



Capgemini  engineering

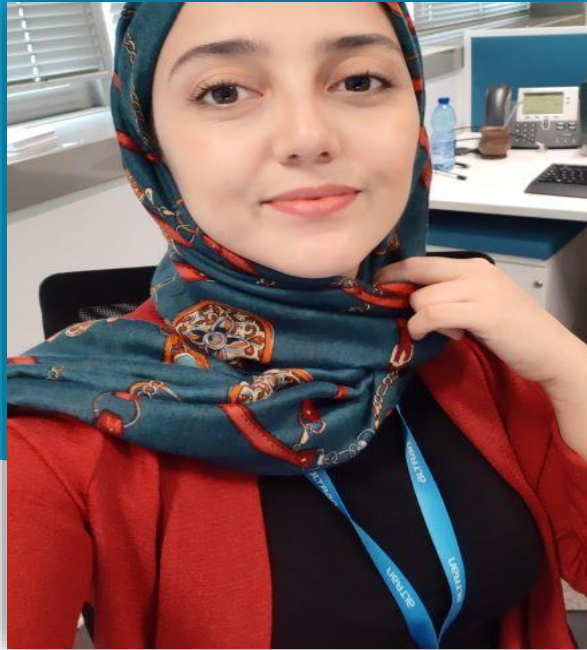
**BRAININFO 2021**

**July 18, 2021 to July 22, 2021 - Nice, France**

# ***Non-invasive Brain-Computer Interface***

## ***Industrial Applications***

***Khalida DOUBI  
Mind&Act project  
PhD Biomedical Informatics &  
Data scientist***

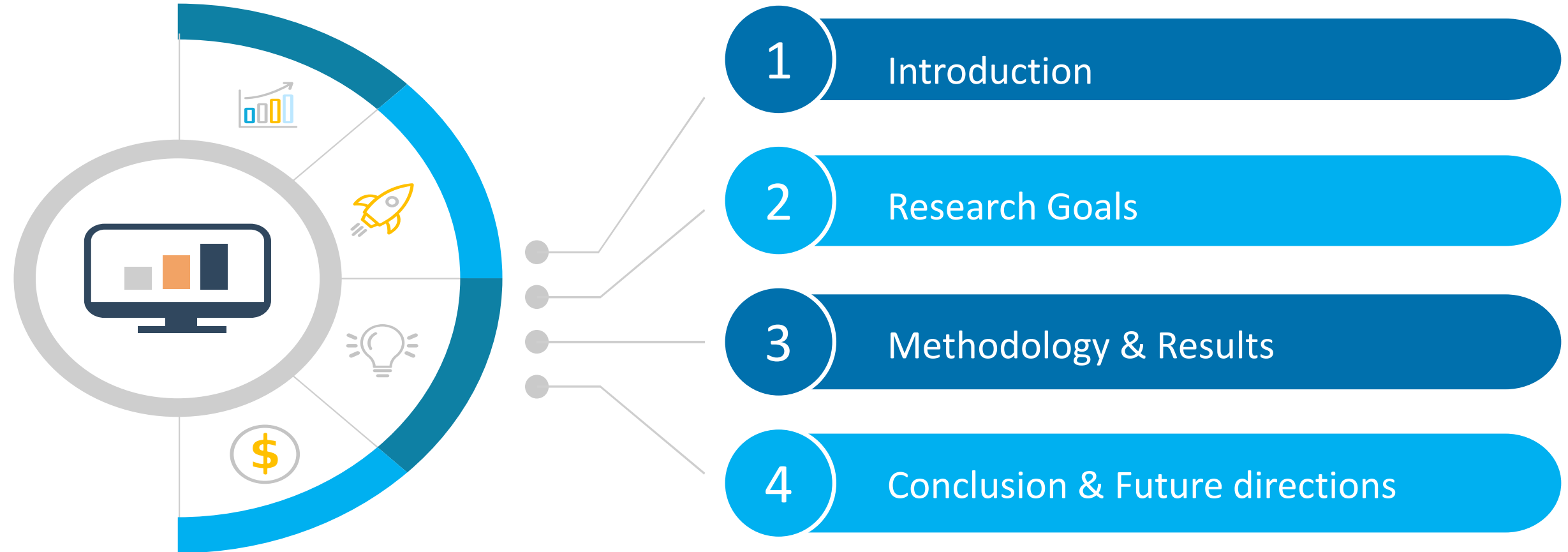


## Speaker

- Khalida DOUIBI
- Phd Biomedical Informatics & Data scientist
- Mind&Act project, Capgemini Engineering, France

