Interreg
France-Wallonie-Vlaanderen
UNION EUROPÉENNE
EUROPESE UNIE

NOMADe

AVEC LE SOUTIEN DU FONDS EUROPÉEN DE DÉVELOPPEMENT RÉGIONAL
MET STEUN VAN HET EUROPEES FONDS VOOR REGIONALE ONTWIKKELING

Projet N° 4.7.360 - Project N° 4.7.360

Machine Learning Can be Used to Predict and Identify Acute Neck Pain Patients Assessed with the DidRen laser test

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Renaud Hage, Frédéric Dierick, Fabien Buisseret, Lecointre Julien, Martin Houry.

16/10/21

Lille 2021
SOFMER
Société Française de Médecine Physique et de Réadaptation

36e CONGRÈS DE LA SOCIÉTÉ FRANÇAISE DE MÉDECINE PHYSIQUE ET DE RÉADAPTATION

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Neck Pain

Definition

Unpleasant **sensory and emotional experience** associated with **real or potential** tissue damage in the neck region.

Acute

Chronic

Neck Pain

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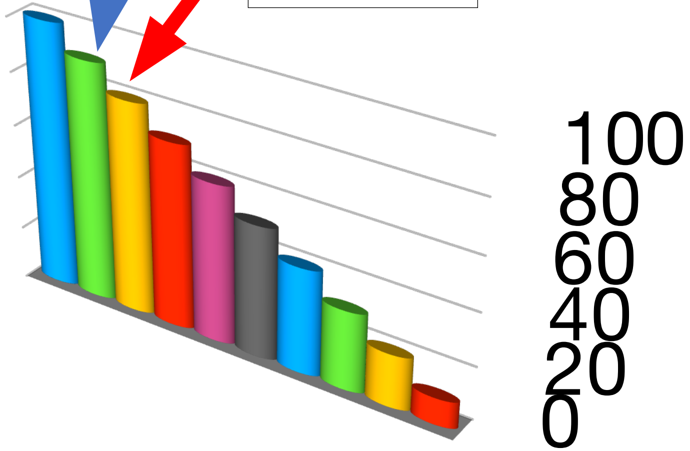
Prevalence

« Top Ten » Causes of Years Lived with Disability in Belgique/France.

Vos et al. in The Lancet, 2015

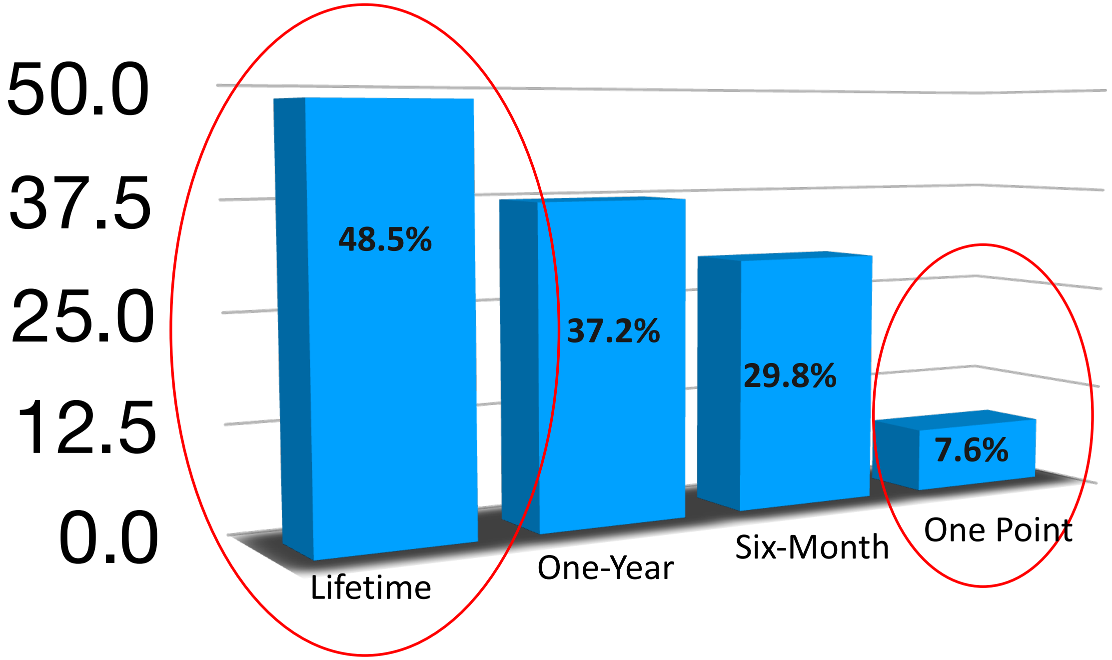
2nd position

3rd position



Neck Pain

Prevalence



Neck pain has a high prevalence in developed countries

(Fejer et al. 2006; Blanpied 2017)

