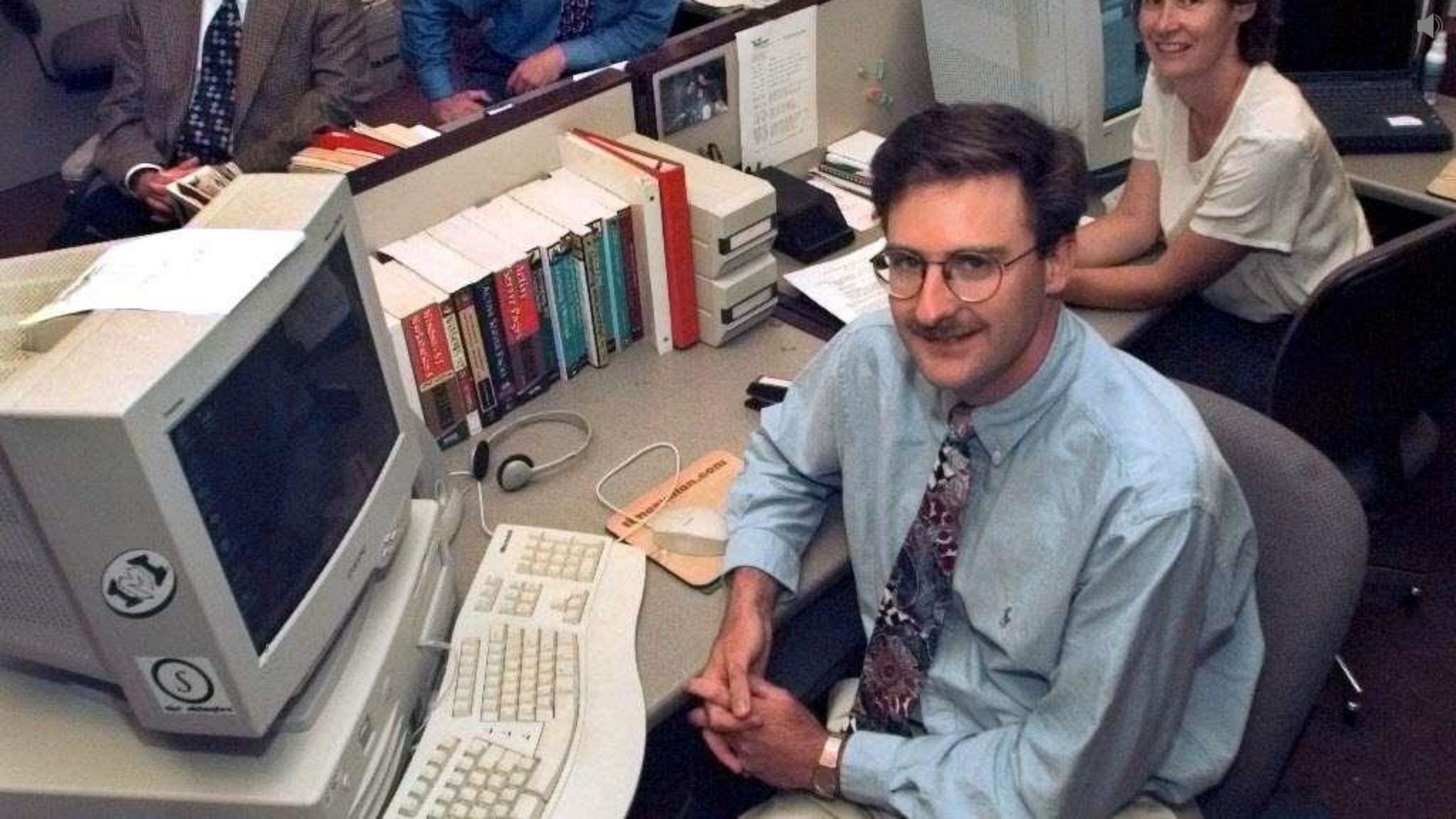
COMP90018 — MOBILE COMP

EDUARDO VELLOSO

Context & Activity
RECOGNITION




Microsoft
amazon

Select font size T T T

Which of the following are elements of the user's context? (Select all that apply)

○ Allow Single Choice Only ◉ Allow Multiple Choices ☐ Shuffle Answers ☑ Allow Retry ☐ Limit Attempts

Location

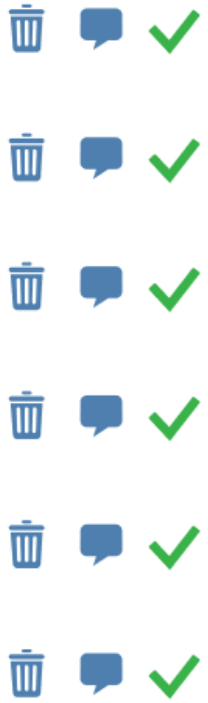
User's identity

Time of the day

Sound levels

Light levels

User's Motion

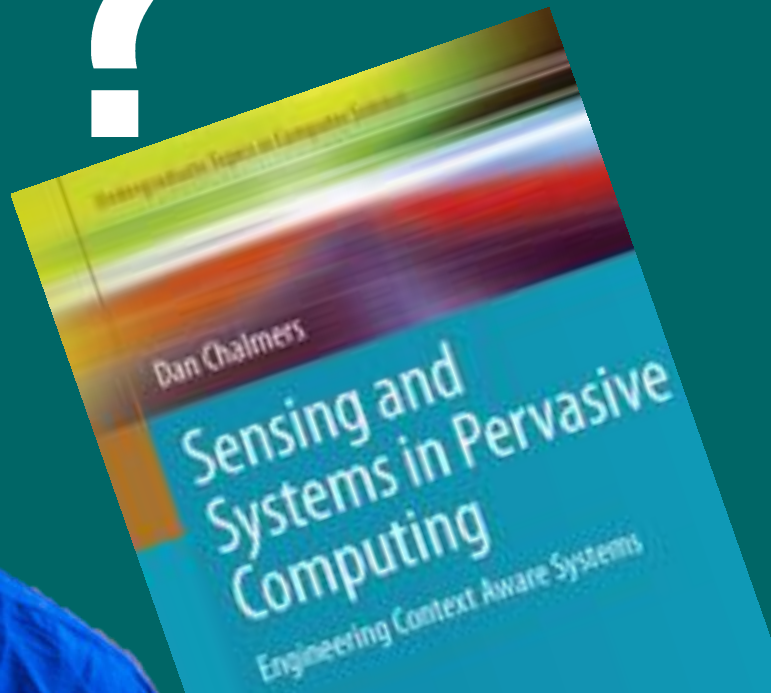


+ Add another answer

Preview

What is CONTEXT? *Awareness*

What is CONTEXT?



