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VOICE BIOMARKERS FOR DIGITAL PSYCHIATRY

THE LESSONS OF A MISSED RENDEZ-VOUS

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April 26, 2023

LaBRI

université
de **BORDEAUX**

 **SANPSY**
BORDEAUX
neurocampus

ATER

Voice biomarkers in **psychiatry**

2022-.

DIU PHILO OF PSYCHIATRY

2021

2019-2022 Ph. D.

« New **voice biomarkers** for the automatic detection of **sleepiness**»

Jean-Luc Rouas (LaBRI - IS)

Pierre Philip (SANPSY, CHU de Bordeaux)

RESEARCH ENGINEER 2018-2019

Projet Région IS-OSA

2015-2018 ENGINEER ENSEA

Specialty: **multimedia systems** electronics

**TW : suic*de,
psy disorder**

« Health is a state of complete **physical, mental and social** well-being and not merely the **absence of disease** or infirmity.»

WHO Constitution, 1999



$\frac{1}{8}$ of the pop.
Mental disorder

-20 year
Life expectancy

$\frac{1}{3}$ dépression
Without structured mental health care

CHALLENGES OF DIGITAL MEDICINE

REGULAR

ECOLOGICAL

OBJECTIVE

“Gold-standard diagnostic and assessment tools for depression and suicidality remain rooted, almost exclusively, on the **opinion of individual clinicians** risking a range of **subjective biases**. Currently there is no **objective measure**, with **clinical utility**, for either depression or suicidality”

NEED FOR OBJECTIVE DIAGNOSTIC

28 mhealth professional

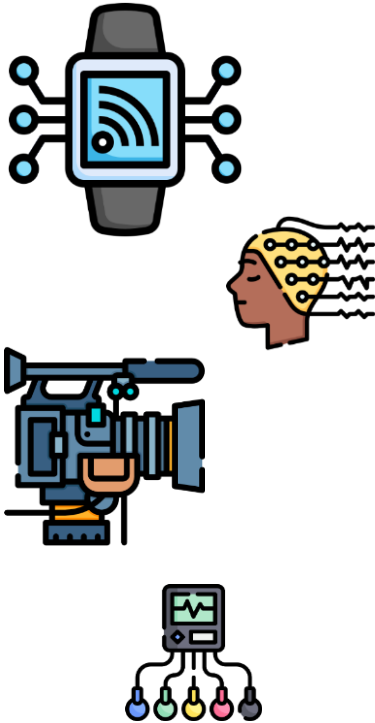
87% diagnostic = not reliable

14,9% pathologies definition

21,6% patient characteristics

63,5% clinicians





« Physiological » measurement

Not invasive

Passive

Smartphones

80% of the world pop.



- 1 Transparency
- 2 Scientific validity



179 applications

2 publications



53% proof

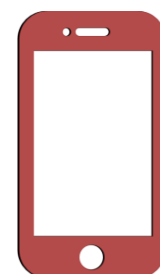
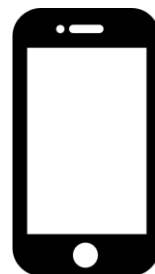
73 applications

