BMDs for Sleep

Operationalizing sleep from actigraphy in normal elderly and neurodegenerative disease

March 2017

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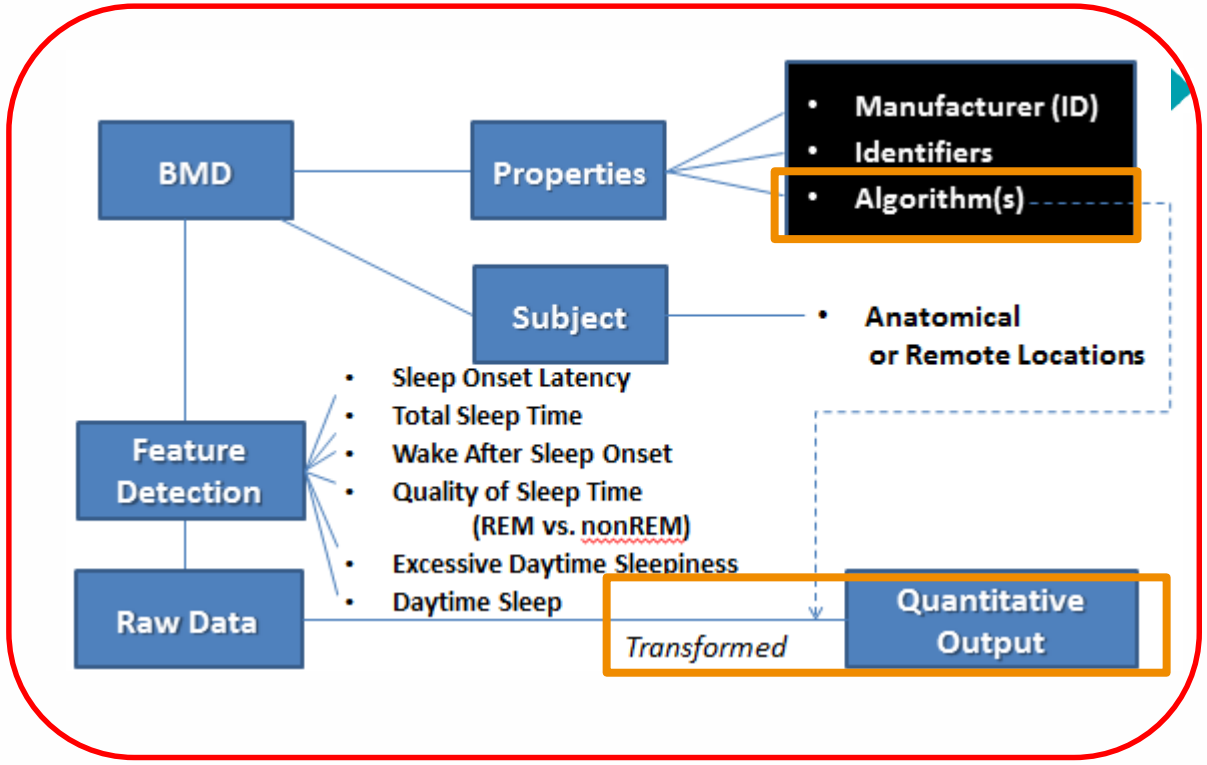
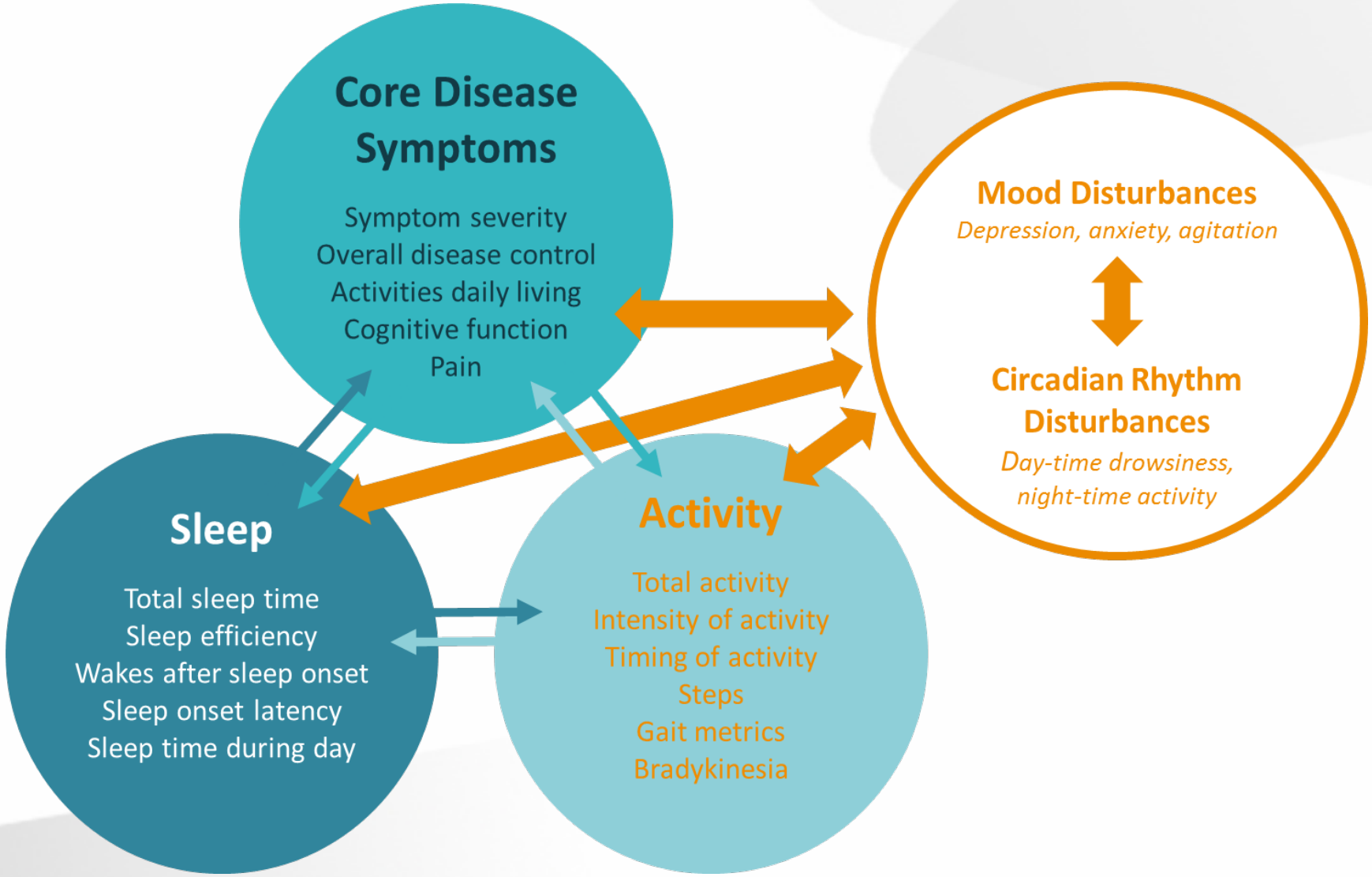
Overview