Context-Aware presentation

Contextual mediation

Context-triggered actions

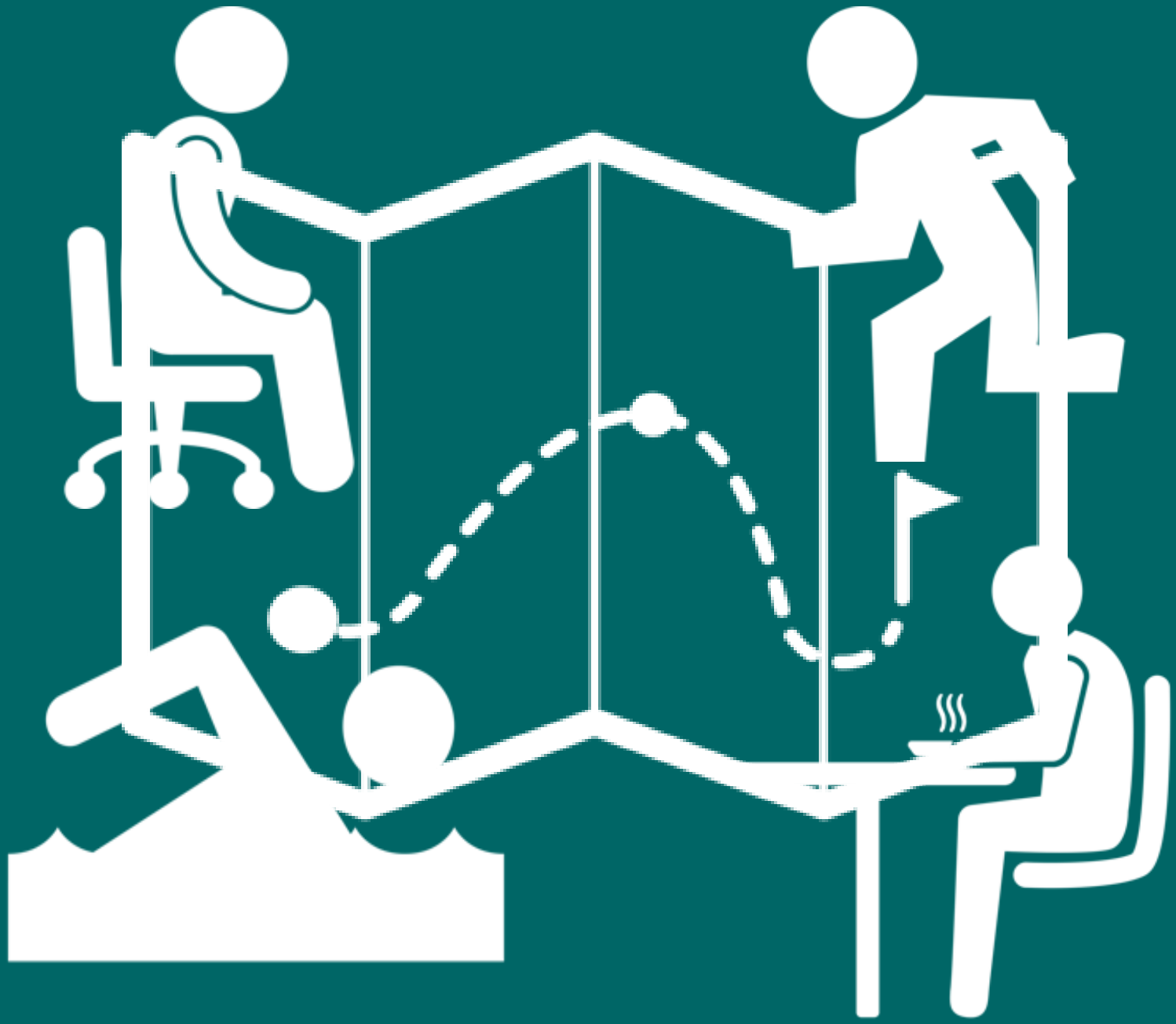
Context Display

CONTEXT

Contextual adaptation of the environment

Contextual Augmentation

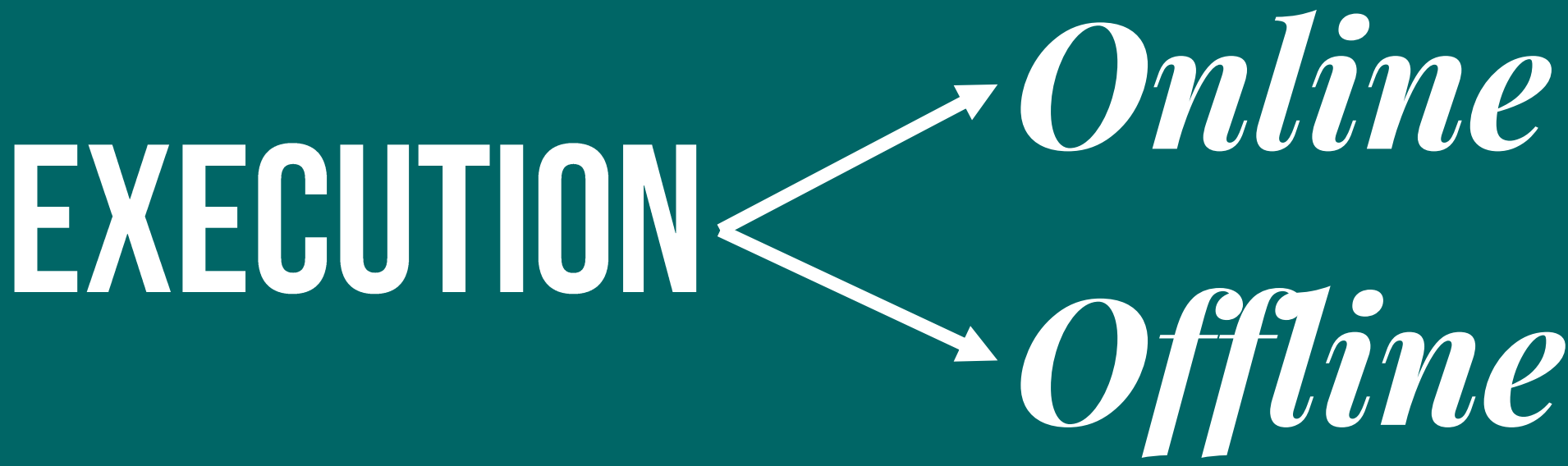
Context-aware configuration

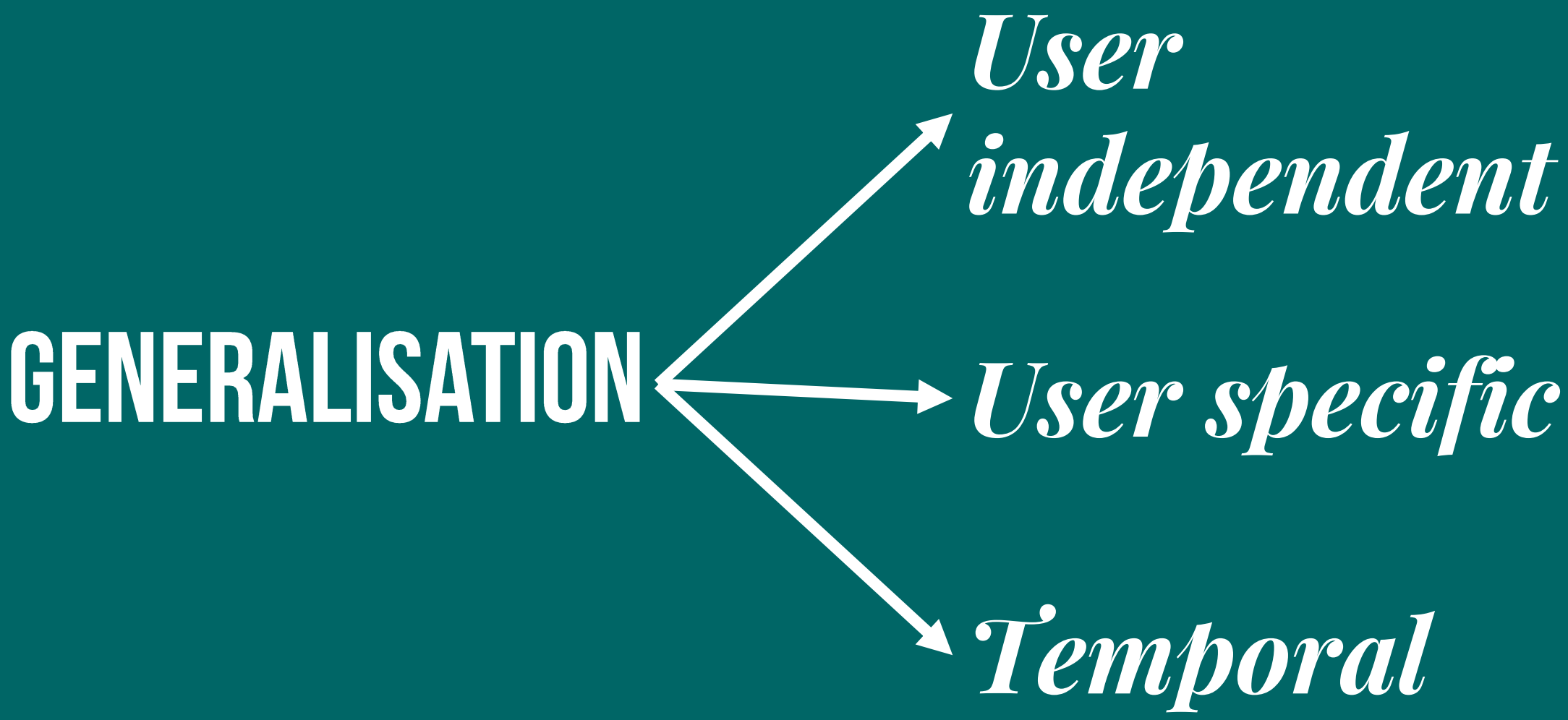


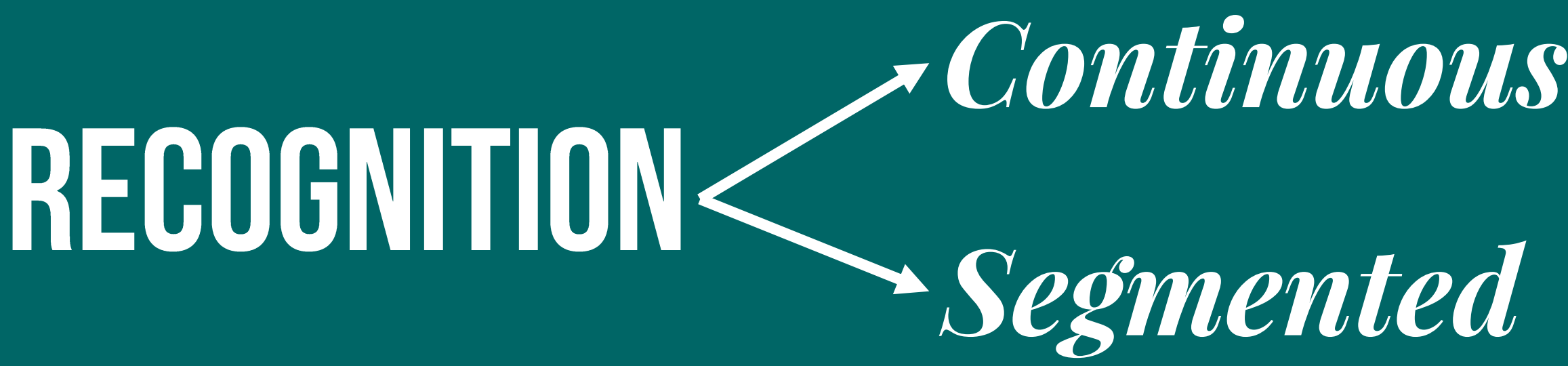
A TUTORIAL ON HUMAN ACTIVITY RECOGNITION USING BODY-WORN INERTIAL SENSORS

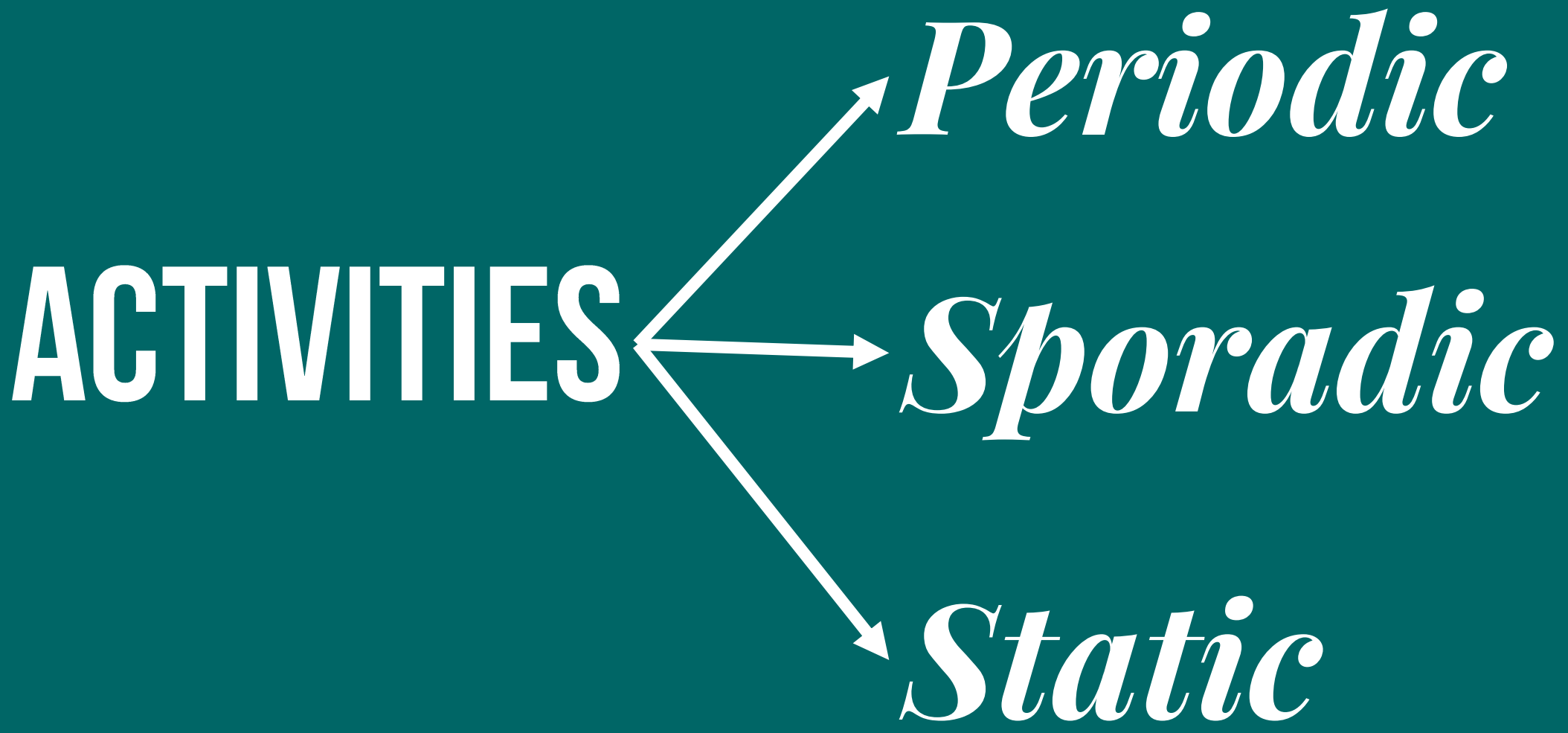
Andreas Bulling et al.