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Important Considerations

Neck Pain

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Improving **Understanding** of the pathophysiological mechanisms **AND Management** of neck pain

Conducting observational **Sensorimotor Assessment** studies **using large databases** holds great promise (Tack, 2019; Sjolander 2008; de Zoete 2016; Treleaven 2017).

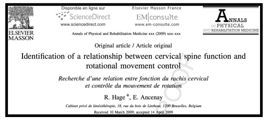
Machine learning is a field of artificial intelligence that can be used to **predict** status of Acute Non-Specific Neck Pain Patients and **identify** discriminative data (Tack, 2019).

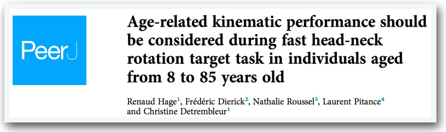
Neck Pain

The Objective of this Study

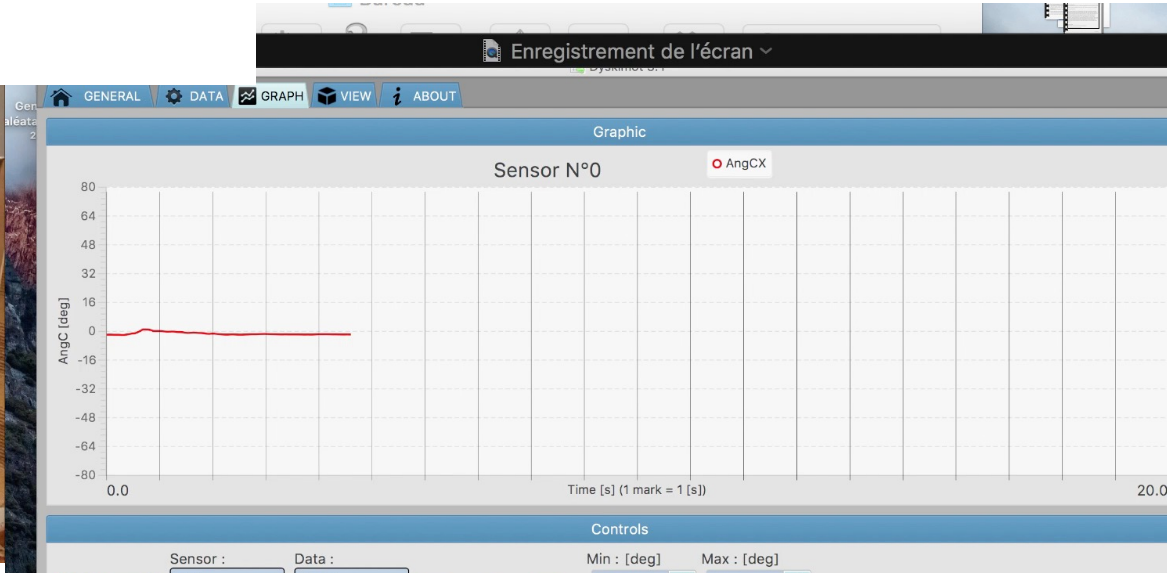
- Evaluate the potential usefulness of Artificial Intelligence methods in the assessment of **Sensorimotor Performance** of the neck with the **DidRen laser test** of Acute Neck Pain Patients compared to healthy control.

- **Thanks to dataset obtained during Sensorimotor Performance (DidRen laser test)**:
  - N=80 (38 Neck Pain Patients/42 Healthy Controls)


Disponible en ligne sur ScienceDirect www.sciencedirect.com
Elsevier Masson France EM|consulte www.em-consulte.com
Annals of Physical and Rehabilitation Medicine xxx (2009) xxx–xxx
Original article / Article original
Identification of a relationship between cervical spine function and rotational movement control
Recherche d'une relation entre fonction du rachis cervical et contrôle du mouvement de rotation
R. Hage*, E. Ancenay
Cabinet privé de kinésithérapie, 18, rue du bois de Linthout, 1200 Bruxelles, Belgium
Received 10 March 2009; accepted 14 April 2009