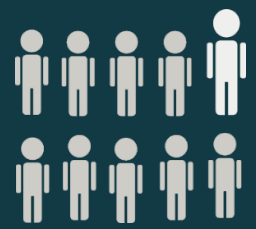
Challenges to deploying BMS for Sleep in Clinical trial of older people and those with neurodegenerative diseases

- Clinical contextualization: a very different group from main users of commercial activity trackers
- GCP deployment and data management – what we can do now
- Further work


Core Disease Symptoms
Symptom severity
Overall disease control
Activities daily living
Cognitive function
Pain
Mood Disturbances
Depression, anxiety, agitation
Circadian Rhythm Disturbances
Day-time drowsiness, night-time activity
Sleep
Total sleep time
Sleep efficiency
Wakes after sleep onset
Sleep onset latency
Sleep time during day
Activity
Total activity
Intensity of activity
Timing of activity
Steps
Gait metrics
Bradykinesia

CONTEXT

Actigraphy vs Polysomnography PSG and Sleep Diaries



- 30+ subjects
PD patients
Elderly controls

- Clinical and sleep assessments

Sleep Laboratory

- PSG & actigraphy
- 1 night

Home

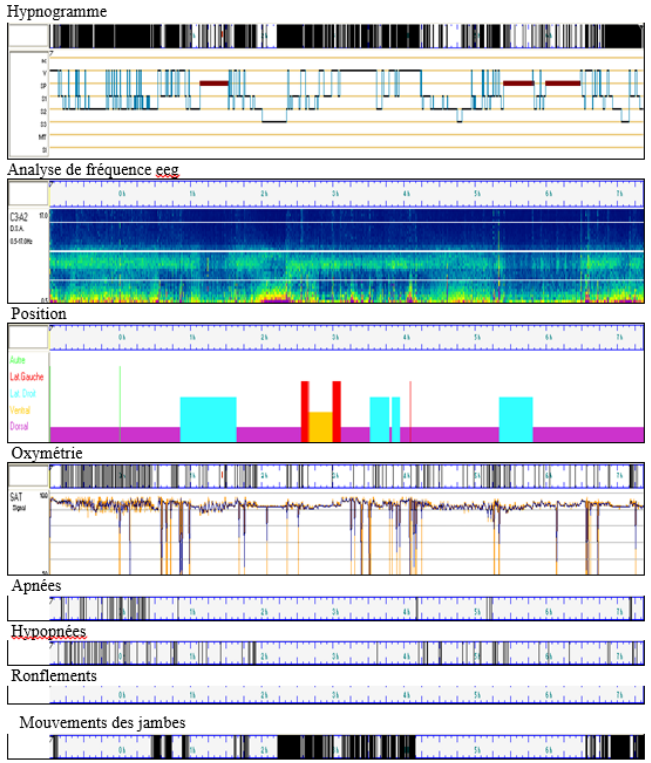
- Sleep diaries & actigraphy
- 13 nights

- Device data, PSG & sleep diary outcomes compared
- End points & algorithms defined

Collaboration between IXICO and Yves DAUVILLIERS, Montpellier

CONTEXT

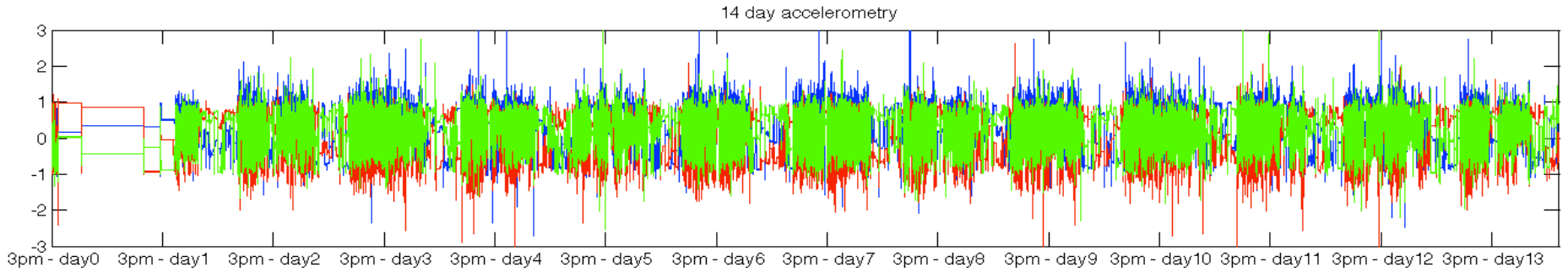
Study Data



PSG

Day 1 Overnight sleep lab
Simultaneous PSG & actigraphy

Day 2-14 home recording
Sleep diary & actigraphy



Actigraphy

CONTEXT

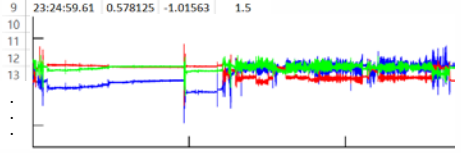
Sleep Measurement From Actigraphy

Download data

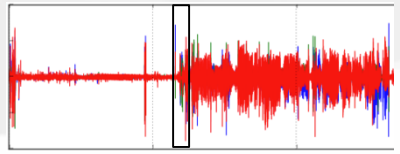
Binary (.cwa)

Extract raw data

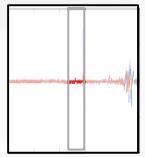
	Timestamp	ACC-X	ACC-Y	ACC-Z
2	23:24:59.54	0.625	-0.21875	0.75
3	23:24:59.55	0.625	-0.42188	0.796875
4	23:24:59.56	0.65625	-0.60938	0.8125
5	23:24:59.57	0.625	-0.60938	0.65625
6	23:24:59.58	0.578125	-0.60938	0.53125
7	23:24:59.59	0.546875	-0.65625	0.484375
8	23:24:59.60	0.546875	-0.75	0.484375
9	23:24:59.61	0.578125	-1.01563	1.5