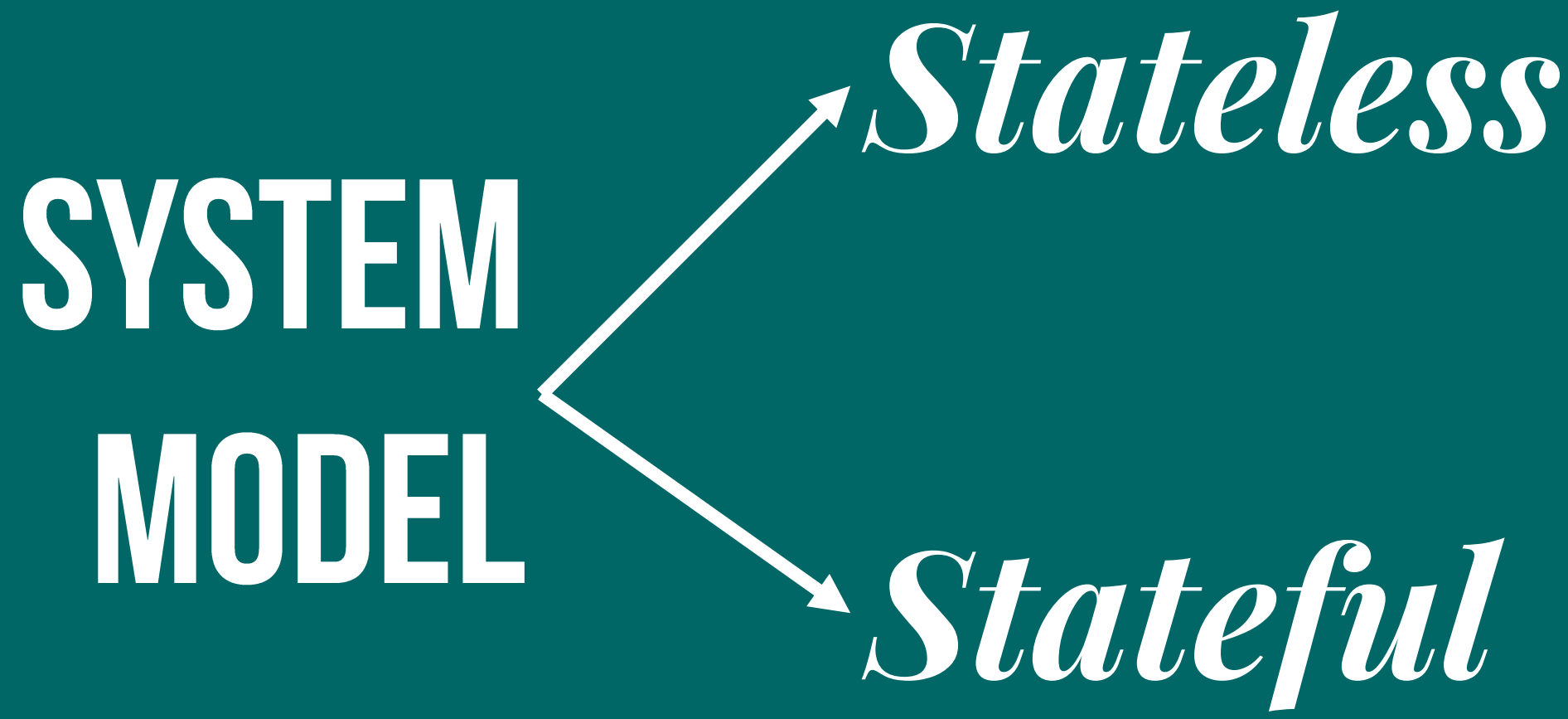
CHARACTERISTICS OF HAR SYSTEMS


EXECUTION
Online
Offline


GENERALISATION
User independent
User specific
Temporal


RECOGNITION
Continuous
Segmented


ACTIVITIES
Periodic
Sporadic
Static


SYSTEM MODEL
Stateless
Stateful

Select font size T T T

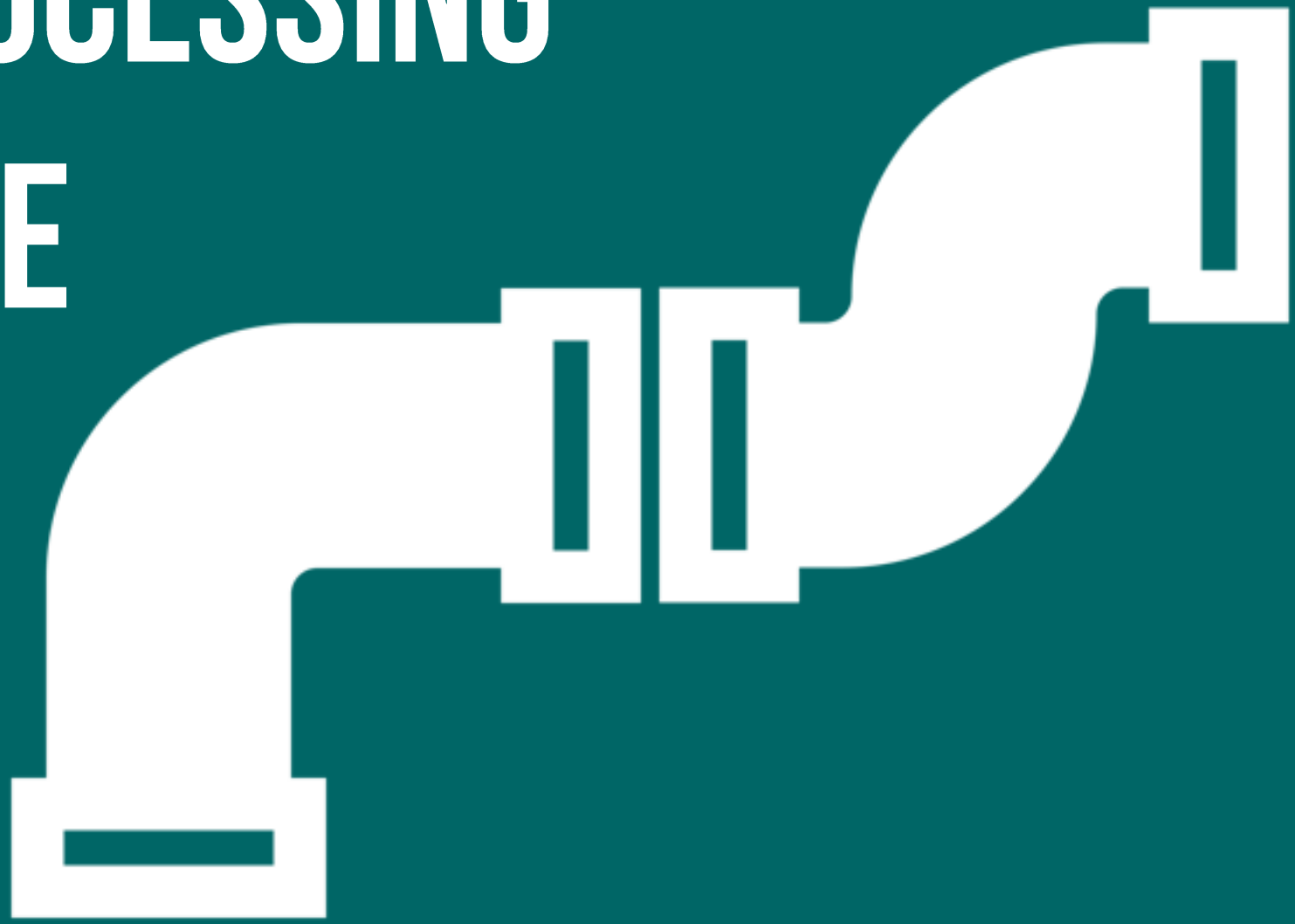
Imagine an app that analyses your shopping lists and suggests at the end of the week recipes with a better nutriotional value based on the ingredients of that list. Check all characteristics tha apply to this app.

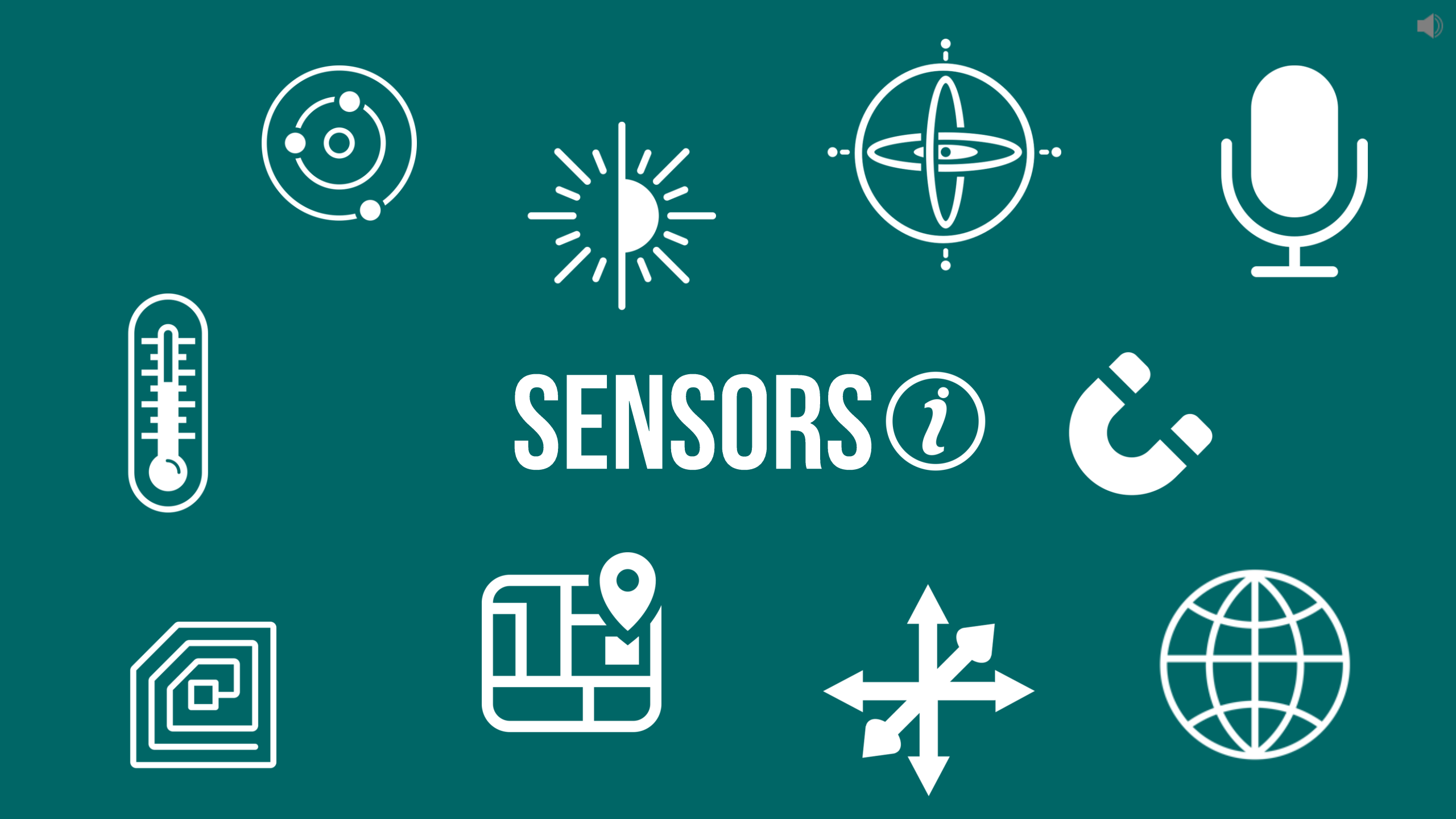
○ Allow Single Choice Only ◉ Allow Multiple Choices ☐ Shuffle Answers ☑ Allow Retry ☐ Limit Attempts