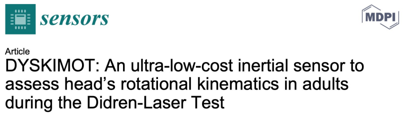

PeerJ
Age-related kinematic performance should be considered during fast head-neck rotation target task in individuals aged from 8 to 85 years old
Renaud Hage[1], Frédéric Dierick[2], Nathalie Roussel[3], Laurent Pitance[4] and Christine Detrembleur[1]


PLOS ONE
RESEARCH ARTICLE
Head-neck rotational movements using DidRen laser test indicate children and seniors' lower performance
Renaud Hage[1*], Fabien Buisseret[2], Laurent Pitance[1,3], Jean-Michel Brismée[4], Christine Detrembleur[1], Frédéric Dierick[2]



Development of a <u>valid</u> and <u>reliable</u> test to assess the sensorimotor function during Cervical Rotation: « DidRen Laser Test » (Hage et al. 2009; 2019).

Measured with a <u>Validated Inertial Sensor</u> : DYSKIMOT (Hage et al. 2019).


sensors
MDPI
Article
DYSKIMOT: An ultra-low-cost inertial sensor to assess head's rotational kinematics in adults during the Didren-Laser Test

Gyroscope=Angular displacement (Deg/s) and
Acceleromter=Acceleration (g)

The Objective of this Study

2	RECORD:	Start date :	21/02/19 19:19	End date :	21/02/19 19:20	Time [hh:mm:ss]:	00:00:52	Frequency [Hz
3								
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7	0.02	0.99	0.01	0.07	0.07	3.22	1.54	
8	0.03	0.98	0.02	0.07	0.7	3.15	1.4	
9	0.04	0.98	0.02	0.07	0.98	2.87	1.19	
10	0.05	0.98	0.03	0.06	1.89	2.59	0.84	
11	0.06	0.98	0.03	0.06	2.59	2.8	0.49	
12	0.07	0.98	0.03	0.07	3.01	2.66	0.07	
13	0.08	0.98	0.02	0.07	4.06	2.31	-0.07	
14	0.09	0.98	0.02	0.07	4.13	2.73	0.07	
15	0.1	0.98	0.02	0.06	4.9	2.73	-0.28	
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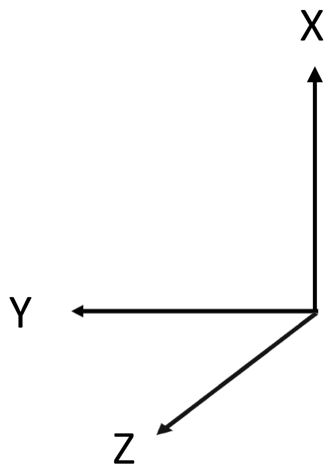
18	0.13	0.98	0.01	0.07	5.25	3.01	-0.7	
19	0.14	0.98	0	0.07	5.04	2.73	-0.77	
20	0.15	0.98	0	0.07	4.9	2.59	-1.19	
21	0.16	0.98	0	0.07	4.9	2.59	-1.12	
22	0.17	0.99	0	0.07	4.62	2.87	-0.7	
23	0.18	0.99	0	0.07	4.27	2.52	-0.77	
24	0.19	0.99	0	0.07	3.99	2.52	-0.63	
25	0.2	0.98	0	0.07	3.36	2.45	-0.28	
26	0.21	0.98	0	0.06	3.5	2.38	0.07	
27	0.22	0.98	0.01	0.07	3.64	1.89	-0.07	
28	0.23	0.98	0.01	0.07	3.78	1.68	-0.21	
29	0.24	0.98	0.02	0.07	3.99	1.4	-0.42	
30	0.25	0.98	0.01	0.08	3.85	1.68	-0.28	
31	0.26	0.98	0.01	0.08	4.06	1.26	-0.56	
32	0.27	0.98	0.01	0.08	3.85	1.61	-0.49	
33	0.28	0.97	0.01	0.08	4.27	1.82	-0.14	
34	0.29	0.98	0.01	0.08	3.85	2.24	0.07	
35	0.3	0.97	0.01	0.08	4.27	2.24	-0.35	
36	0.31	0.98	0.01	0.07	4.2	2.38	-0.49	
37	0.32	0.97	0.01	0.08	4.55	2.17	-0.84	
38	0.33	0.97	0.01	0.08	3.99	2.8	-0.7	