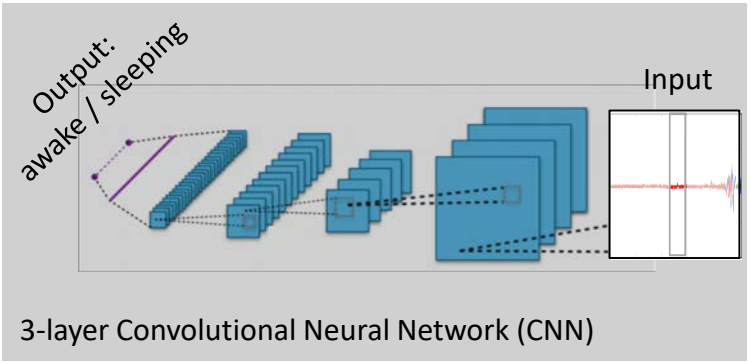


Normalize data



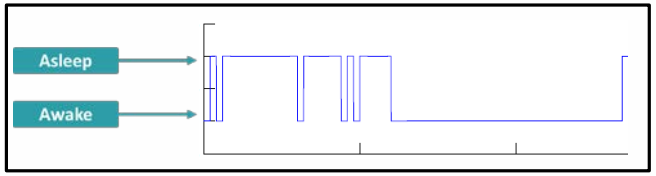
Extract features





3-layer Convolutional Neural Network (CNN)

Predict sleep



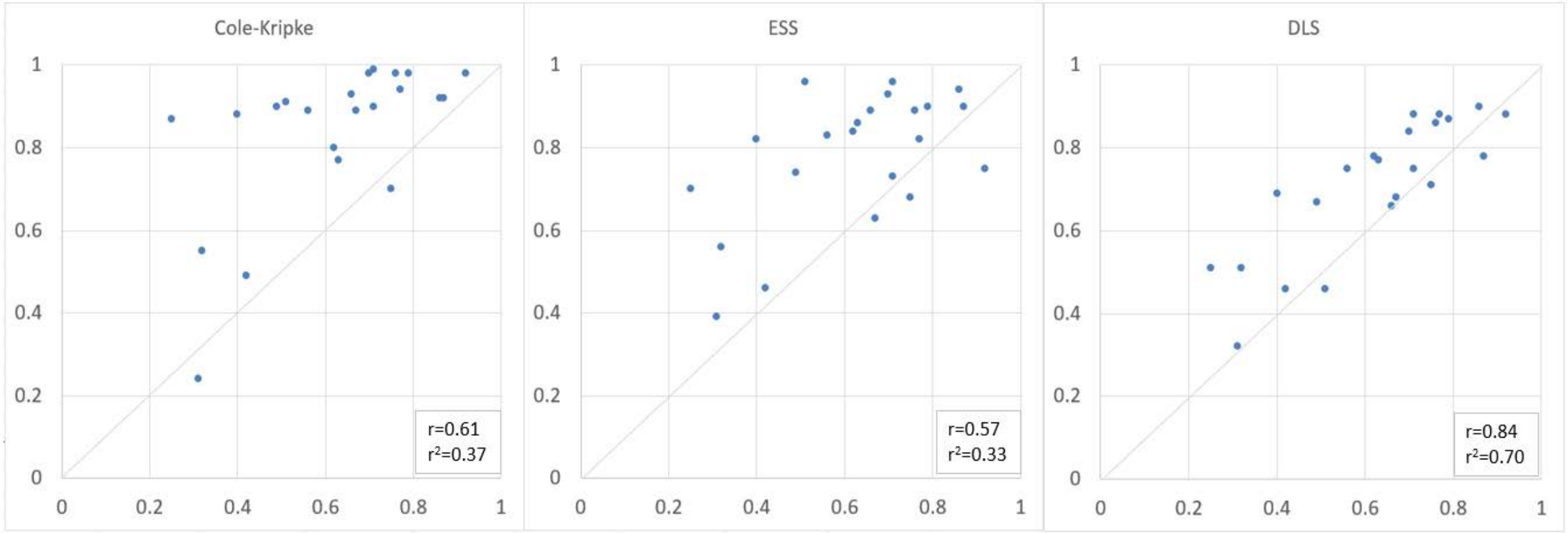
Derive metrics

Derived metrics:

- **Sleep /awake status**
- **Sleep efficiency**
- Total time asleep
- Total time awake
- Sleep onset latency
- Times awake