- Online
- Offile
- User-Independent
- User-specific
- Insert option here
- Periodic
- Sporadic

Preview

THE PROCESSING PIPELINE

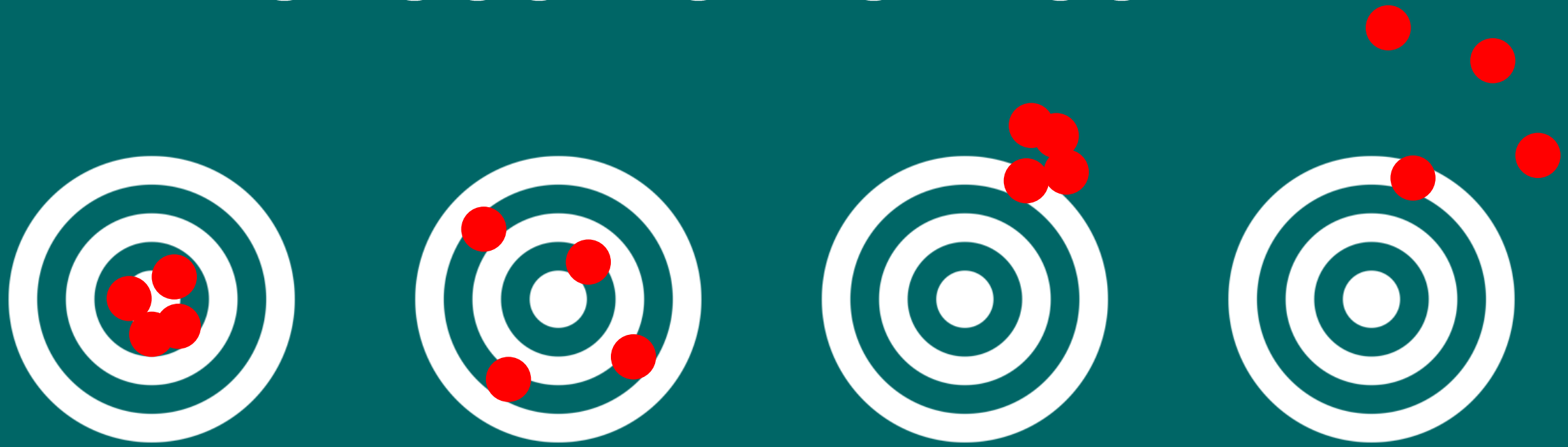



SENSORS

CHOOSING A SENSOR

What is it measuring?

CHOOSING A SENSOR

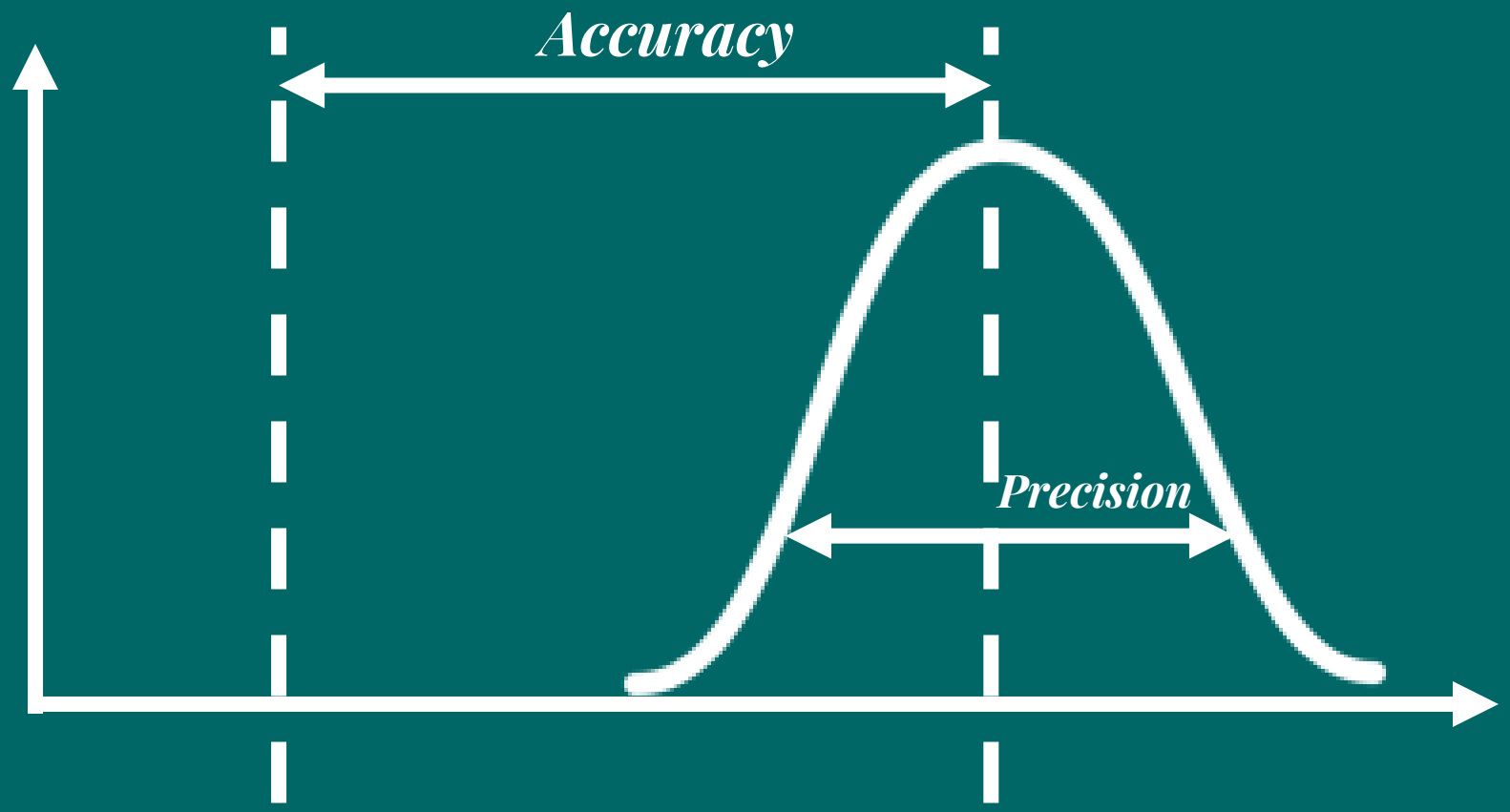


High Accuracy
High Precision

High Accuracy
Low Precision

Low Accuracy
High Precision

Low Accuracy
Low Precision


Accuracy
Precision
True value

Select font size T T T

A certain broken thermometer always outputs 20 degrees regardless of the actual temperature of the environment. One could argue that this behaves like a sensor with...

◉ Allow Single Choice Only ○ Allow Multiple Choices ☑ Shuffle Answers ☑ Allow Retry ☐ Limit Attempts

Low accuracy, High precision

Low accuracy, because the measurement mean is totally wrong, but high precision, because they are always the same.

Low Accuracy, Low Precision

High Accuracy, High Precision

High Accuracy, Low Precision

+ Add another answer

Preview

CHOOSING A SENSOR

Operating range

CHOOSING A SENSOR

Resolution or Sensitivity

Infrared camera optris PI 400 / PI 450

The **infrared cameras optris PI 400 / PI 450** are the **smallest thermographic cameras in their class**. Being equipped with a measurement speed of 80 Hz and an optical resolution of 382 x 288 pixels they provide **real-time thermographic images in high speed**.

The IR camera PI 450 is, due to its thermal sensitivity of 40 mK specifically suited for detection of slightest temperature differences, making it indispensable in quality control of products and in medical prevention.

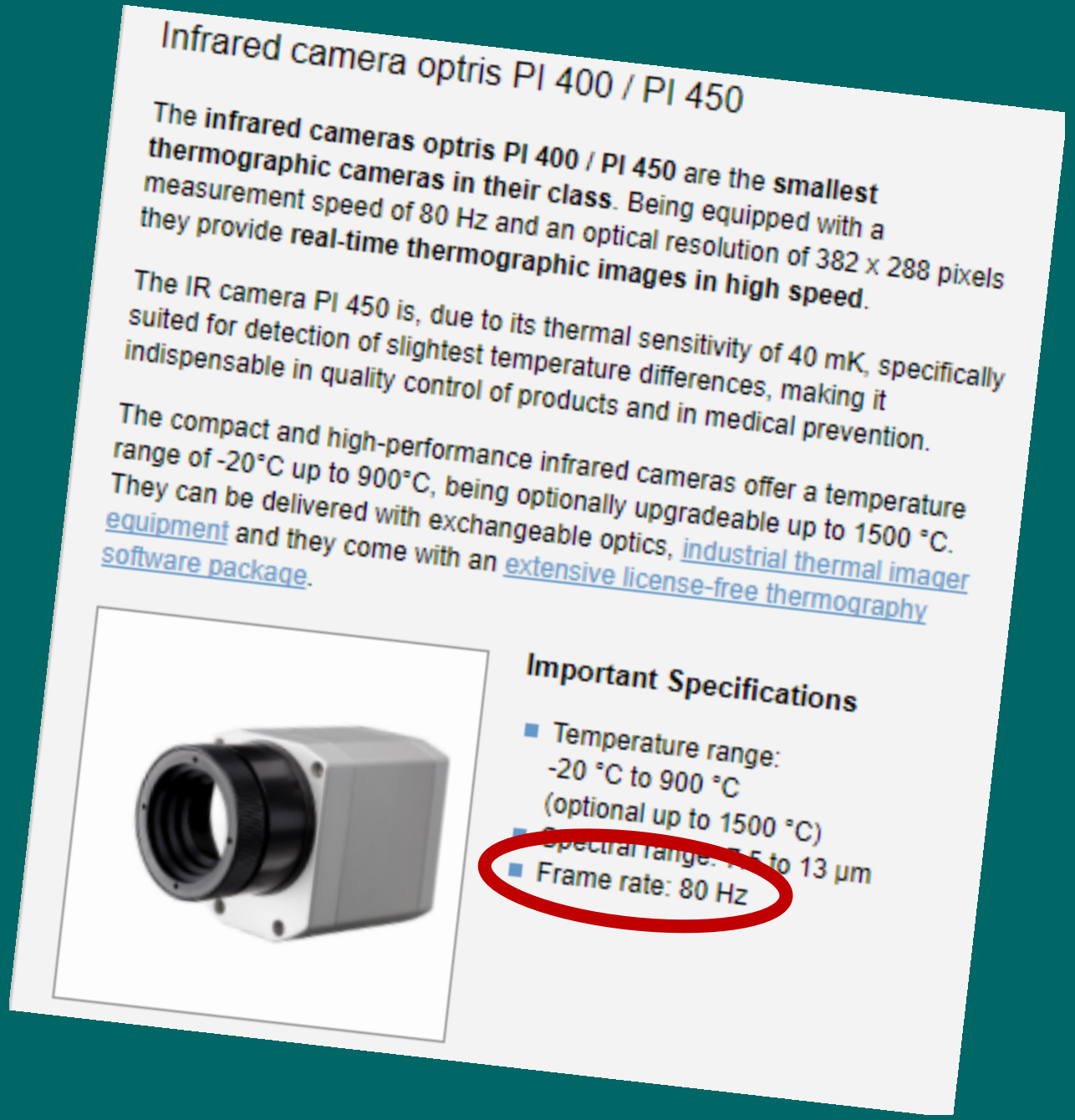
The compact and high-performance infrared cameras offer a temperature range of -20°C up to 900°C, being optionally upgradeable up to 1500 °C. They can be delivered with exchangeable optics, industrial thermal imager equipment and they come with an extensive license-free thermography software package.