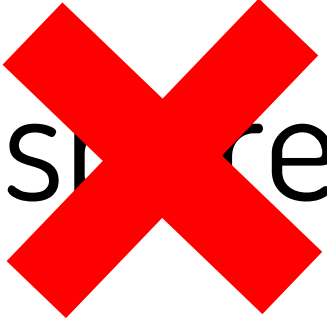
49 claims

27% not clear

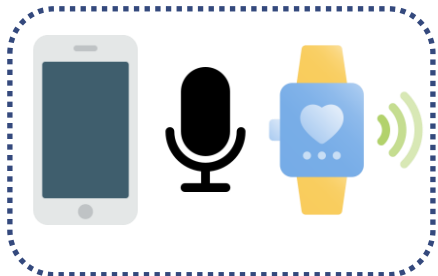


20% no proof



- 1 Transference 
- 2 Scientific validity
- 3 Therapeutic relationship

THERAPEUTIC RELATIONSHIP



SELF-OPTIMIZATION

RESPONSABILITY

CLINICAL TIME

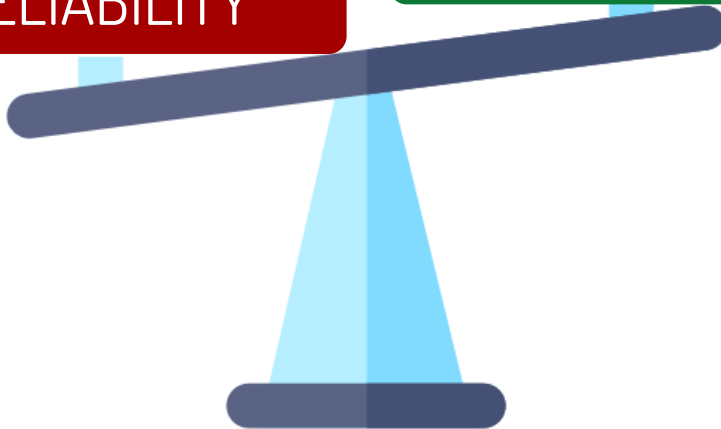
TRANSPARENCY

RELIABILITY

EMPOWEREMENT

NEW DATA

MORE DATA



« You have a XX% chance of being depressive »*

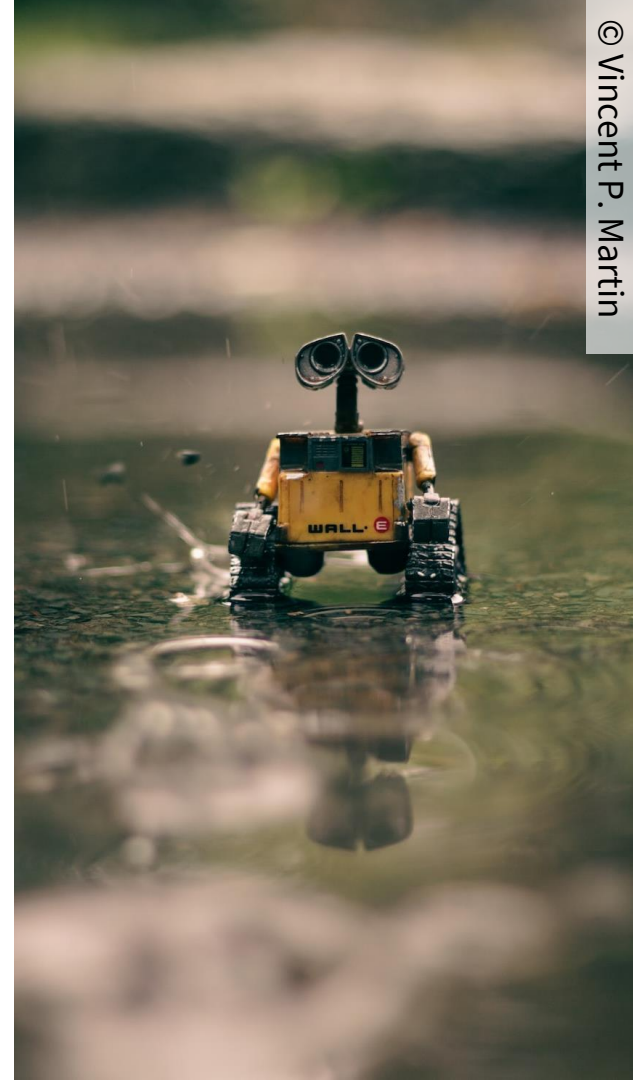
« You may have schizophrenia »*

« You are bipolar »*

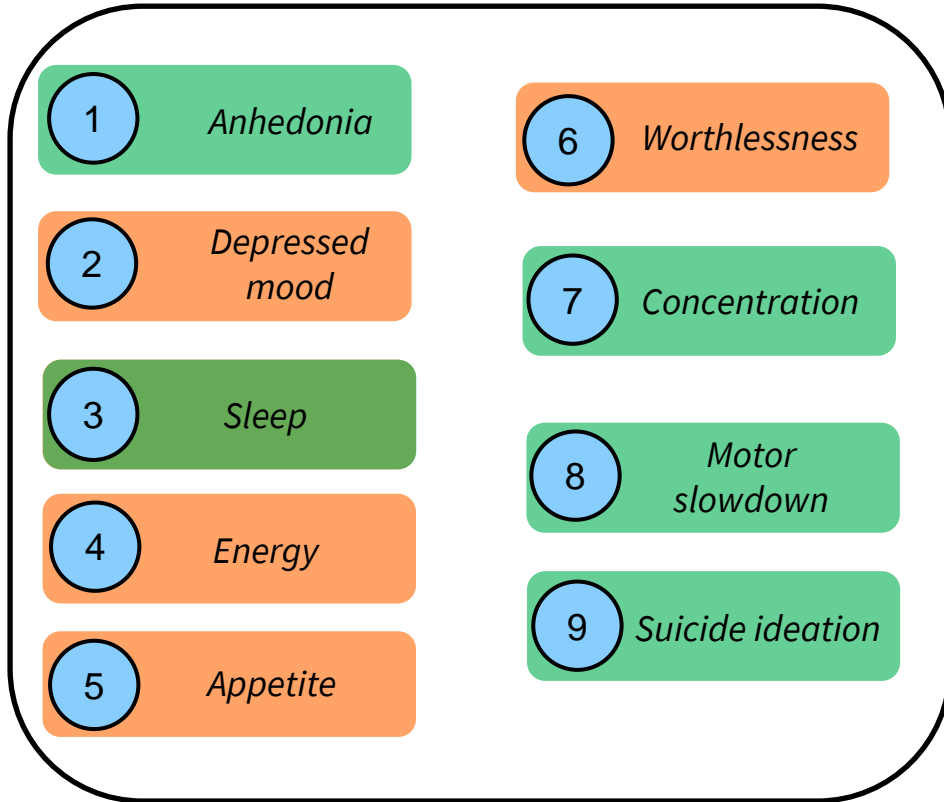
**semi-fictitious examples*

THE MISSED RENDEZ-VOUS

- ▶ Diagnostic = epistemological **limitations**
 - ▶ Time
 - ▶ Culture
 - ▶ Heterogeneity



HETEROGENEITY



Depression =

- At least 5
- With n^o1 or n^o2

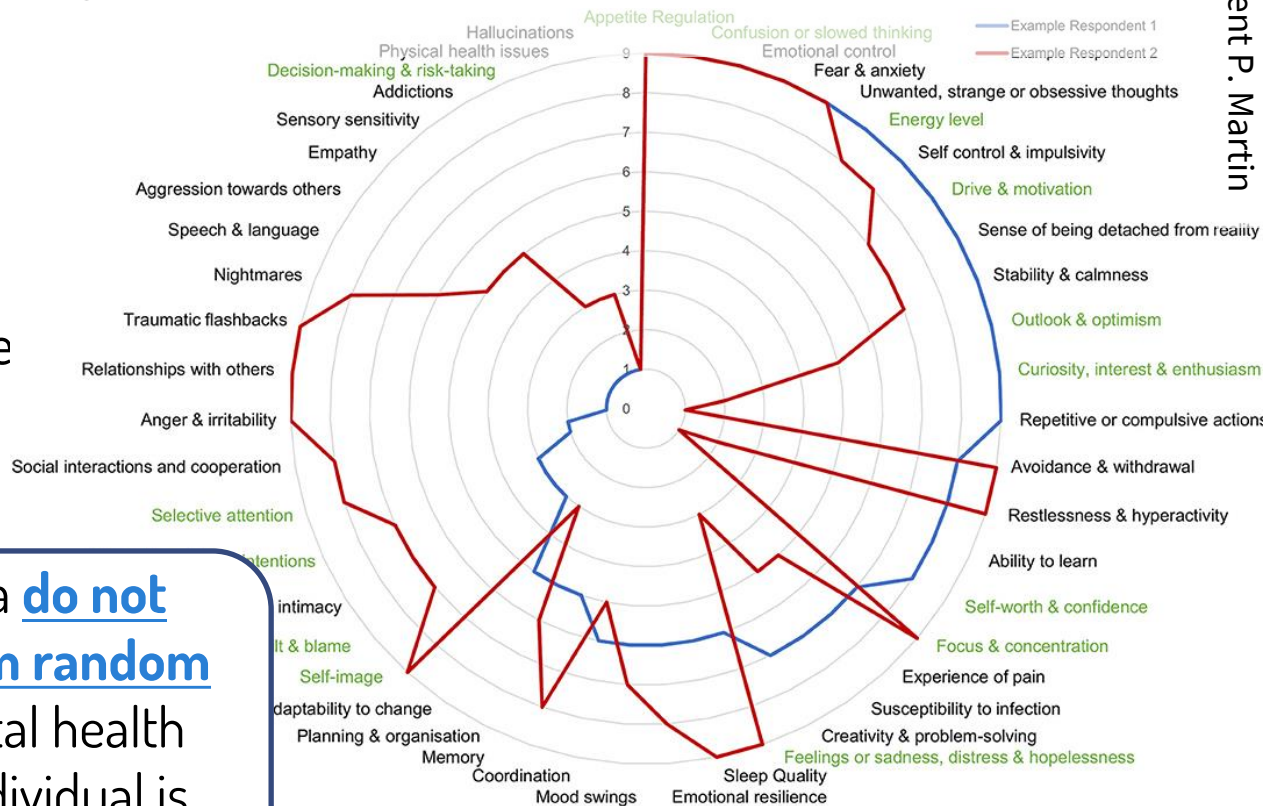
326 profiles

DIAGNOSTIC vs. SYMPTÔMES

- ▶ **107349** patients
- ▶ **10** most prevalent disorder
- ▶ **47** symptoms

« DSM-5 disorder criteria do not separate individuals from random

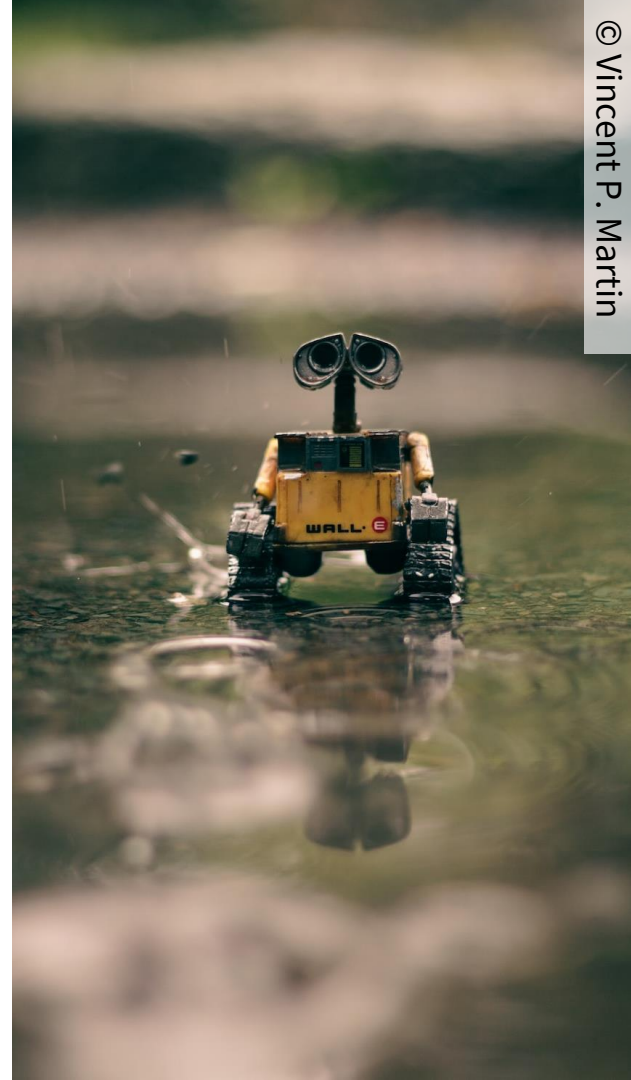
when the complete mental health symptom profile of an individual is considered»



THE MISSED RENDEZ-VOUS

- ▶ Diagnostic = epistemological **limitations**
 - ▶ Time
 - ▶ Culture
 - ▶ Heterogeneity
- ▶ Diagnosis = **societal recognition** and **dialogue** between stakeholders

« [...] one of its most important goal is to **facilitate communication among clinicians, researchers, administrators and patients** [...] by establishing a common language.” *Derek Bolton, 2012*



WHAT TO DO?

A young girl with dark hair, wearing a pink and white floral patterned jacket and a pink backpack, is looking towards a white robot. The robot has a round head with large blue eyes and is holding a bouquet of pink cherry blossoms. The background is a blurred city street at night with many lights.

Interest = **symptoms & signs**

Treatment = **symptoms & signs**

Martin 2023 Under review for Interspeech 2023.