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The Objective of this Study

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7	0.02	0.99	0.01	0.07	0.07	3.22	1.54	
8	0.03	0.98	0.02	0.07	0.7	3.15	1.4	
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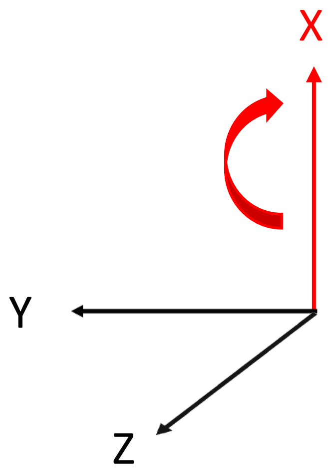

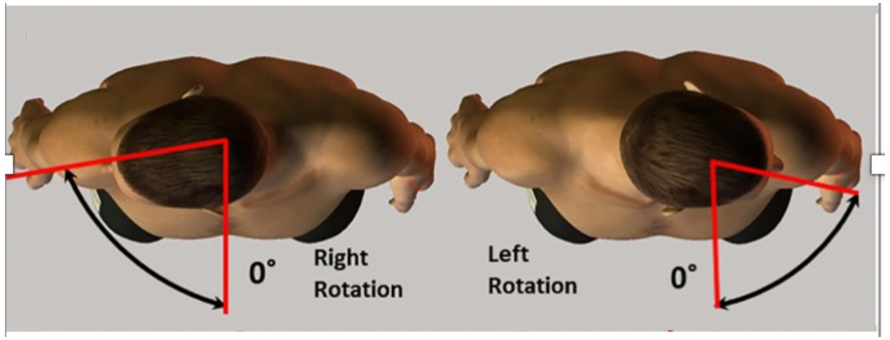

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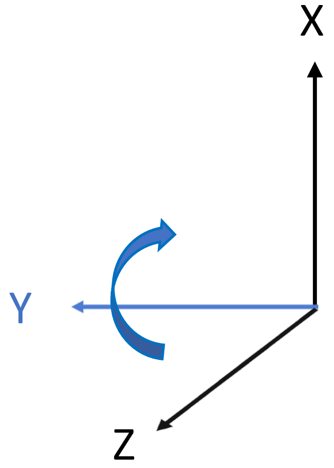

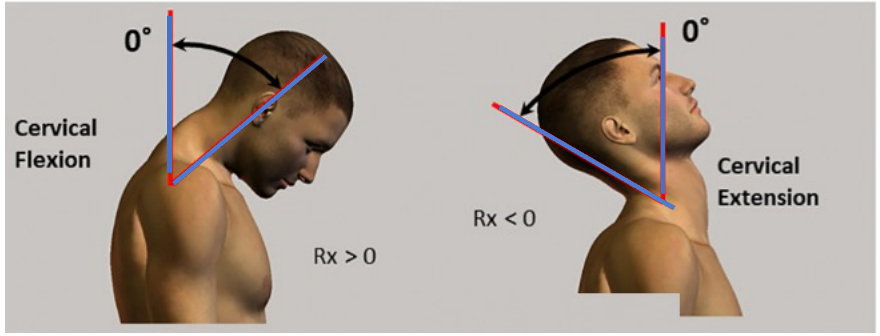

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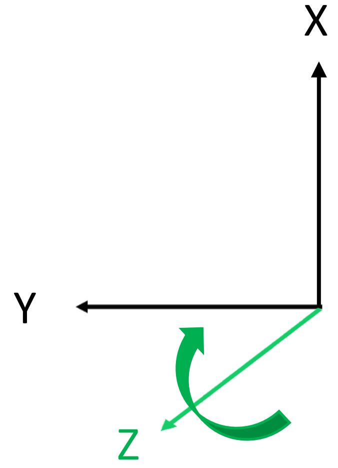