Important Specifications

- Temperature range:
  -20 °C to 900 °C
  (optional up to 1500 °C)
- Spectral range: 7.5 to 13 µm
- Frame rate: 80 Hz

CHOOSING A SENSOR

Sampling Rate or Frame Rate



CHOOSING A SENSOR

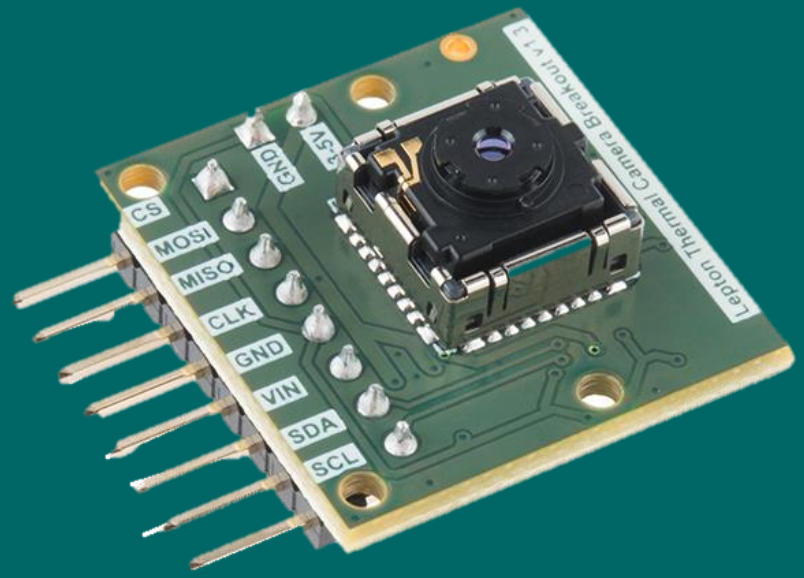
Cost

$259.95

ADD TO CART

Shipping outside of the US?

Click here for info



RAW DATA

$$D = (d_1 \dots d_n)^T$$

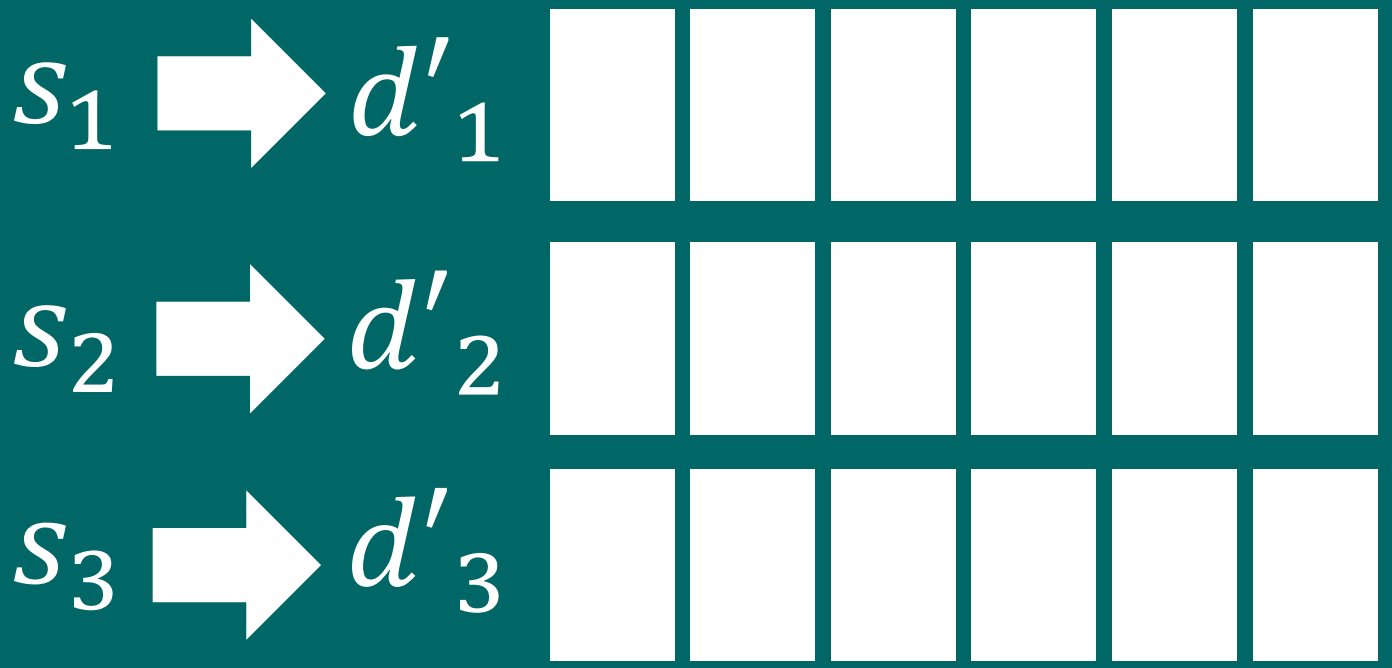
$$s_i = (\boldsymbol{d}^1, \boldsymbol{d}^2, \ldots, \boldsymbol{d}^t)$$

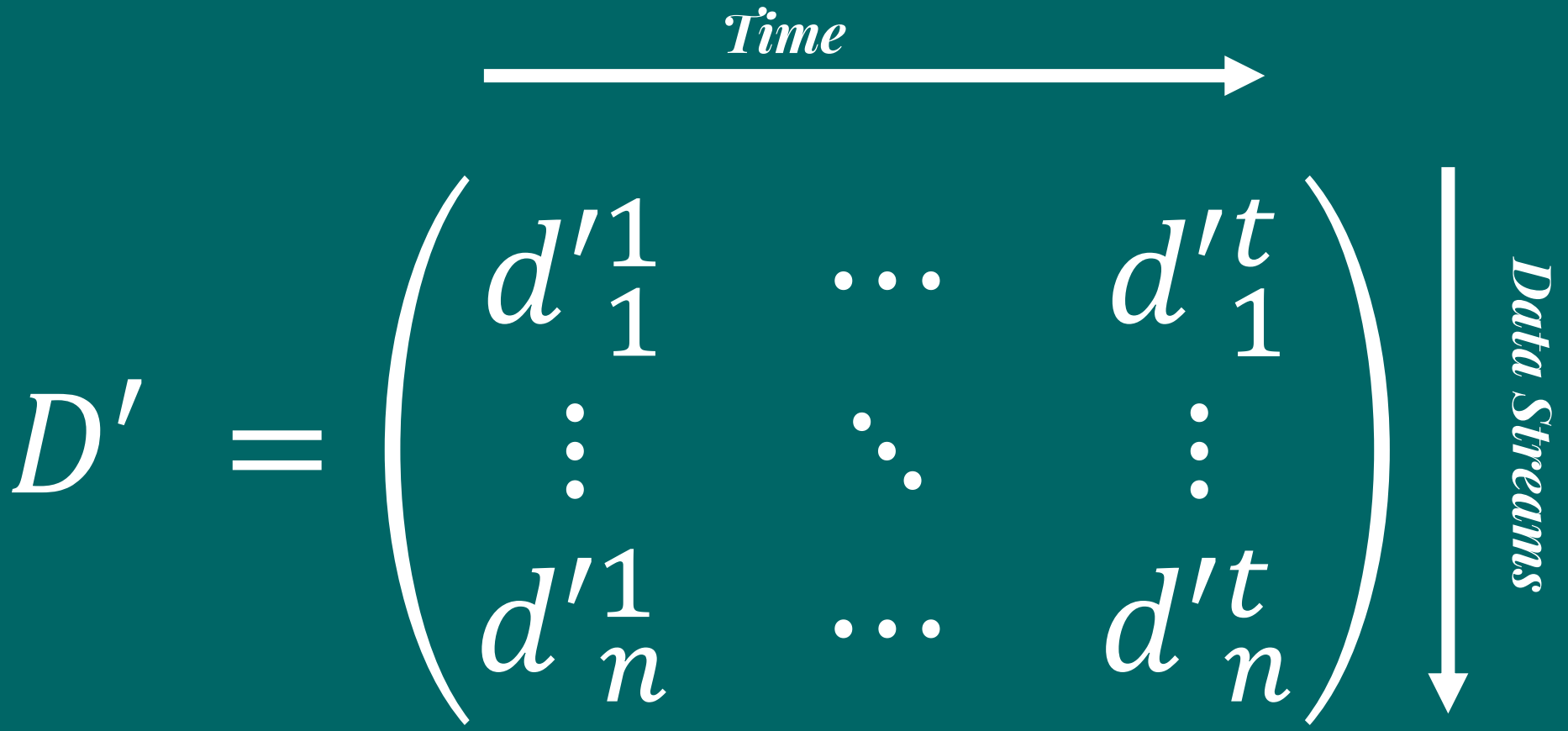
$$\boldsymbol{d}^1 = \begin{pmatrix} d_x^1 \\ d_y^1 \\ d_z^1 \end{pmatrix}$$