SLEEPINESS



1/4 of deadly accident
on highways in France¹

43% of pilots
(n=500, 2012)² **31%** copilot

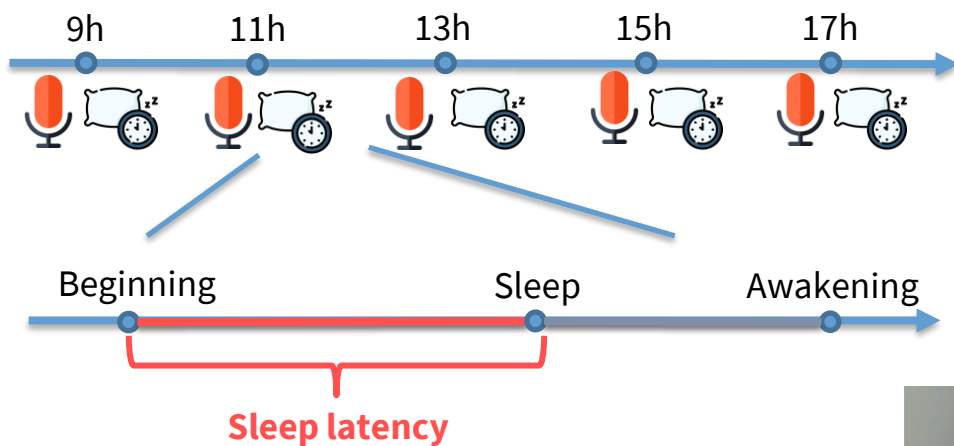
1/4 of general pop.

USA

[Kolla et al. 2020](#), *Sleep Health*

¹<https://www.preventionroutiere.asso.fr/2016/03/30/somnolence-au-volant/>

²<https://www.bbc.com/news/health-19837178>



MSLT database

MSLT = Multiple Sleep Latency Test

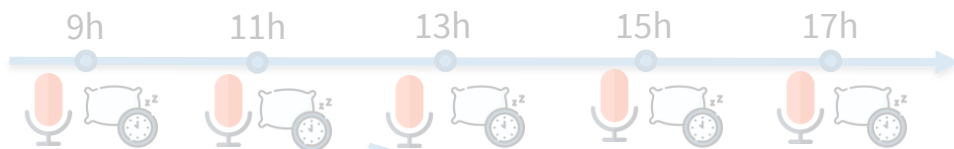


[Martin et al. 2021](#) *Frontiers in Digital Health*

[Martin et al. 2020](#) *Language Resources and Evaluation Conference*

[Martin et al. 2022](#) *Médecine du Sommeil*

[Martin et al. 2023](#) *Sleep Medicine Reviews*



125 patients

750 recordings

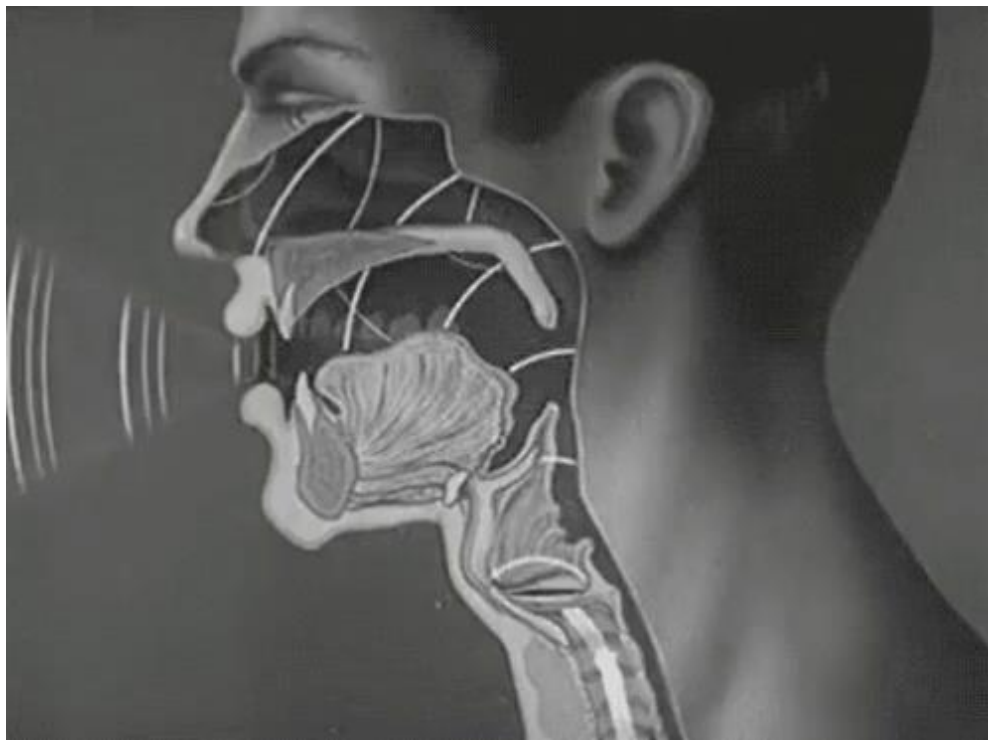
13 hours 26 minutes

MSLT database

MSLT = Multiple Sleep Latency Test



ACOUSTIC DESCRIPTORS




<https://fuckyeahmedicaldiagrams.tumblr.com/post/13093912072>

[Martin et al 2019](#) *10th Conference on Speech Technology and Human-Computer Dialogue 2019*

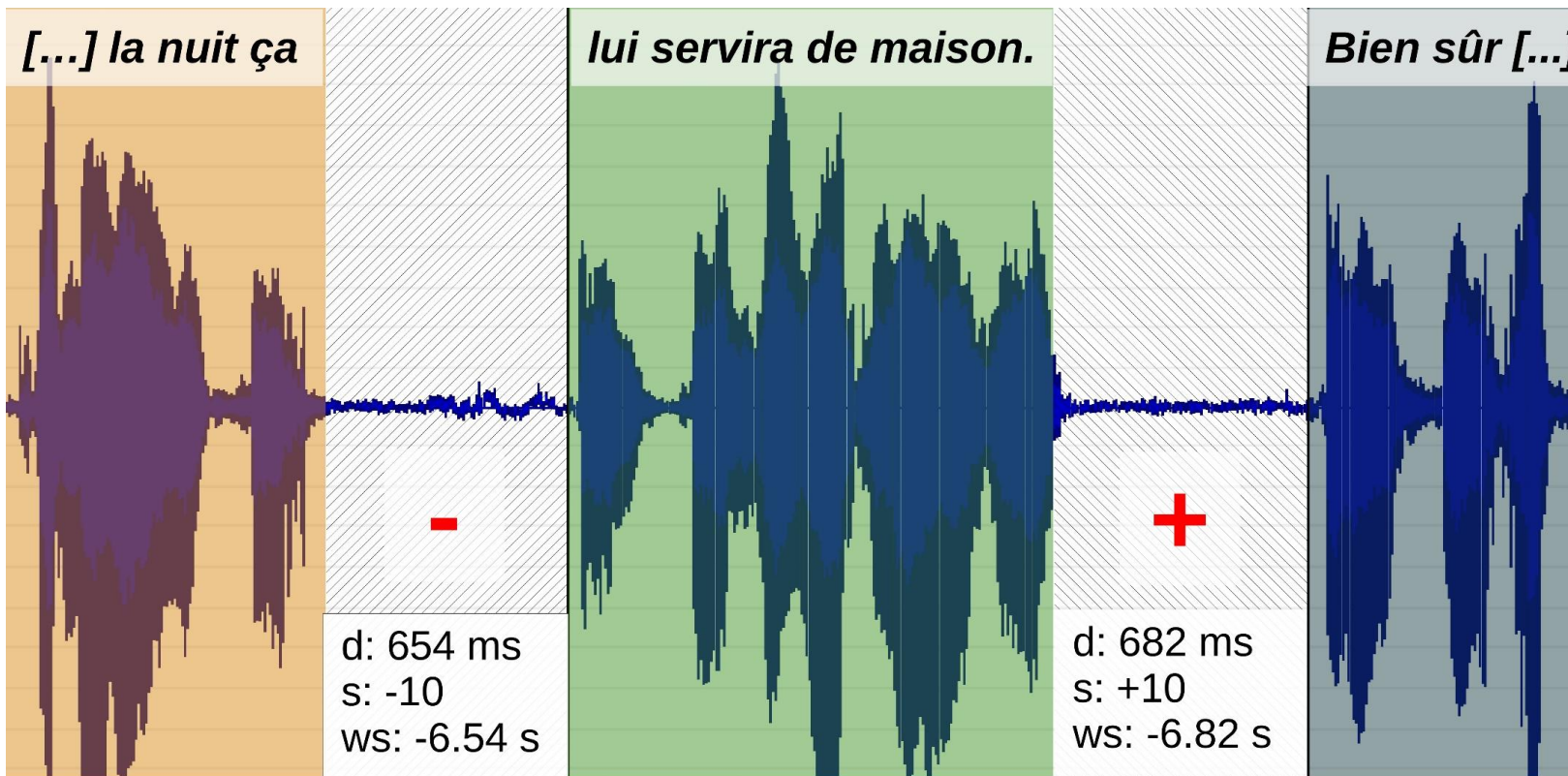
[Martin et al. 2020](#) *Traitement Automatique des Langues*