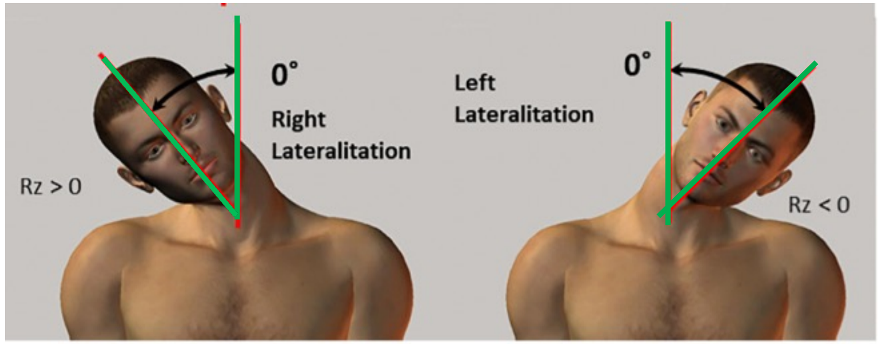

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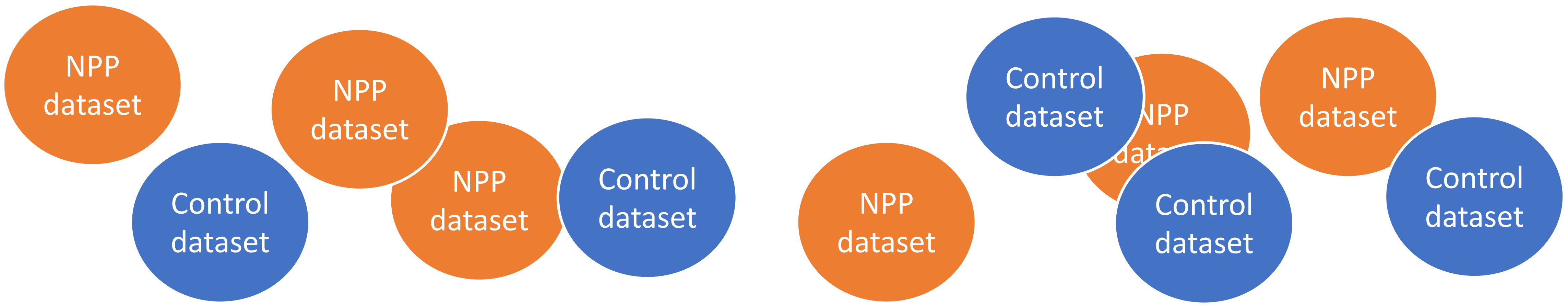
3 Stages:

chine Learning – How does it work?

- Machine Learning algorithms learns and acquire experience based on datasets…to predict….

- Learn ……. main differences between the populations.

- Acquire Experience …….. to predict their appartenance of Healthy Control Participants or Acute Neck Pain Patients.



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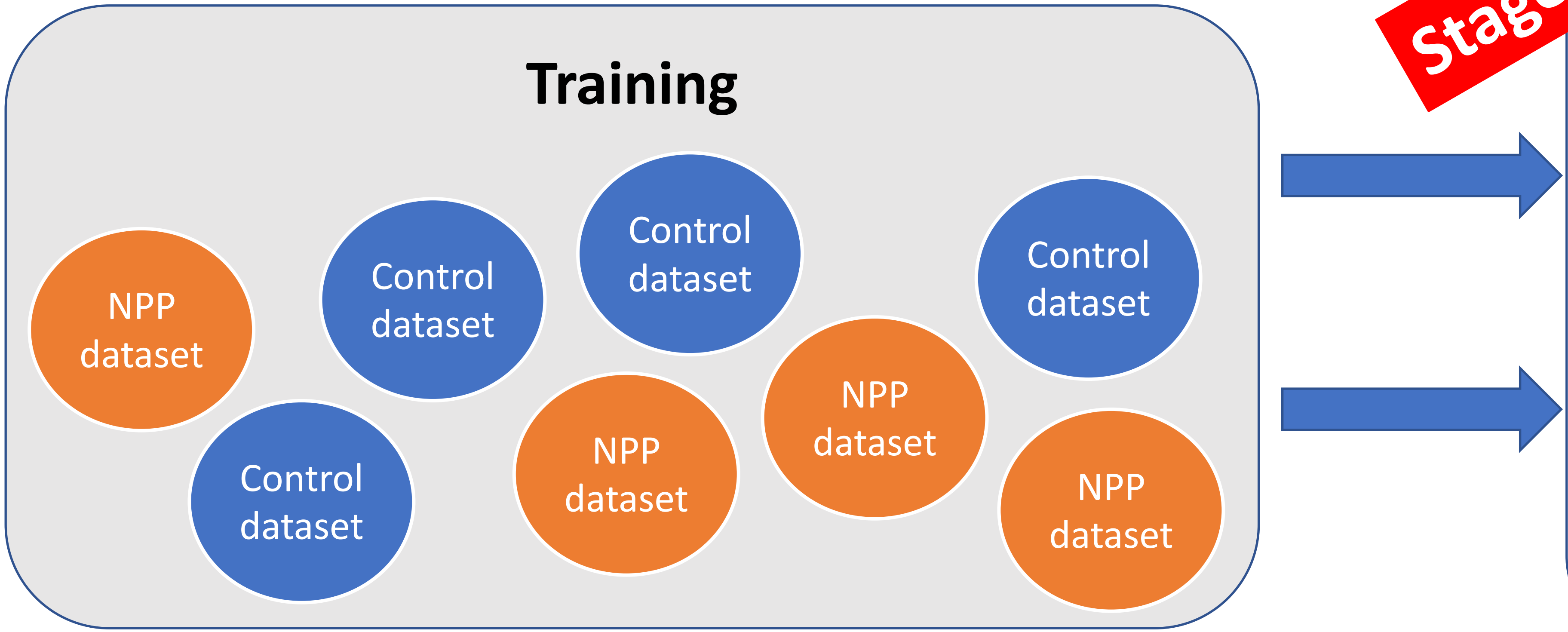
Stage 1

