

Compass

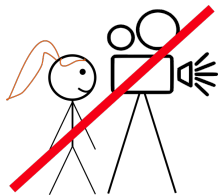
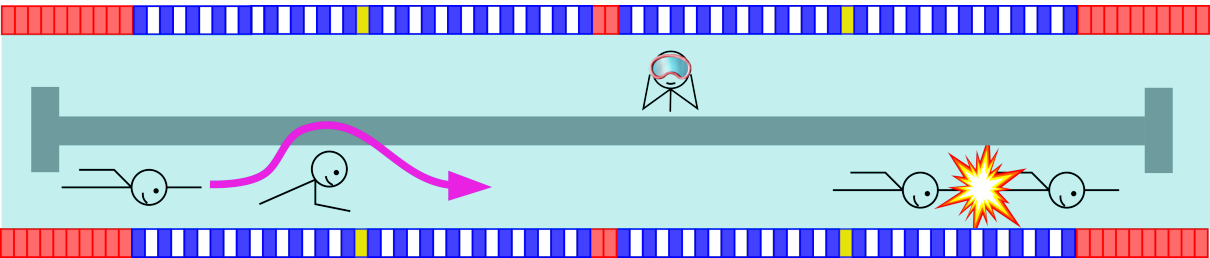
Gyrometer

Light Sensor



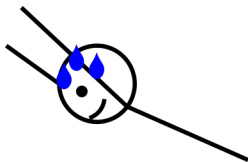


- aged from 25 to 75
- wide range of skills
- 40 users

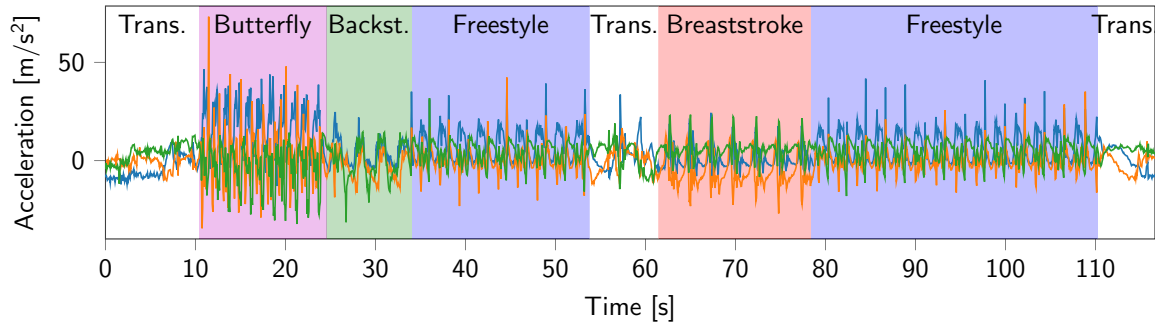


Data

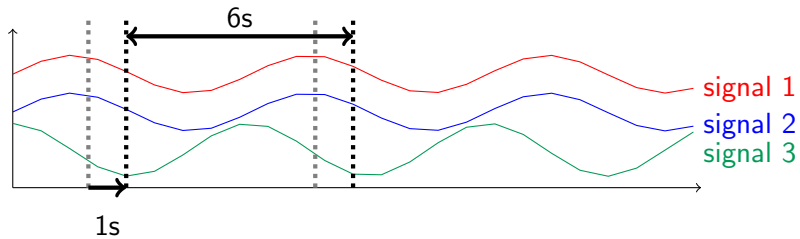
Class	Duration [hours]	Nr. of users
Butterfly:	1.0	23
Backstroke:	2.3	31
Breaststroke:	1.4	24
Freestyle:	6.8	37
Transition:	5.5	40