READING MISTAKES

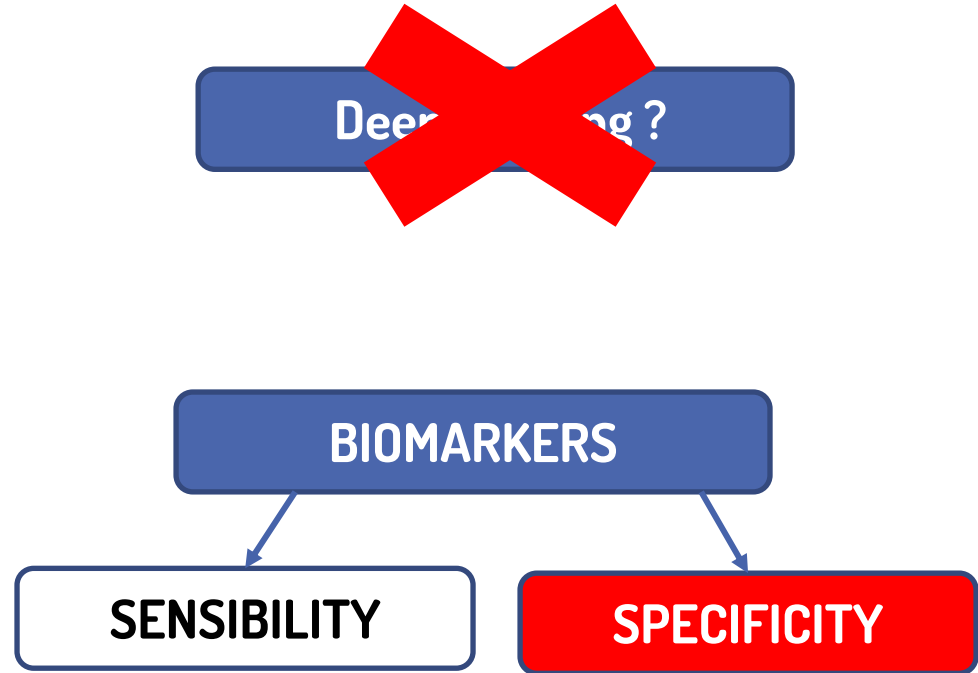


Quand le mystère est trop impressionnant, on n'ose pas
« il »
désobéir. Aussi absurde que cela me semblât à mille milles
« semblais »
de tous les endroits habités et en danger de mort, je sortis
<ach>
de ma poche une feuille de papier et un stylographe.

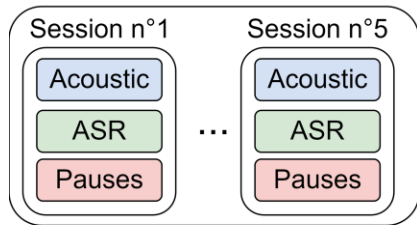
READING PAUSES



BIOMARKERS AND CLASSIFICATION



CLASSIFICATION



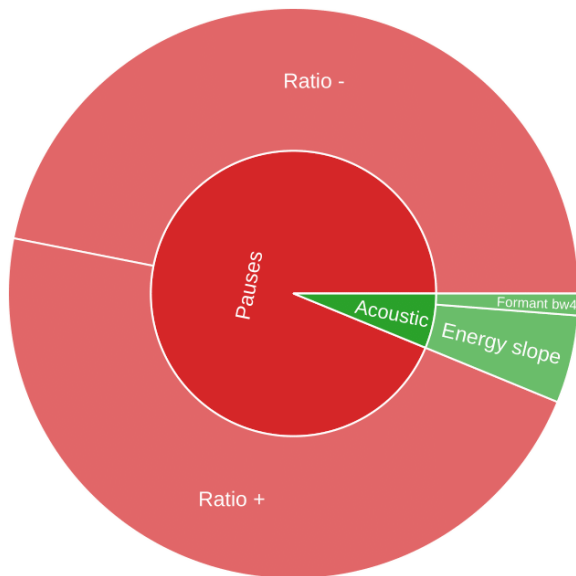
$$\hat{X}_i(\text{sleepiness}) = X_i(\text{measure}) - \hat{X}_i(\mathbf{f})$$

F0	Sex	Age	BMI	Neck circum.	Edu. level	Depression	Anxiety
ρ (sig) before	-0,29 **	-0,76 ****	-0,34 ***	-0,57 ****	0,30 **	-0,27 **	0,14 ns
Coef.	-0,57	-75,5	-0,12	-0,13	0,19	-1,22	-
ρ (sig) after	0,06 ns	-0,12 ns	0,02 ns	-0,07 ns	0,06 ns	0,03 ns	0,15 ns

BIOMARKERS

Physiological Sleepiness

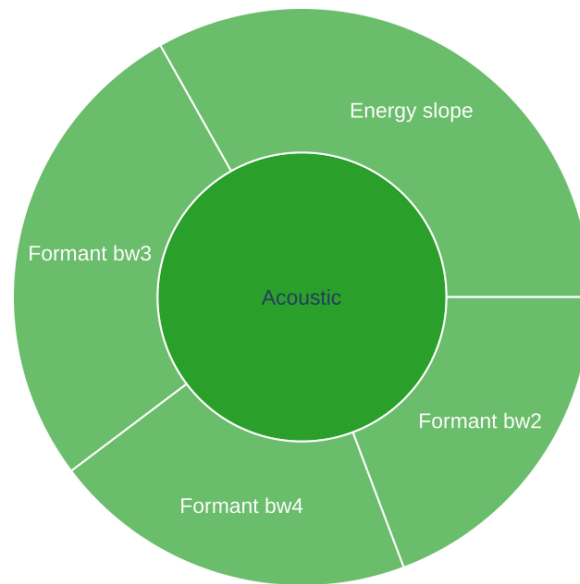
UAR = 81.5%



$$\text{UAR} = 0.5 \times \text{TP}/\text{P} + 0.5 \times \text{TN}/\text{N}$$

Subjective Sleepiness

UAR = 76.6%



WHAT'S NEXT?