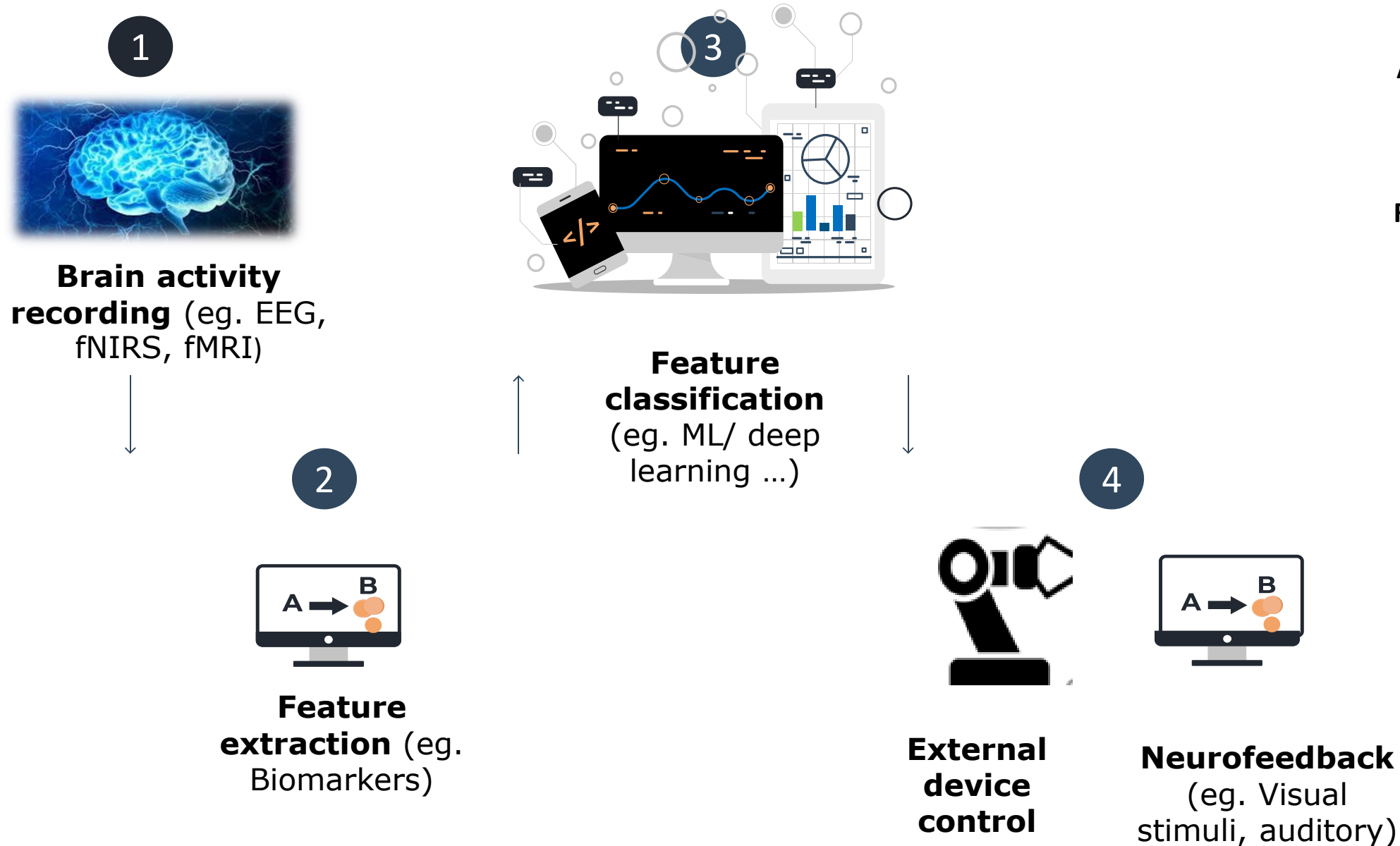
## Further questions:

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# Introduction



Active BCI

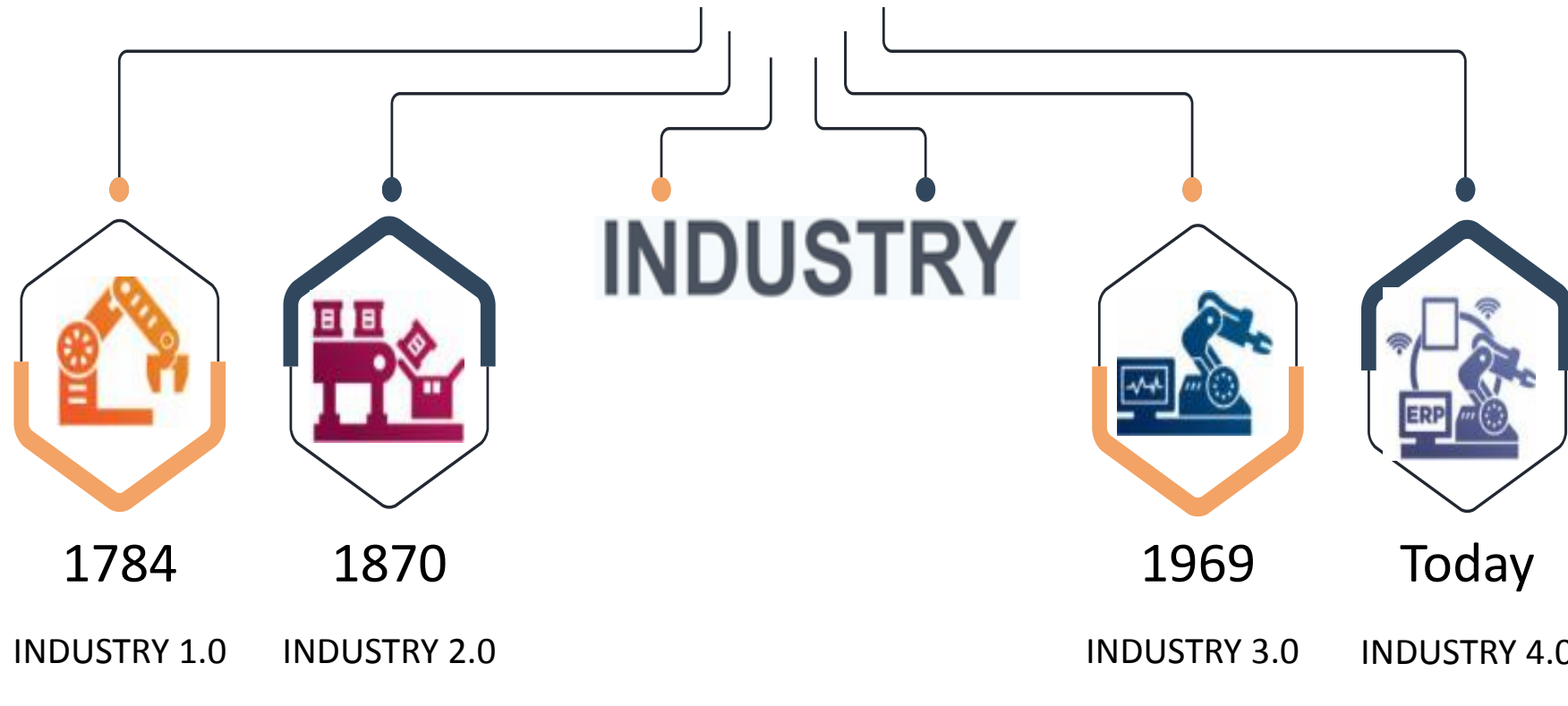


Reactive BCI



Passive BCI

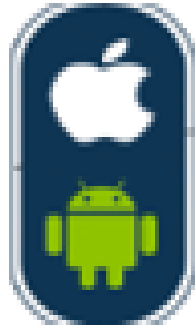






**Age of fixed-  
point control**

Computer  
Operating system



**Age of  
mobile  
touch and  
apps**

Mobile Operating  
system



**Age of voice  
control**

Speech recognition  
system



**Age of Visual  
image  
control**

Image recognition  
systems



**Age of Brain  
control**

**Brain signal  
recognition  
systems**

\*<http://www.naolubrain.com/>



## Research Goal & Methodology

- ❖ BCI for Industry4.0 has been mainly explored through academic research (Rashid et al., 2020).
- ❖ Re-introduce humans within the industrial processes, by facilitating the operator's work and limiting potential risks and human errors.
- ❖ Identify relevant applications and BCI techniques for Industry4.0