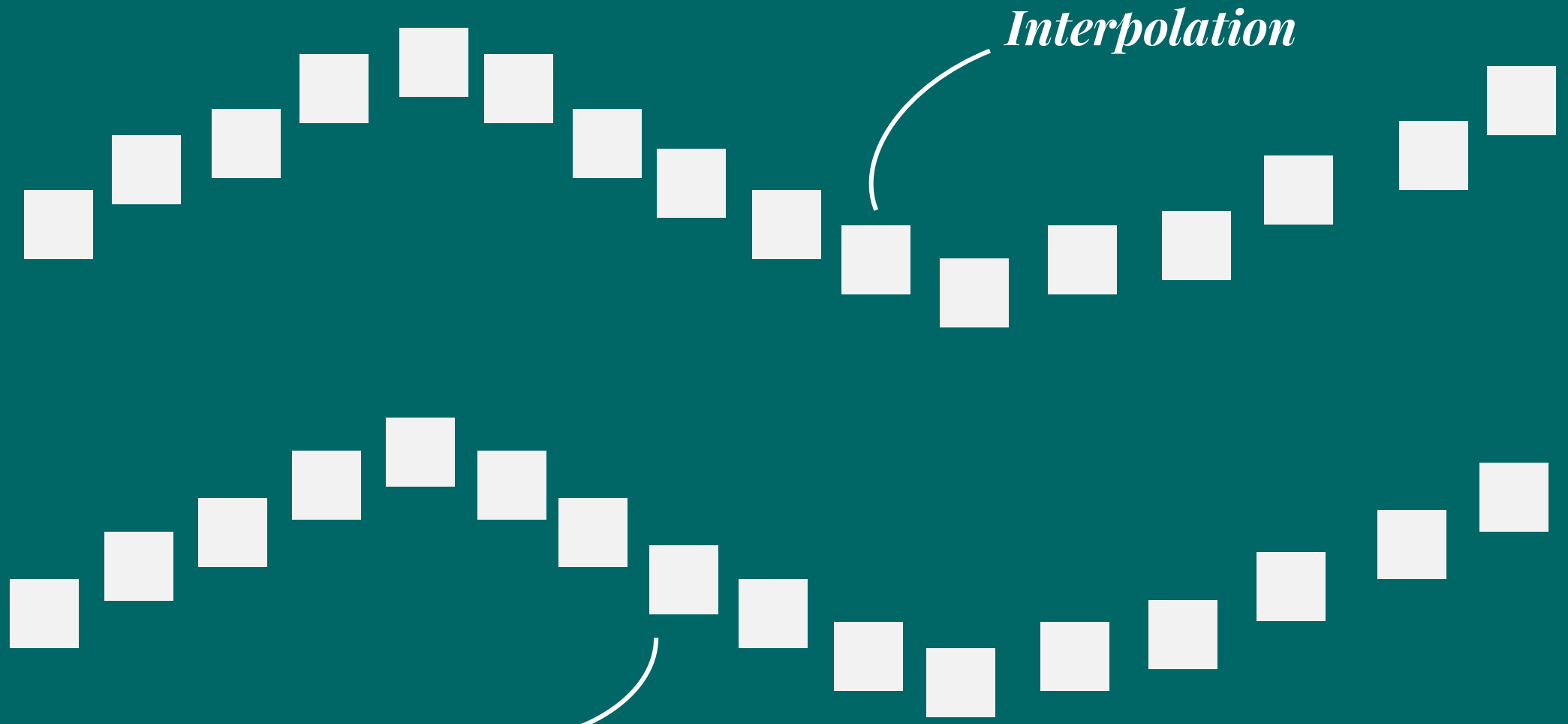
For each sensor

PREPROCESSING

$$D' = (d'_1 \dots d'_n)^T$$

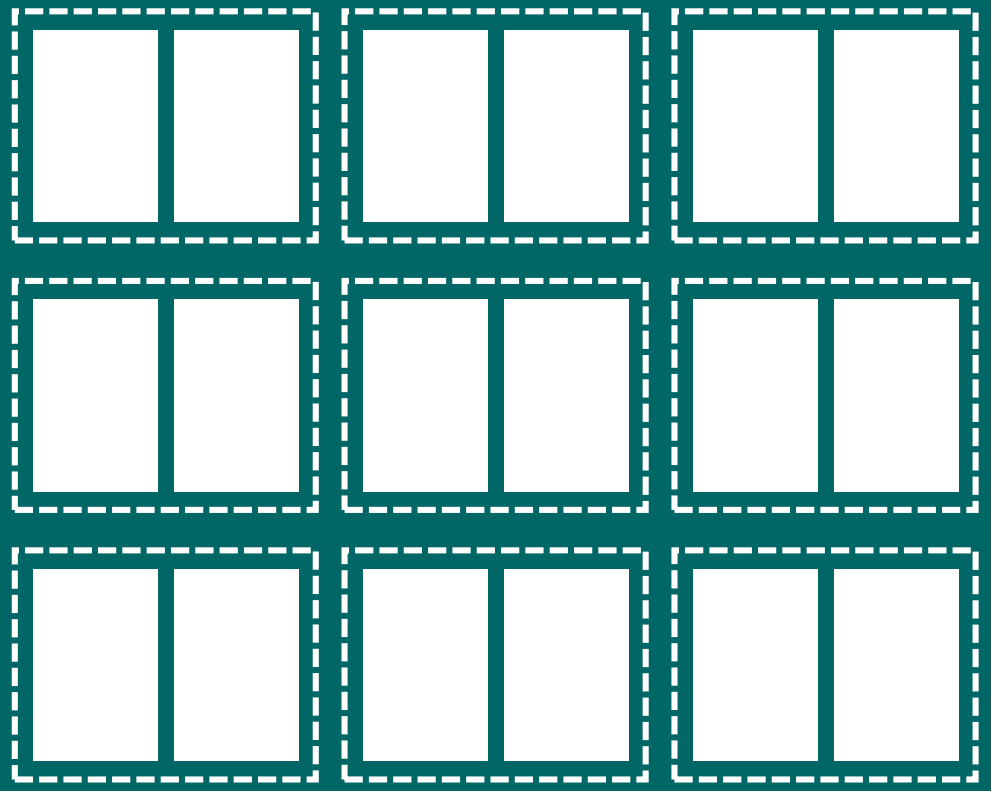



Time
$D' = \begin{pmatrix} d'^{1}_{1} & \cdots & d'^{t}_{1} \\ \vdots & \ddots & \vdots \\ d'^{1}_{n} & \cdots & d'^{t}_{n} \end{pmatrix}$
Data Streams


Interpolation
Downsampling

SEGMENTATION

$$W = \{w_1 \dots w_m\}$$



SEGMENTATION

- *Sliding Window*
- *Energy Based*
- *Additional Context Sources*

Non-Overlapping Sliding Window

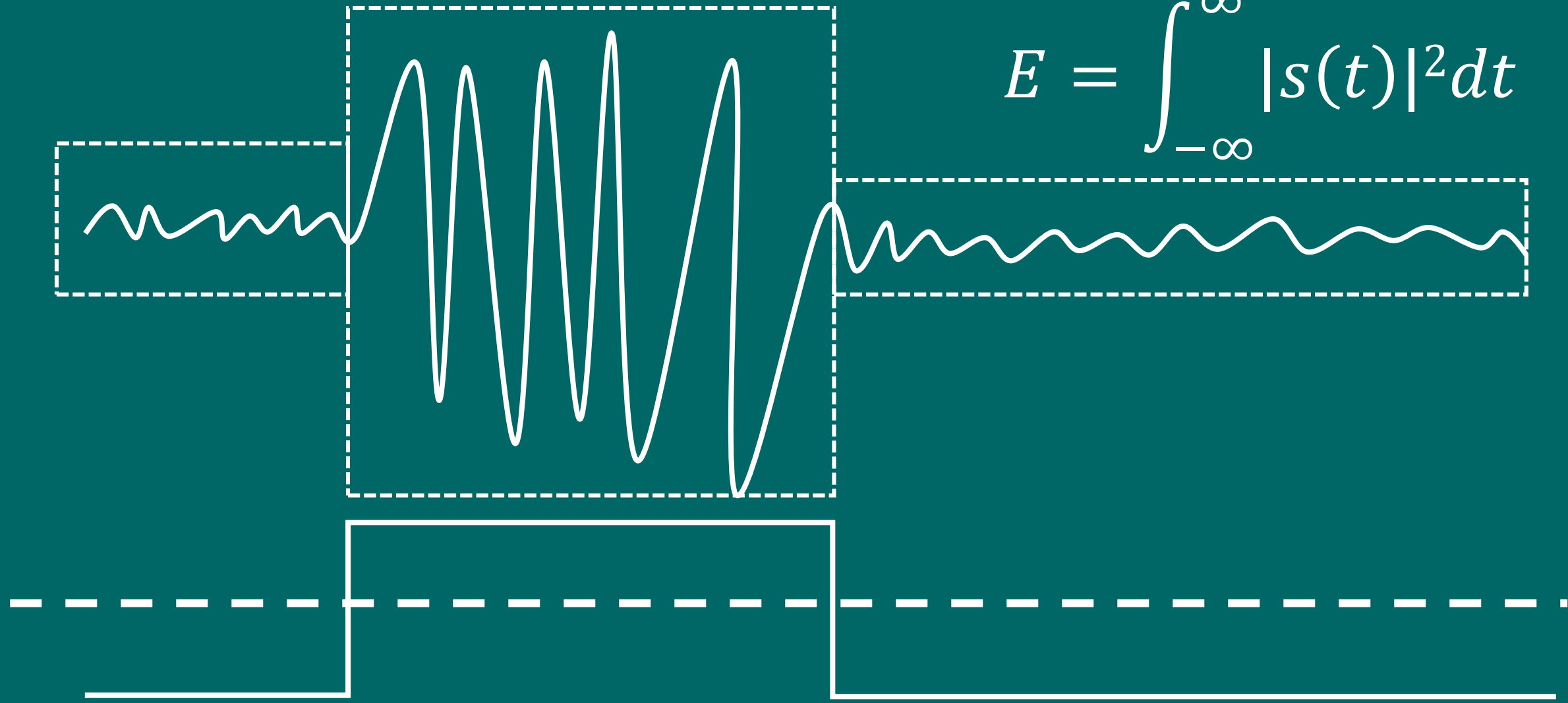
$W_1 = [ABC]$
$W_2 = [DEF]$
$W_3 = [GHI]$
$W_4 = [JKL]$

Overlapping Sliding Window

$W_1 = [ABC]$
$W_2 = [BCD]$
$W_3 = [CDE]$
$W_4 = [DEF]$
$W_5 = [EFG]$
$W_6 = [FGH]$
$W_7 = [GHI]$
$W_8 = [HIJ]$
$W_9 = [IJK]$
$W_{10} = [JKL]$