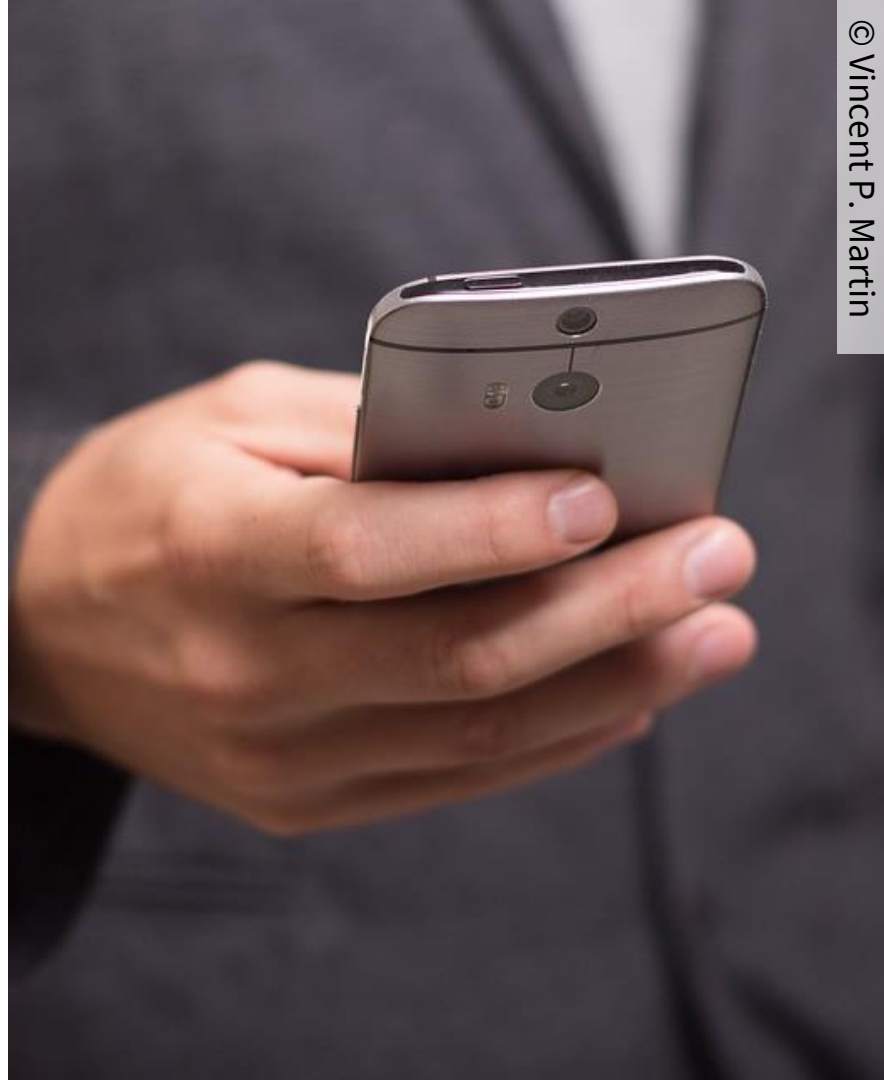
SOMVOICE

C. BEAUMARD

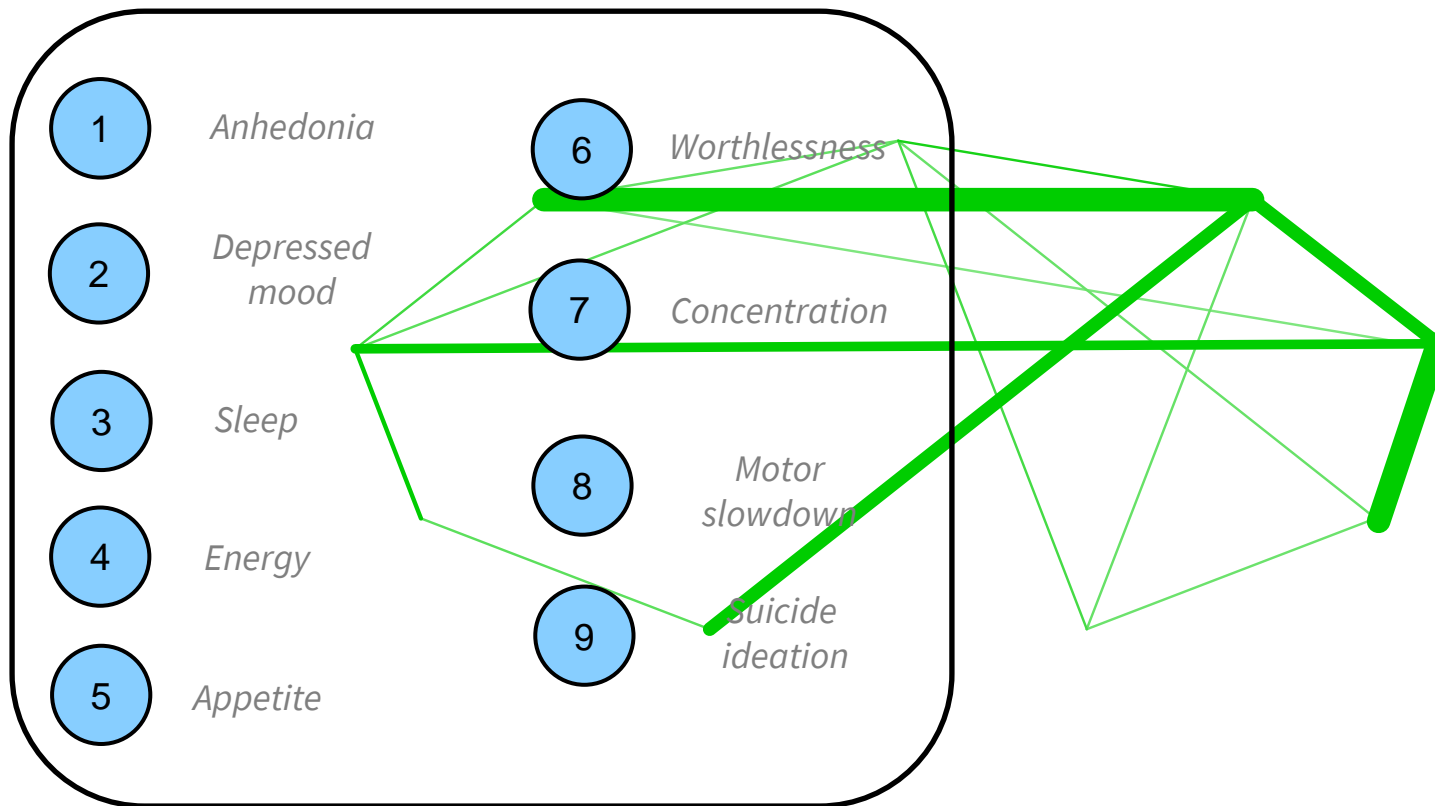
SCHWAS

MEDISPEECH

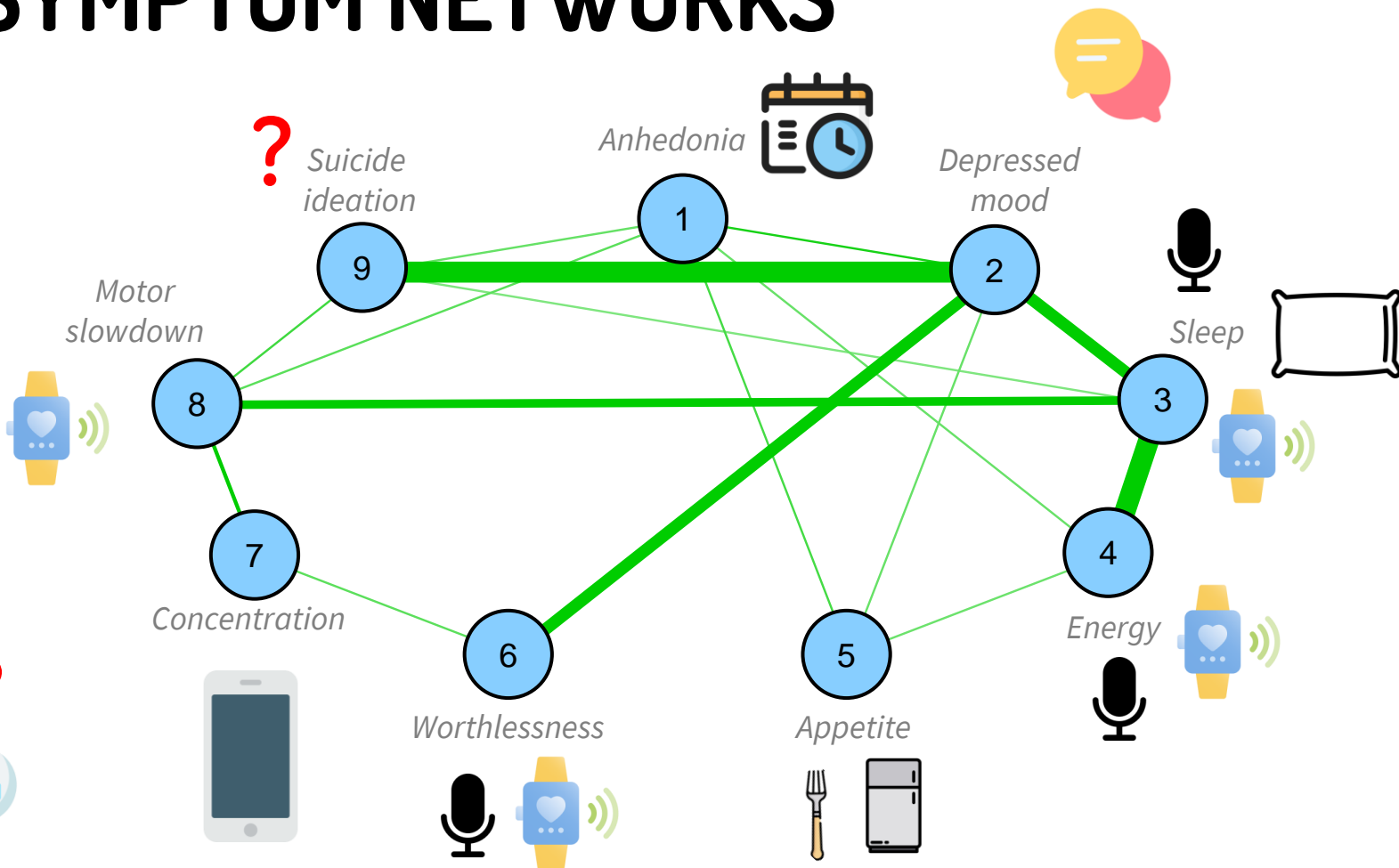
SYMPTOM NETWORKS



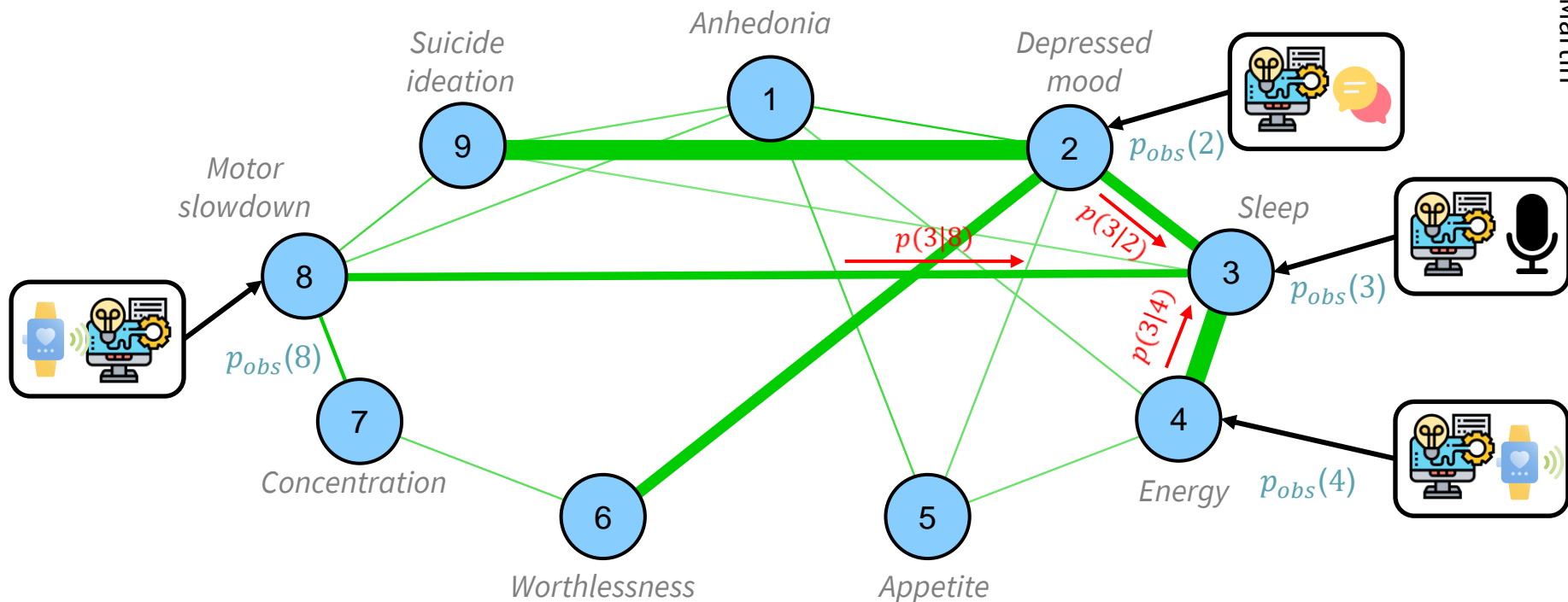