## ***BCI applications and challenges for industrial settings.***

### **Databases**

Science direct, PubMed, IEEE, Springer, ArXiv, ResearchGate, Google Scholar, MDPI, HAL

### **Queries**

BCI and Industry4.0, EEG-based BCI, BCI applications, BCI challenges, Assistive technology

### **Period**

2010-2021





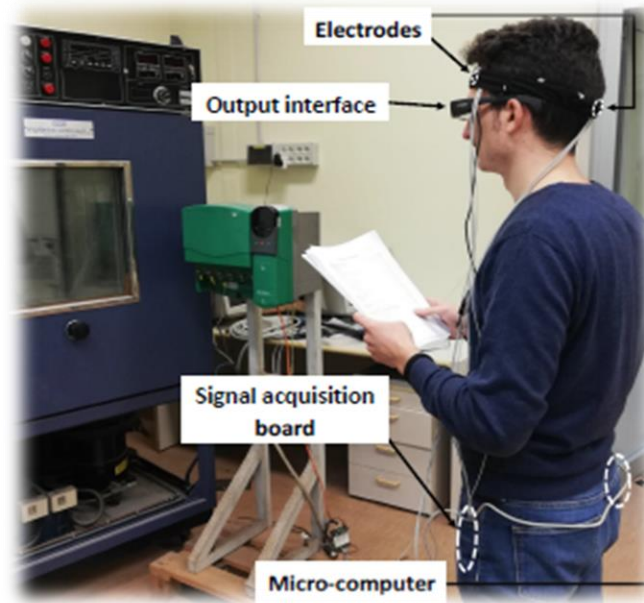
# Results & Discussion



## ❖ **Device control:**

*Operators' assistance through device control.*

Eg. BCI combined with AR glasses could facilitate certain tasks making them hands-free (and therefore, replace buttons/joysticks)



(Angrisani et al., 2018/2020)



<https://www.gtec.at/product/bcisystem/>

## ❖ **Benefits:**

- *Machine control*
- *Productivity gain*
- *Minimizing errors*
- *Hands free*



- ❖ **Safety/ training:** Adaptive training for learning optimization and evaluation.

Eg. boosting attentional processes while adapting task difficulty according to cognitive load or vigilance (Debie et al., 2019), to optimize learning and prevent frustration (Huang et al., 2019).



(Vourvopoulos et al., 2016)

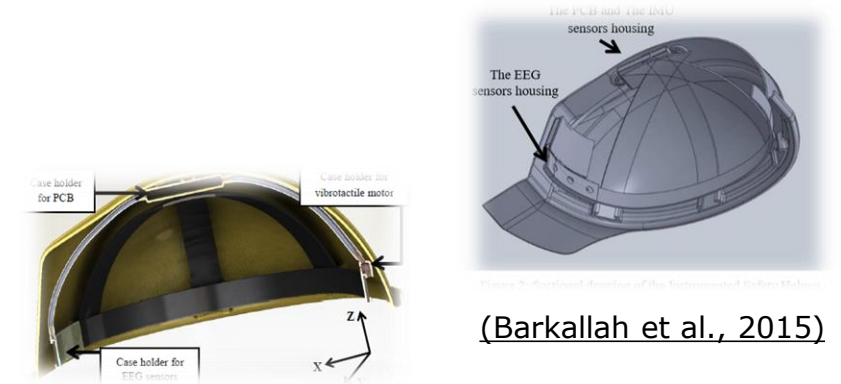
- ❖ **Benefits:**
  - *Effective training.*
  - *Prevention from accidents.*



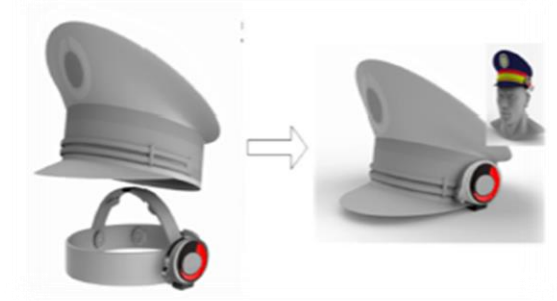
- ❖ **Monitoring:** Prevention of human errors in risky situations.
  - Eg. monitor operators' mental states like fatigue, stress or loss of vigilance [Li et al., 2014; Zhang et al. 2017 ]
  - BCI improves a person's ability to focus and capture emotions in an emergency for decision-making (Liao et al., 2018)