…chine Learning – How does it work?

- The training help the Machine Learning algorithms to identify the usual main differences between Patients datasets and Control Subject datasets.

Stage 2



Main differences

Gyroscope Y (deg/s) values are higher in **Control Subject** datasets

Acceleromer Z (g) values are higher in **Patient** datasets

Machine Learning – How does it work?

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Main differences

Gyroscope Y values are higher in **Control Subject** datasets

Acceleromer Z values are higher in **Patient** datasets

Stage 3

Make predictions

Stage 3

chine Learning – How does it work?

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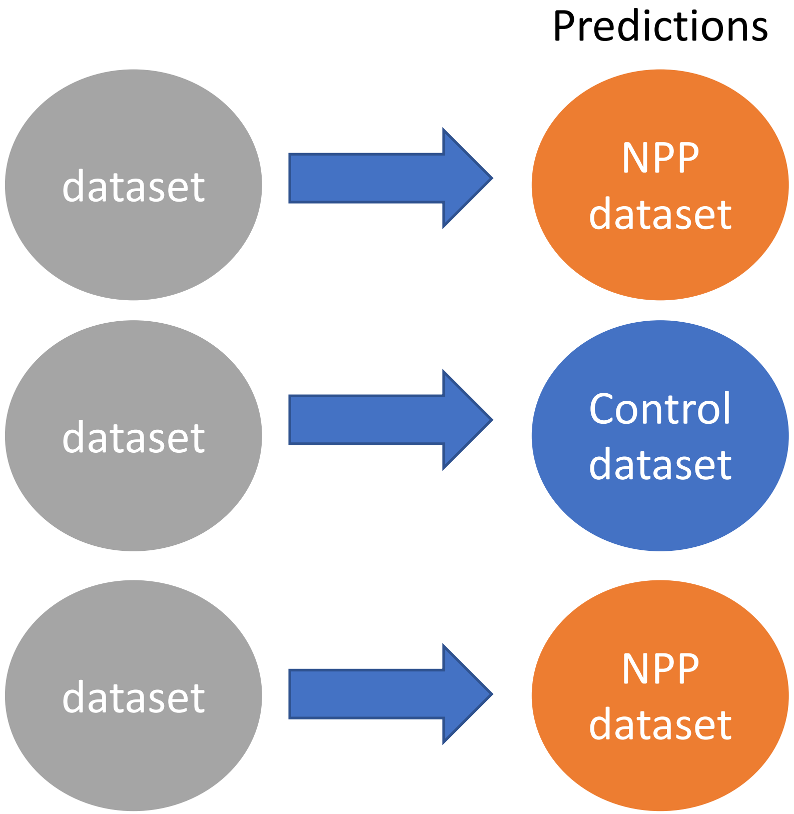
- New datasets are evaluated by the trained machine leanrning algorithm.