SYMPTOM NETWORKS



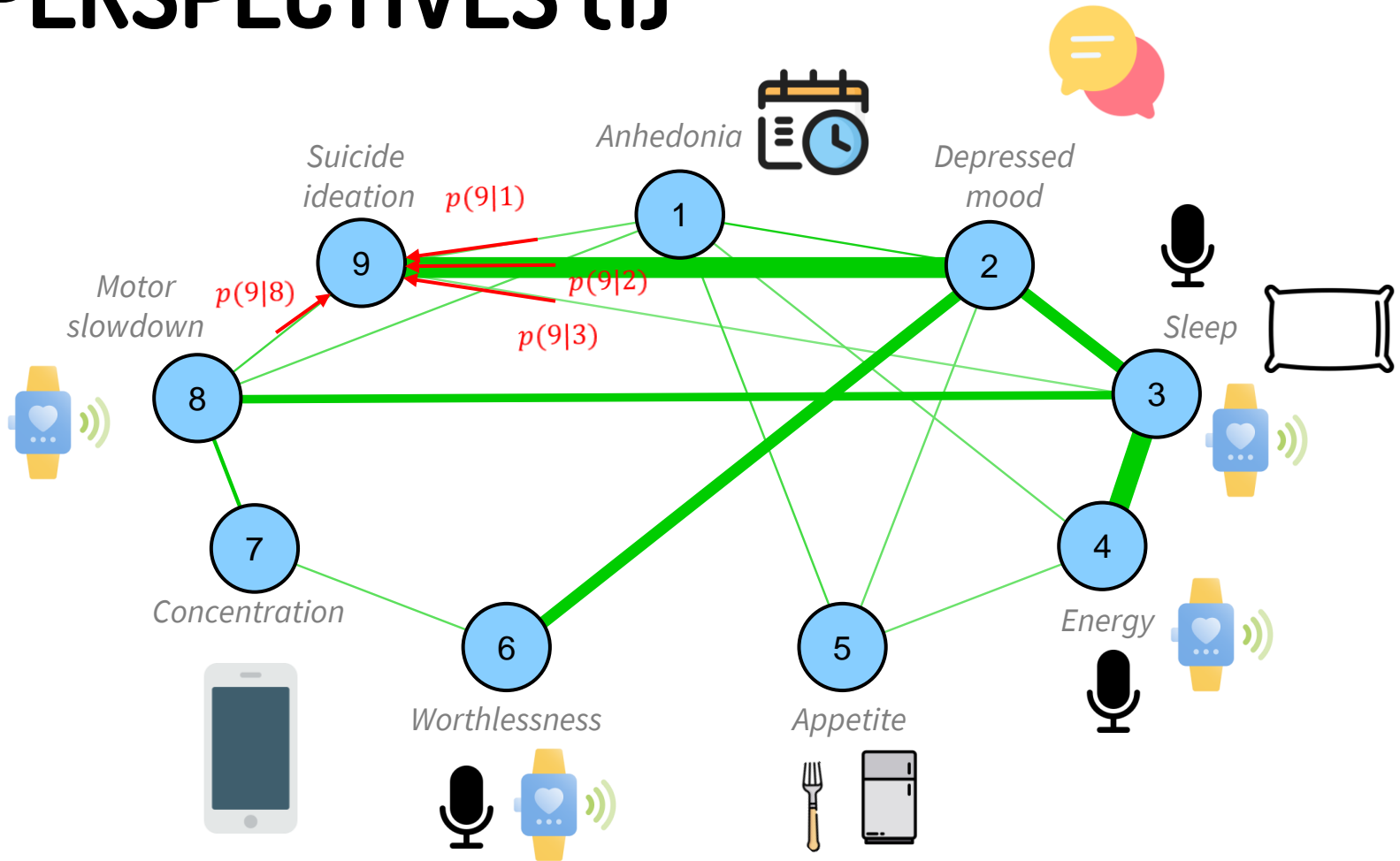
SYMPTOM NETWORKS



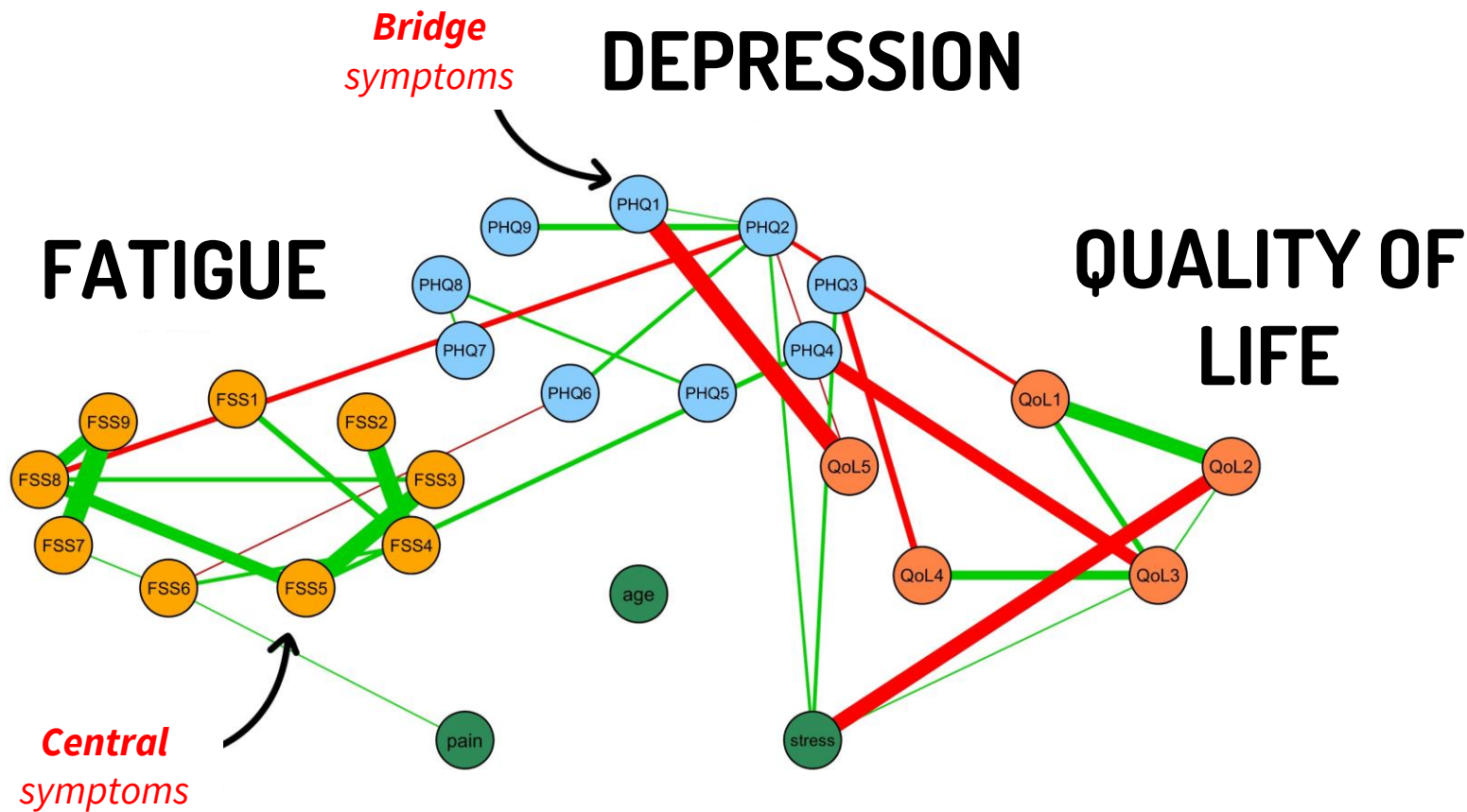
SYMPTOM NETWORKS



PERSPECTIVES (1)

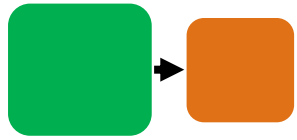


PERSPECTIVES (2)