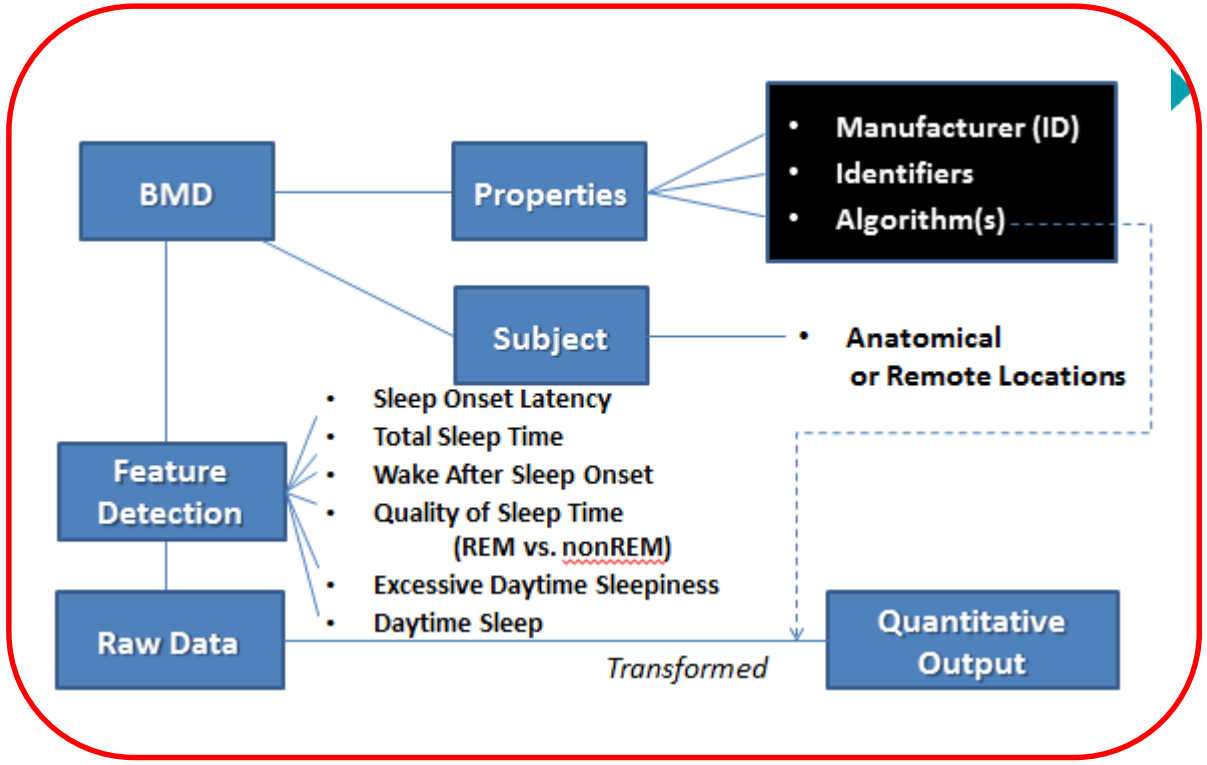
Sleep efficiency: BMD vs PSG

Benefits of deep learning method compared to more standard algorithms



Cole-Kripke: Cole et al. Sleep (1992) ESS: Borazio et al. Int Conf Health Inf (2014) IXICO Deep Learning Sleep

Overview



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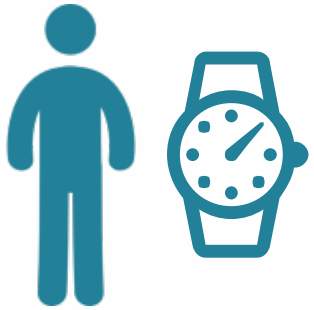
GCP Solution



IXICO Technology Platform

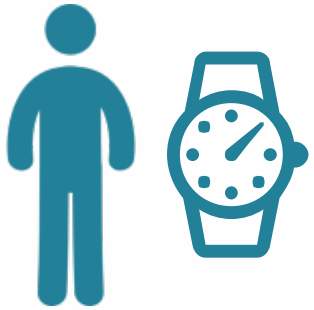
IXICO actigraphy algorithms

Regulatory compliant data handling

3rd party bio-signature algorithms

to CDMS

GCP Solution



IXICO Technology Platform

IXICO actigraphy algorithms

Regulatory compliant data handling

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to CDMS

Operational Delivery

Clinical site

- Distribute devices to subjects
- Train subjects
- Support subjects

CRO (or IXICO)

- Train and monitor sites
- Upload data (or train site to upload data)
- Device distribution to sites

IXICO

- Train CRO
- Provide subject training material
- Process raw device data to generate endpoints

Sponsor

- Write protocol
- Receive study results

Further work

- Analytics validity: within and between sensor device performance (test:re-test etc)
- More data to improve clinical contextualization
- Extend beyond sleep (mobility, mood, …)

- Leverage clinical trials for collaborations to improve clinical meaningfulness

- Can we have between-device standardization so sensors can be interchanged with the same analysis, without need to repeat clinical studies?