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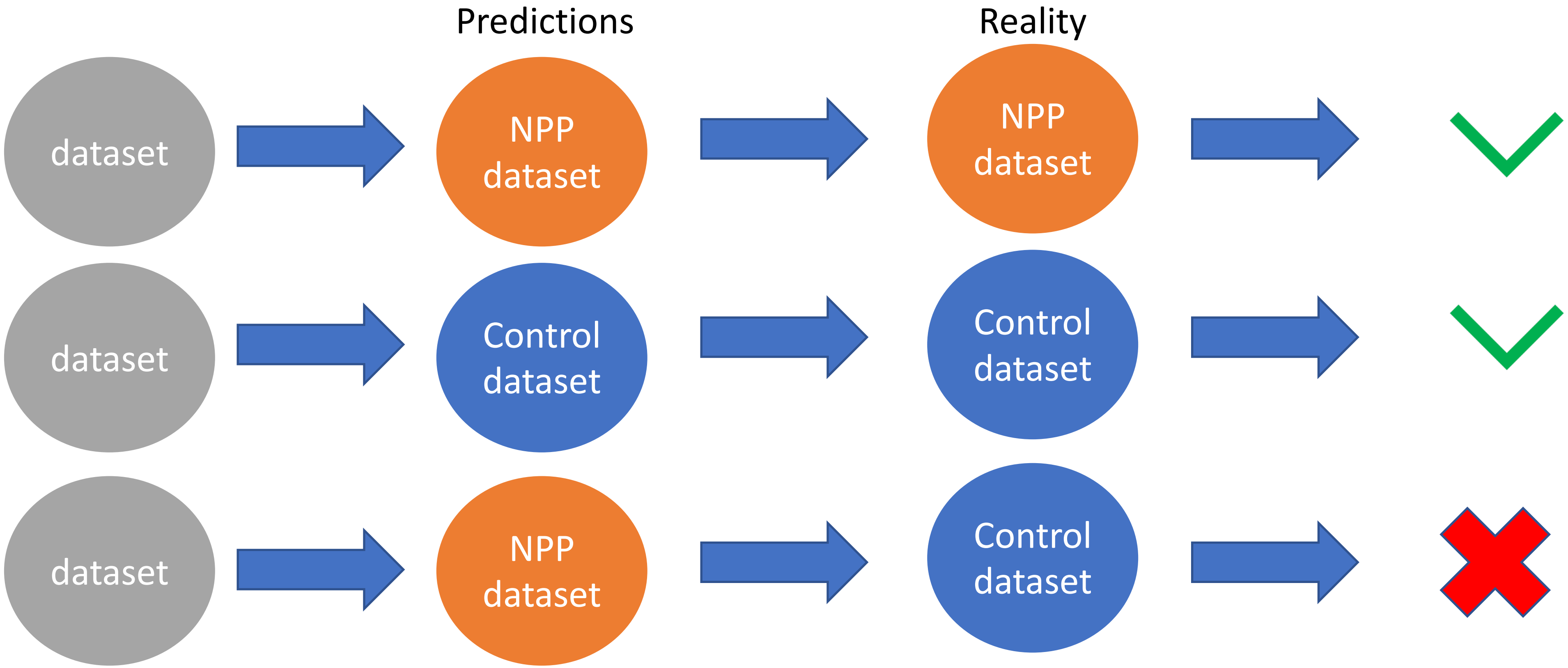
Stage 3

chine Learning – How does it work?

- Datasets are evaluated by the trained machine learning algorithm.
- Then the predictions are compared to reality (Human controled dataset)