Energy-Based

$$E = \int_{-\infty}^{\infty} |s(t)|^2 dt$$



Additional Context Sources

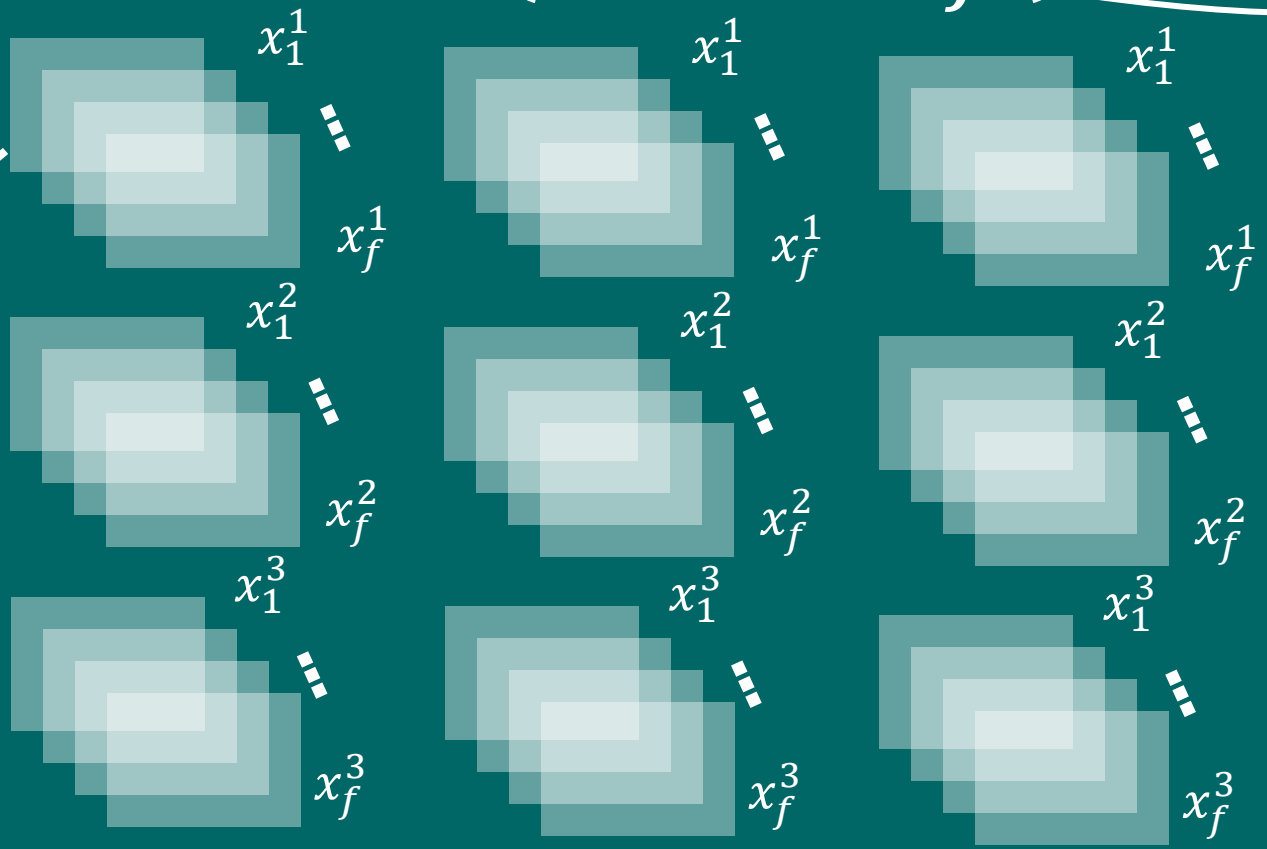
FEATURE EXTRACTION

W

$$X_i = \left(x_1^1, \ldots, x_f^n\right)$$

n data streams

f features



FEATURES

Min

Skewness

Mean

Energy

Range

Kurtosis

Max

Variance

CLASSIFICATION

Activity

$$P_i(y|X_i,\theta)$$

Model parameters

Feature set

For each segment

$P_1(swimming|X_1,\theta)$ $P_1(sitting|X_1,\theta)$ $P_1(running|X_1,\theta)$

Hidden Markov Models

Dynamic Time Warping

kNN

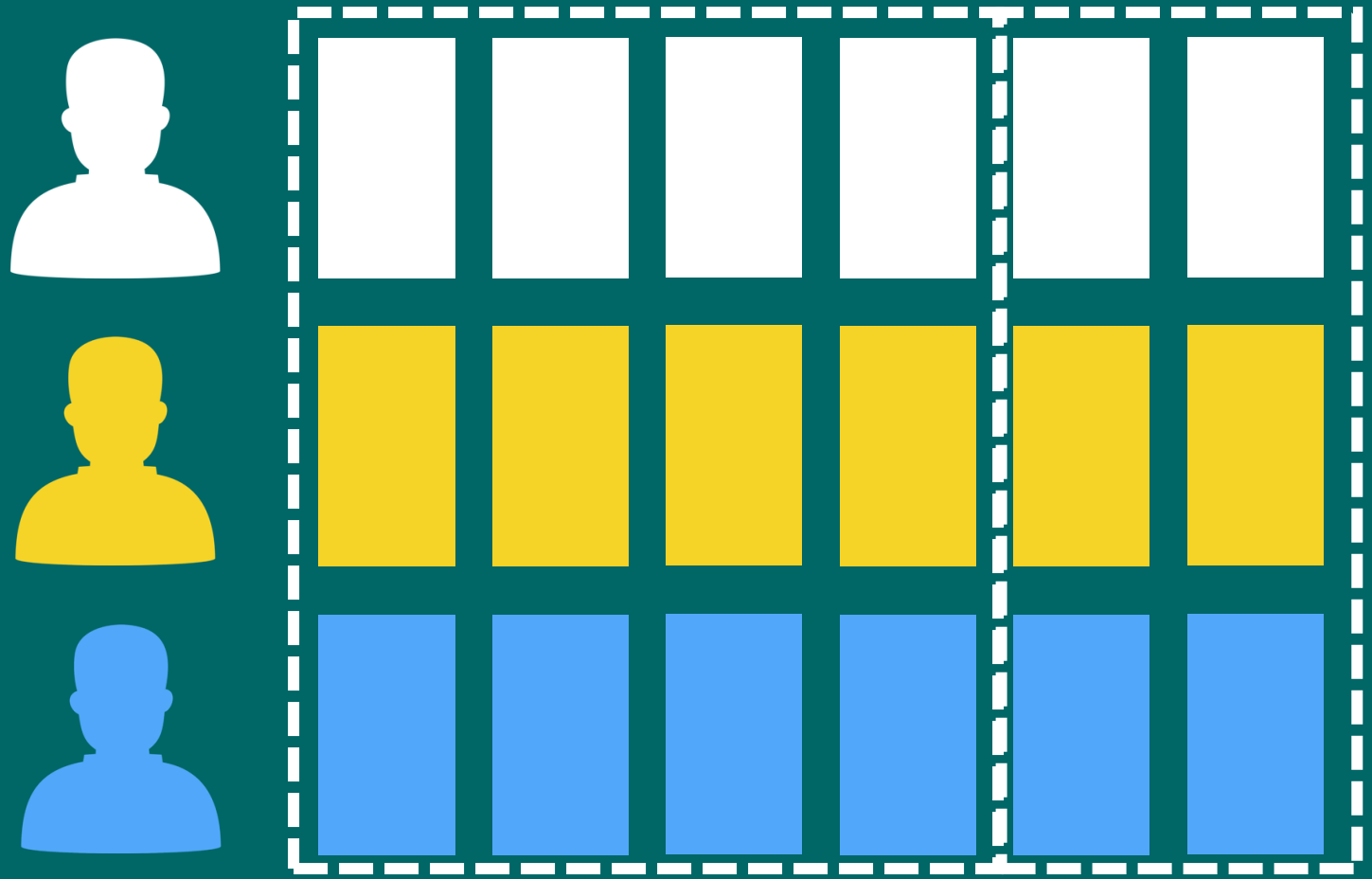
CLASSIFIERS

AdaBoost

Support Vector Machines

Random Forest

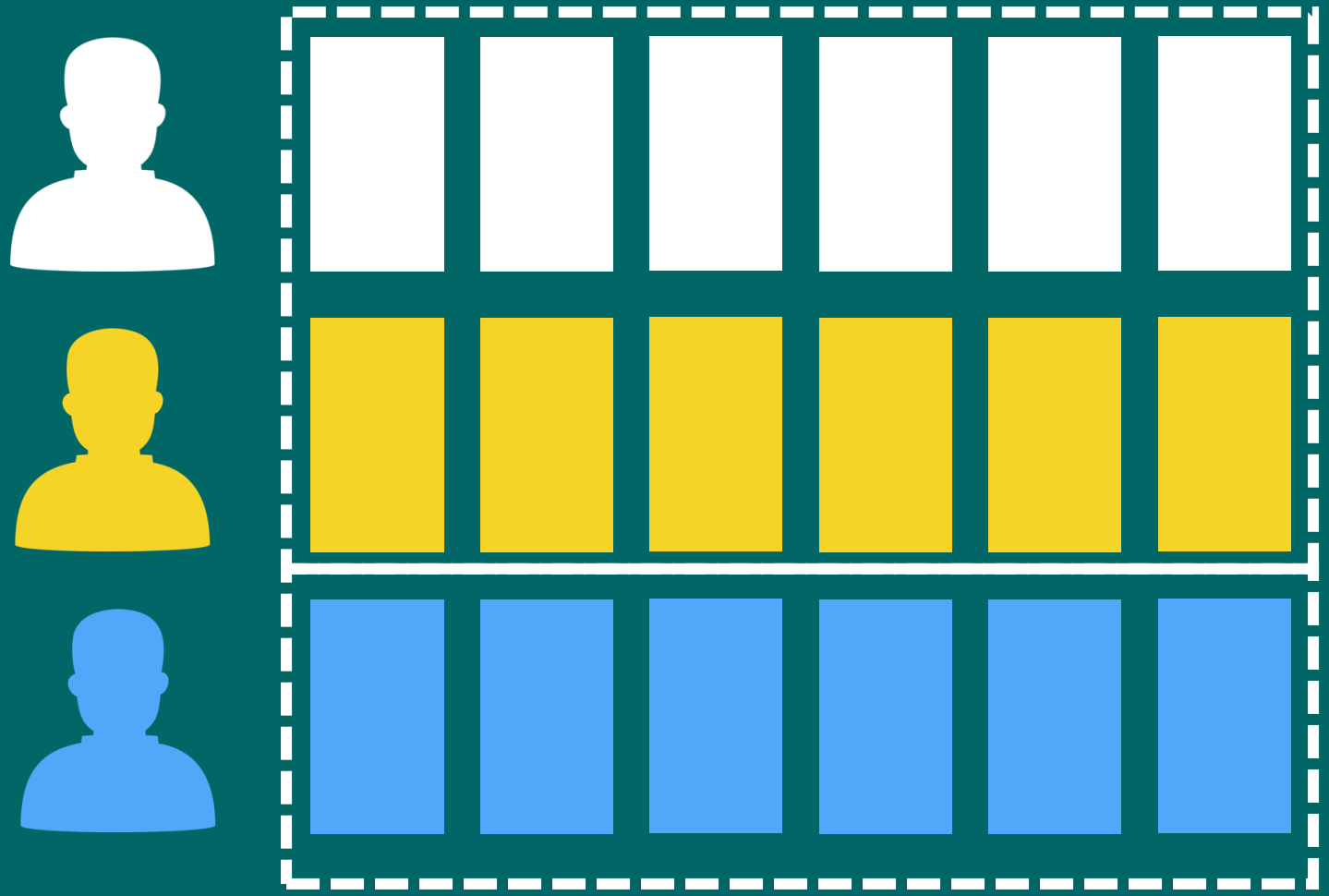
TRAINING A CLASSIFIER



Training *Testing*

User-Dependent

TRAINING A CLASSIFIER

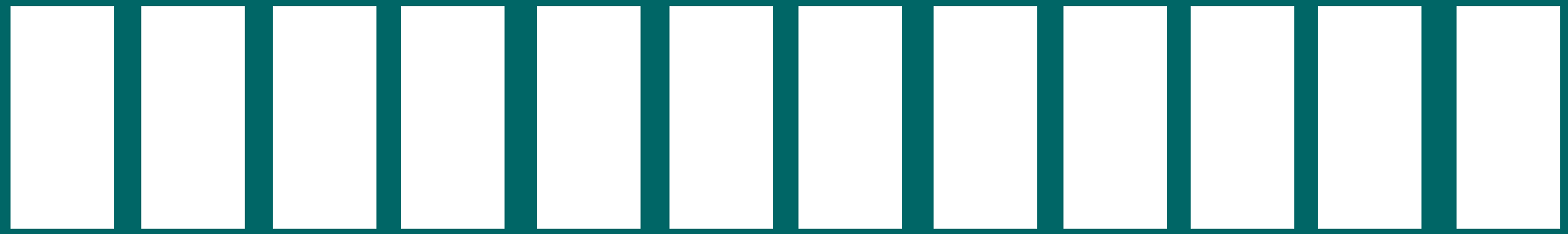


Training

Testing

User-Independent

Cross-Validation

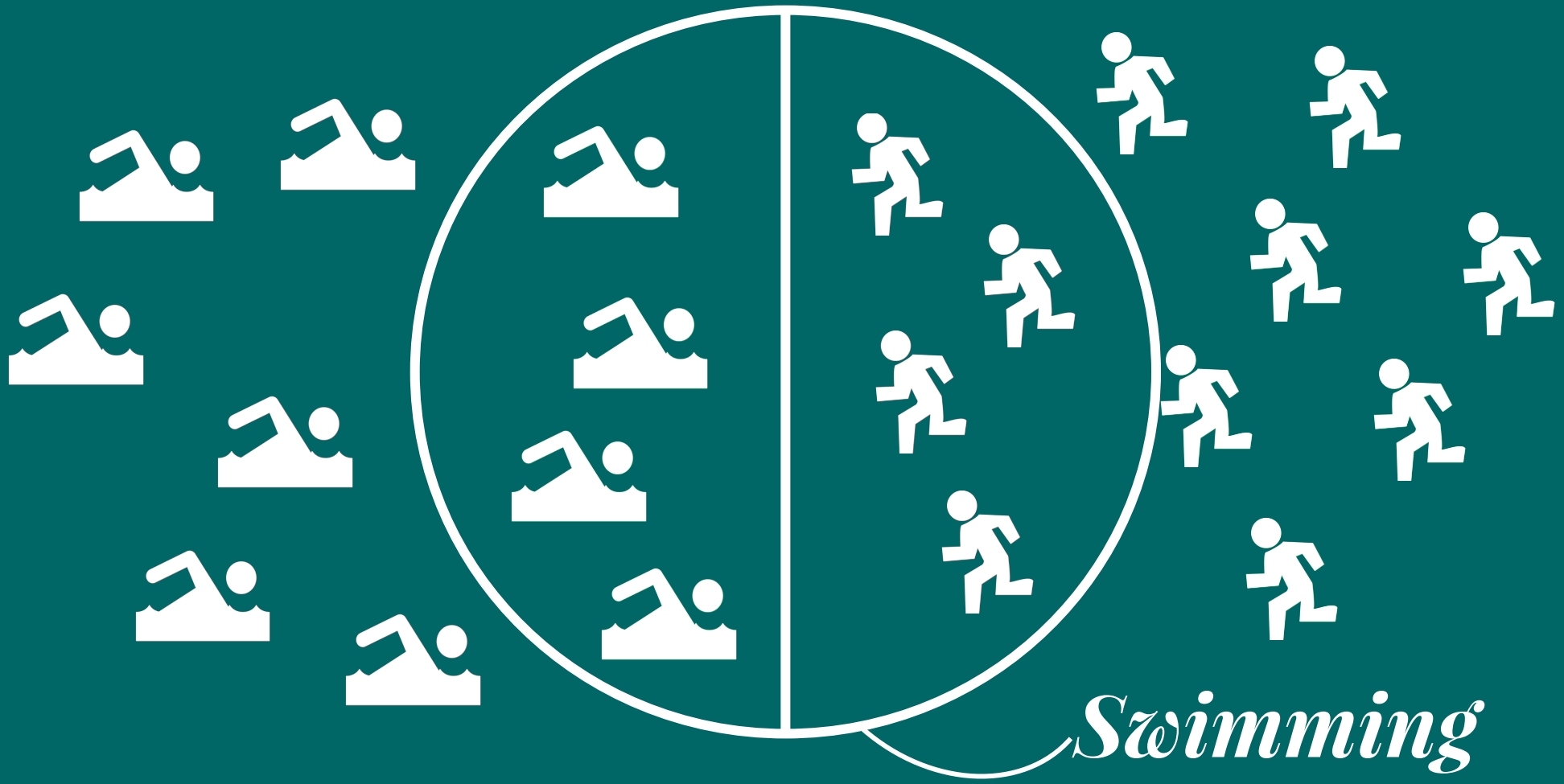
Training 

Testing

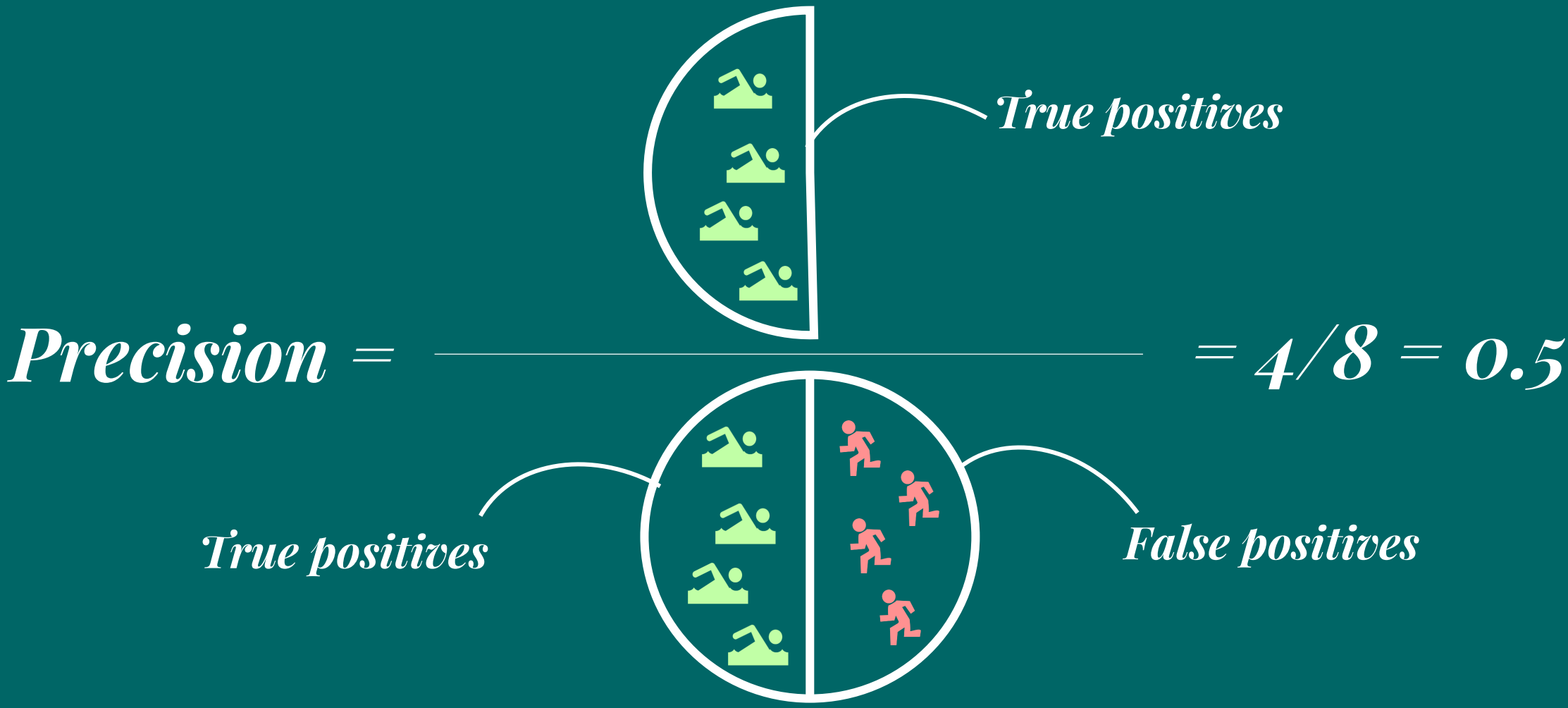
.85

.89 .72 .90 .99 .80 .83 .84 .91 .77 .80

REPORTING PERFORMANCE



What proportion of the labelled items were correct?



Select font size T T T

If the recognition of an activity has 100% precision and the system says that the activity is NOT happening, we can be sure that the activity is not happening.

☑ Allow Retry

True

False

Preview

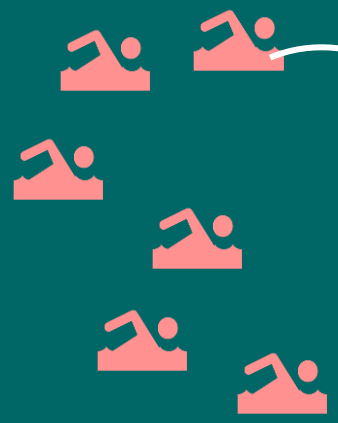
What proportion of the windows with that activity were recognised?

True positives

$$\text{Recall} = \frac{\text{True positives}}{\text{True positives} + \text{False negatives}} = 4/10 = 0.4$$

True positives

+



False negatives

Consider the case of the app for detecting when an elderly person has fallen down. Would you optimise this system for precision or recall? Justify your answer

Combining both metrics…

$$F_1\ Score = \frac{2}{\frac{1}{Recall} + \frac{1}{Precision}}$$

$$= 2\frac{Precision \times Recall}{Precision + Recall}$$

Confusion Matrix

System Output

Ground Truth

0.4	0.1	0.1	0.4
0	1.0	0	0
0	0.1	0.9	0
0.4	0.1	0.4	0.1

A TUTORIAL ON HUMAN ACTIVITY RECOGNITION USING BODY-WORN INERTIAL SENSORS

Andreas Bulling et al.

CASE STUDY