- ❖ **Benefits:**

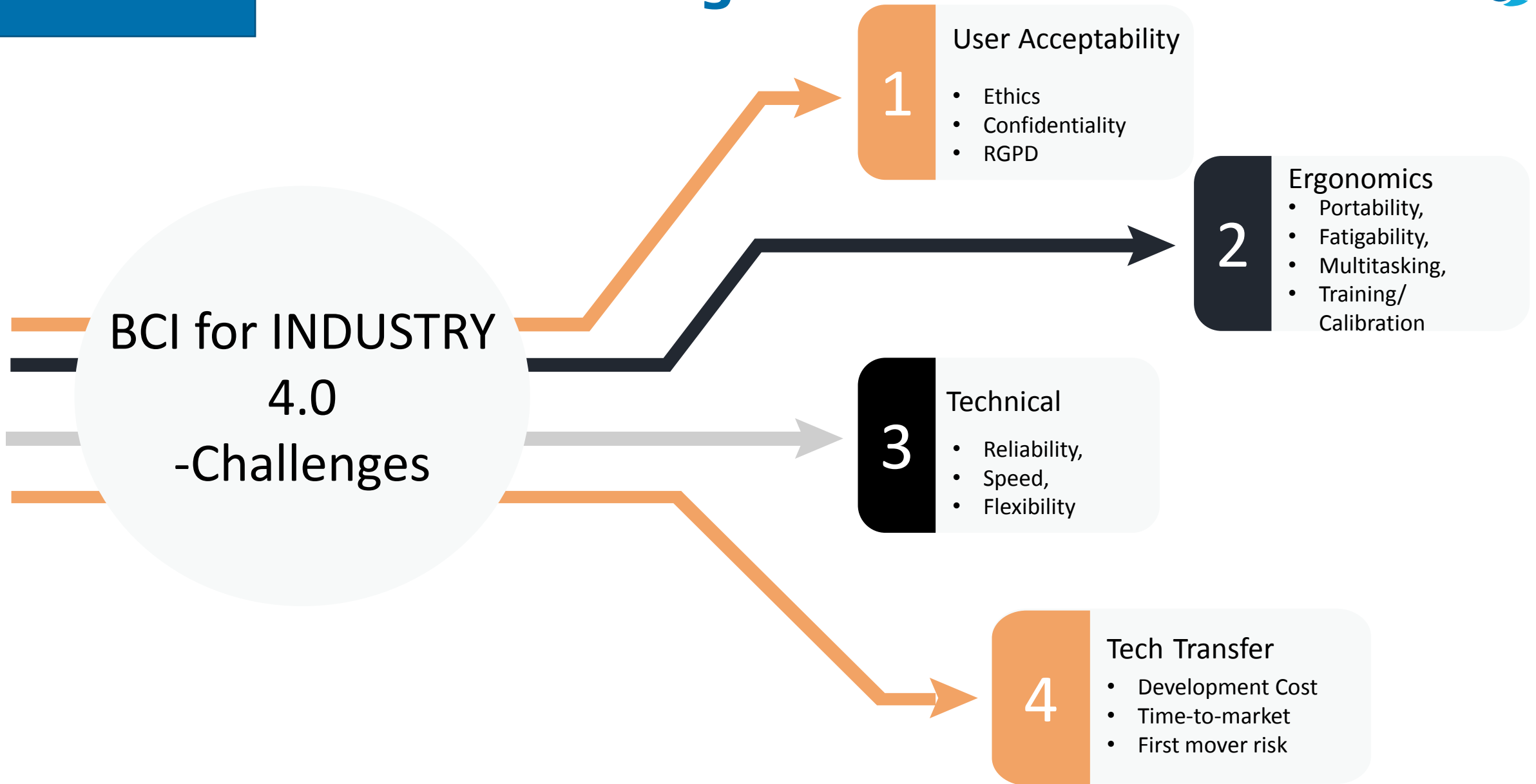
- *Real time alert.*
- *Prevention from risky situations.*
- *Stress management/ decision making*



(Li et al., 2014)



(Zhang et al., 2017)





# Conclusion



- ❖ A growing interest in the application of BCI to Industry 4.0
- ❖ Deployment of BCI applications remains very interesting, particularly for monitoring the mental state of operators, device control and training of operators.
- ❖ Ethical, Societal, Ergonomic and Technical challenges to be addressed.
- ❖ Future work will focus on the main BCI paradigms suitable for Industry 4.0 regarding the identified applications.





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