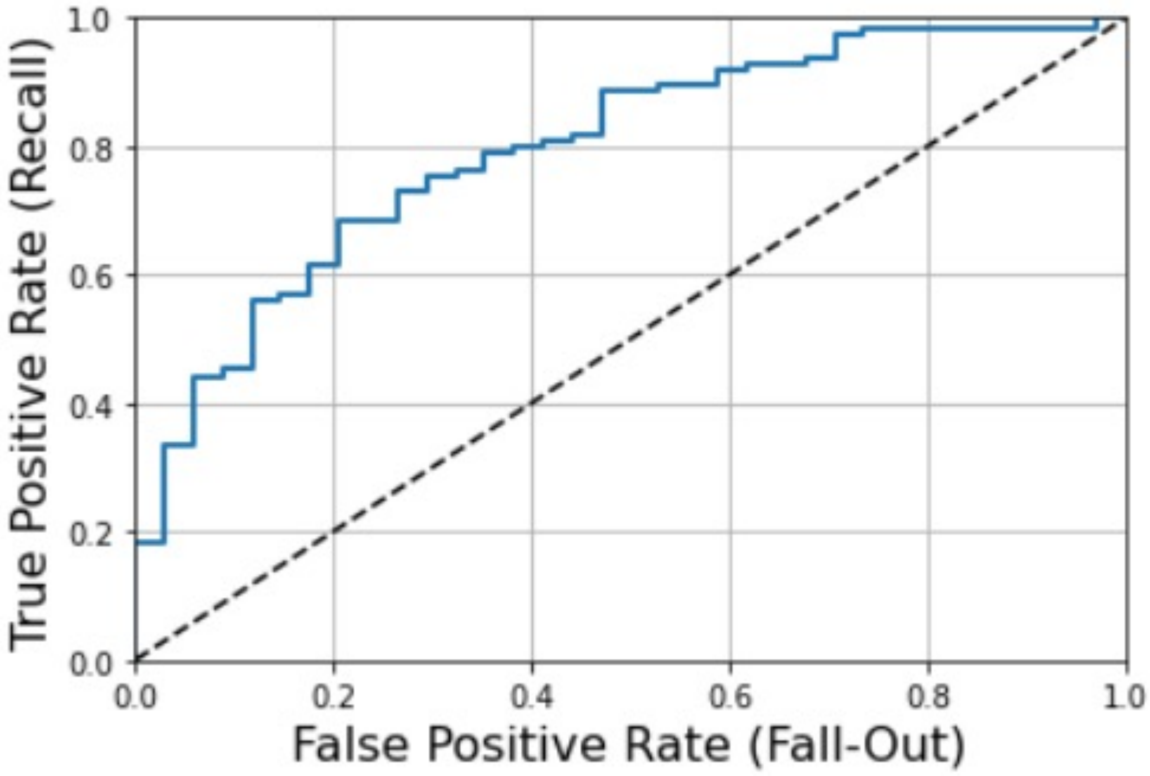


Machine Learning – Results

- After feature selection, model selection and hyper-parameters optimizations :

82,4% Accuracy

79,6% AUC

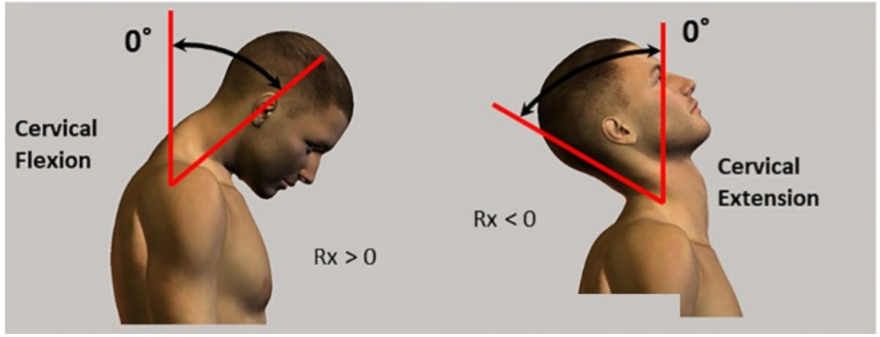


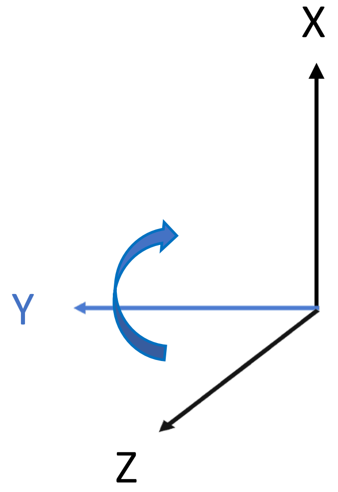
Machine Learning – Results

- The best peforming sensor axe for predictions has been computed with Sequential Feature Selection methods (SFS backward/forward).

Gyroscope Y

Most useful sensor axe for accurate predictions





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Machine Learning – Results

- Clinical Implications:
  - During Rotation (primary movement), it is the Flexion/Extension (secondary movement) that seems to discriminate patients from healthy subjects.
  - Clinical observation of movement focuses on the evaluation of speed, saccades and <u>especially changes in the axis of movement</u>

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MET STEUN VAN HET EUROPEES FONDS VOOR REGIONALE ONTWIKKELING

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ECOSYSTÈME D'APPRENTISSAGE, R&D ET EXPERTISE TRANSFRONTALIER DÉDIÉ AUX TROUBLES NEURO-MUSCULO-SQUELETTIQUES

LEERECOSYSTEEM, O&O EN GRENSOVERSCHRIJDENDE EXPERTISE GEWIJD AAN NEURO-MUSCULOSKELETALE AANDOENINGEN