Plotz et al. 2010

What classes were the authors trying to recognise?

Check section 14.4.3

Describe the sensors used in terms of their form factor, their sampling rate, and the data they captured.

Select font size T T T

How did the authors segment the sensor data?

Allow Single Choice Only | Allow Multiple Choices | Shuffle Answers | Allow Retry | Limit Attempts

- [x] Overlapping sliding window of fixed size

The authors used a window with 50% overlap with 64 samples

- [ ] Non-Overlapping window of fixed size
- [ ] Overlapping windows of variable size
- [ ] Non-overlapping windows of variable size

+ Add another answer

Preview

Which features the authors extracted from each window?

Select font size T T T

How did the authors classify the activities?

Allow Single Choice Only | Allow Multiple Choices | Shuffle Answers | Allow Retry | Limit Attempts

- Gaussian Mixture Density Models
- Support Vector Machines
- Hidden Markov Models
- Naive Bayes
- Random Forest

+ Add another answer

Preview

Select font size T T T

Which activity was "coring" most mistaken with in the closed set experiments?

Allow Single Choice Only | Allow Multiple Choices | Shuffle Answers | Allow Retry | Limit Attempts

Slicing

Observing the "coring" row in table 14.3, we see that 41 samples were mistakenly classified as "slicing", which is higher than all others

Stirring

Chopping

Spreading

Scooping

Shaving

Unknown

Preview

Use the data in table 14.2 to compute the precision, recall, and F1 score for the class "shaving"

RECAP

Evaluation

Characteristics of HAR Systems

Opportunities for context recognition

Segmentation

Smart Utensils

Choosing sensors

Preprocessing

What is context?

Classification

What to do with context?

Feature Extraction

Select font size T T T

How do you feel about this lecture?

◉ Allow Single Choice Only ○ Allow Multiple Choices

Loved it!

Liked it

Neither liked it, nor disliked it

Disliked it

Hated it!

+ Add another answer

Preview

Select font size T T T

What did you like and dislike about this lecture? How can I improve it?

Preview