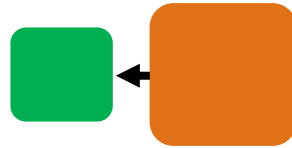


CONCLUSION

PLURIDISCIPLINARITY



Application of digital
technology to health

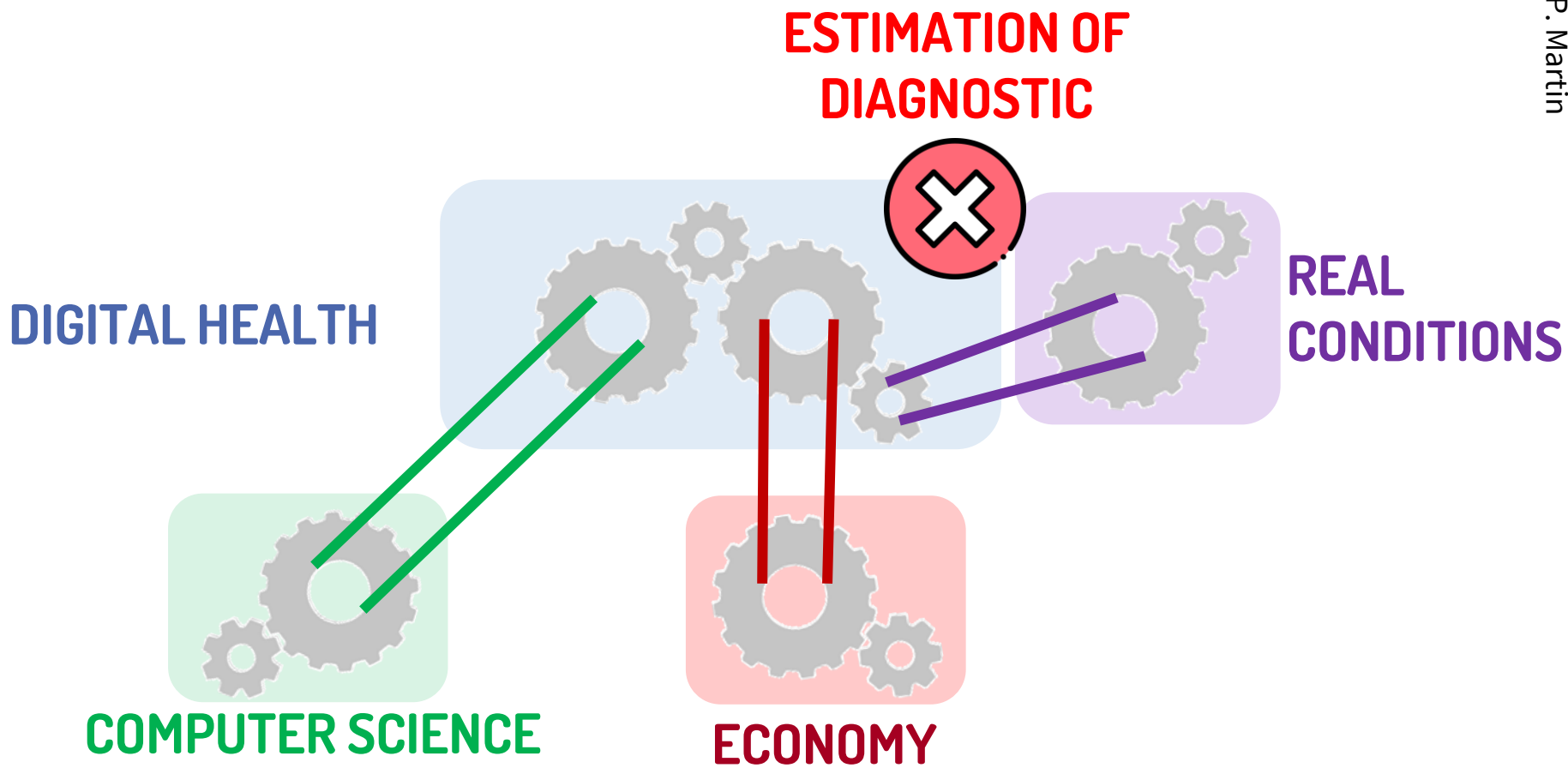


Telemedicine

HEALTH

DIGITAL

CONCLUSION

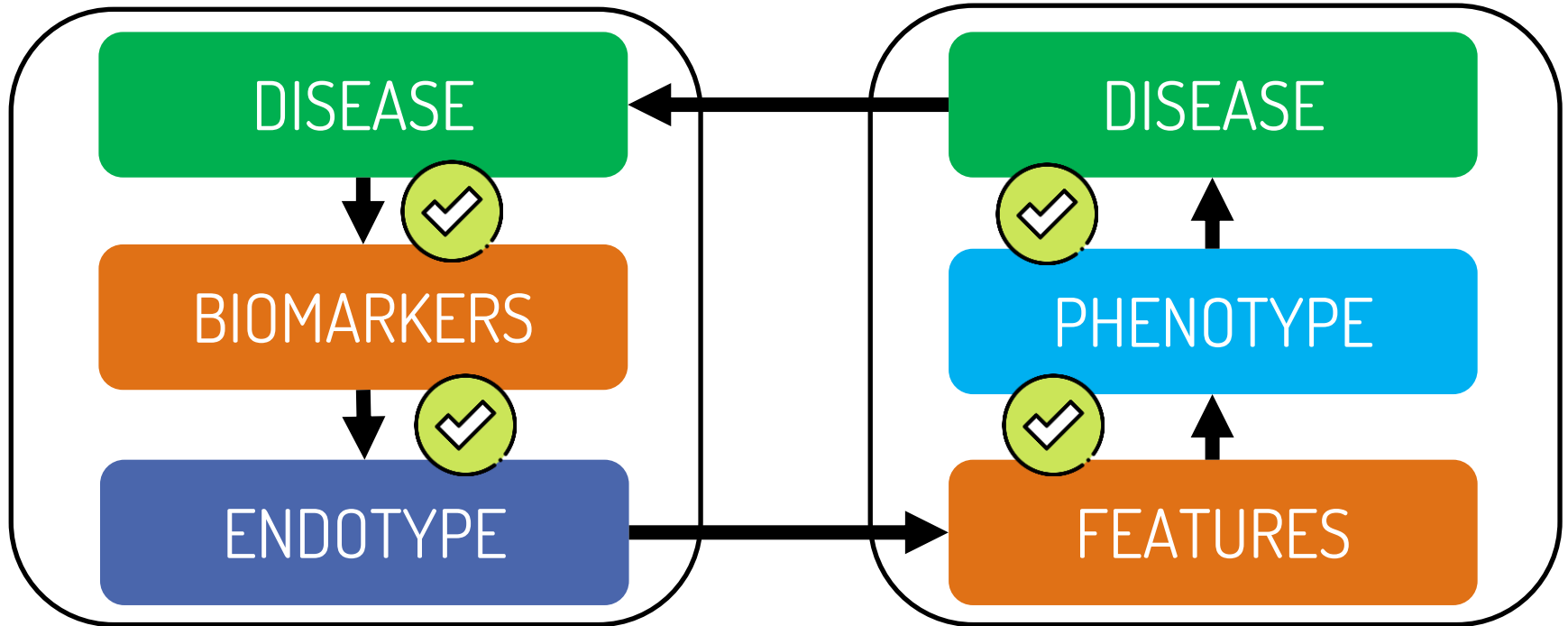


CANCER

CARDIO-VASCULAR

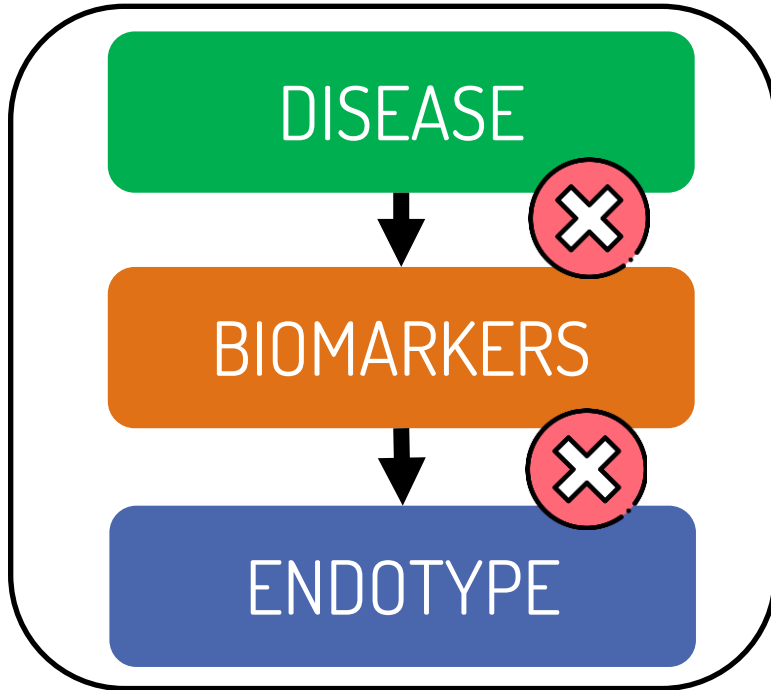
PRECISION MEDICINE

STRATIFIED MEDICINE

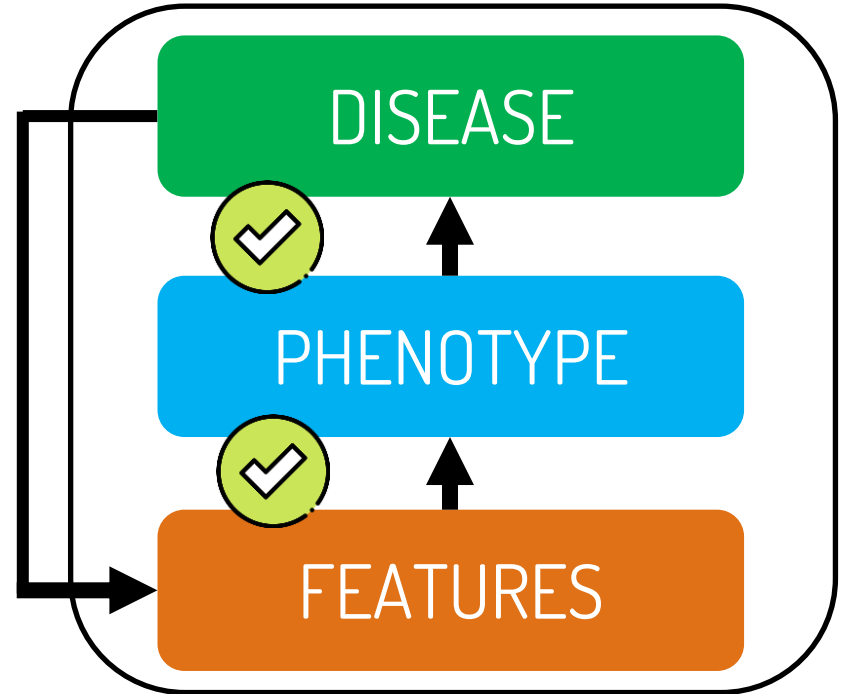


PSYCHIATRY

PRECISION MEDICINE



STRATIFIED MEDICINE



CONCLUSION

PLURIDISCIPLINARITY



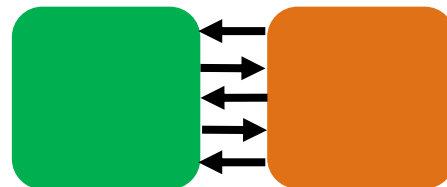