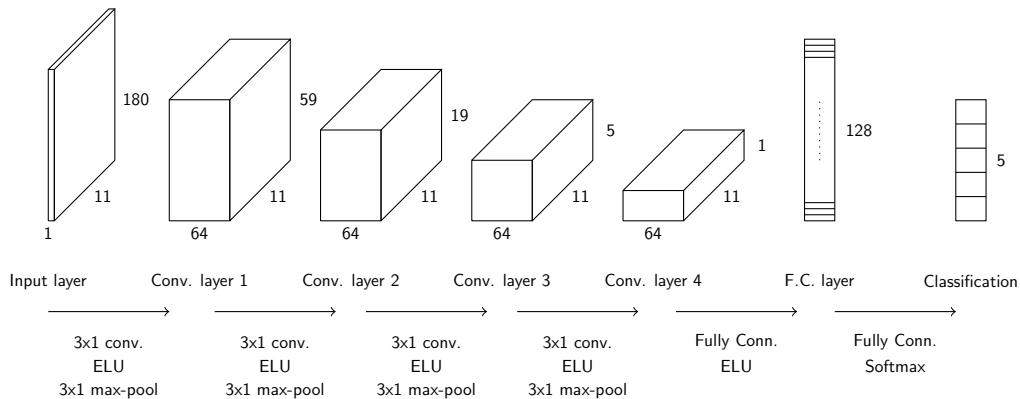
Data - Example Recording



Processing



CNN



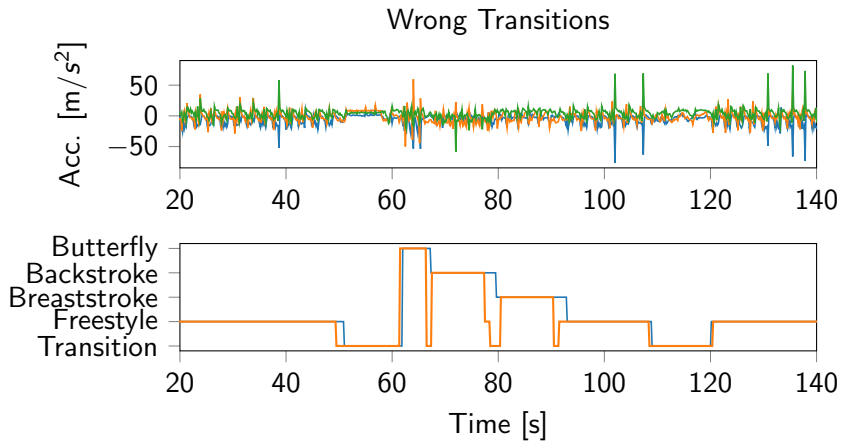
Style Recognition - Confusion Matrix

[%]		Predicted Class				
		Butterfly	Backstroke	Breaststroke	Freestyle	Transition
True Class	Butterfly	96.5	0.0	0.0	3.4	0.1
	Backstroke	0.0	98.2	0.2	0.4	1.2
	Breaststroke	0.0	1.7	94.9	1.8	1.7
	Freestyle	0.5	0.1	0.0	98.5	0.8
	Transition	0.0	0.3	0.2	0.7	98.7
Recall		96.5	98.2	94.9	98.5	98.7
Precision		99.4	97.9	99.4	94.0	96.4
F1		97.9	98.1	97.1	96.2	97.5
Accuracy		97.4				
Average F1		97.4				

Lap Recognition

	Deviation				
	1s	2s	4s	6s	8s
True Pos.	421	676	732	747	749
False Pos.	331	76	20	5	3
False Neg.	336	81	25	10	8
Precision [%]	56.0	89.9	97.3	99.3	99.6
Recall [%]	55.6	89.3	96.7	98.7	98.9

Lap Recognition



Style Recognition for a Lap

		Predicted Class				
		Butterfly	Backstroke	Breaststroke	Freestyle	Mixed
True Class	Butterfly	77	0	0	1	6
	Backstroke	0	156	0	0	2
	Breaststroke	0	0	85	0	4
	Freestyle	0	0	0	546	5
	Mixed	0	4	0	0	54