Application of digital
technology to health

Telemedicine

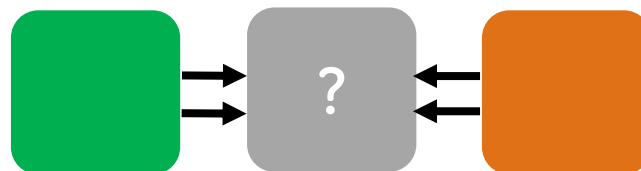
HEALTH

DIGITAL

INTERDISCIPLINARITY



TRANSDISCIPLINARITY



EPISTEMOLOGY

SOCIOLOGY

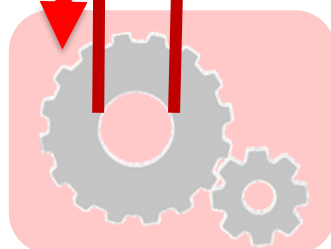
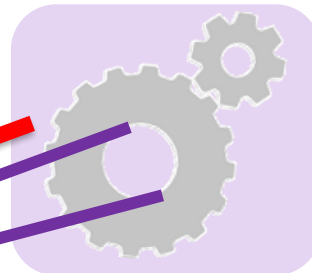
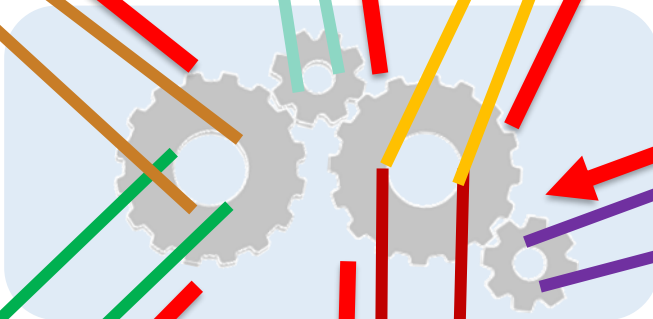
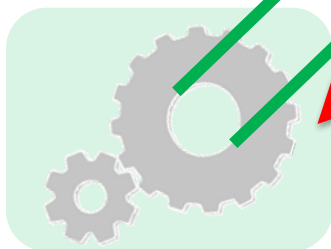
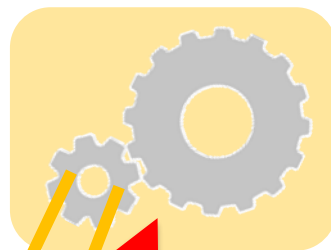
ETHICS

DIGITAL HEALTH

REAL
CONDITIONS

COMPUTER SCIENCE

ECONOMY

ESTIMATION OF
SYMPTOMS

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