20 June 2019, Colleretto Giacosa (TO)

Presentation of 2 research projects
The company

**K-Tree Srl** is a start-up born in 2015 at “Pépinière d’Entreprise” in Aosta Valley. The team is composed by a group of junior and senior researchers and consultants.
Research areas

Monitoring system
- Objective parameters: detection of vital parameters and motion with IoT sensors
- Subjective parameters: administration of standardized questionnaires to collect PROMs

Medical images analysis
- Automatic analysis of medical images through deep learning
- Calculation of relevant parameters of the spine (angles and distances)
Configurable monitoring system

**Hardware**
- Sensors
- Board
- Server

**Software**
- Artificial intelligence to extract and classify data

IoT sensors in patient house

Clinicians

PC Smartphone Tablet
Target patients

POST OPERATIVE MONITORING:
- Orthopedic surgery patients
- Monitoring: motion, heart rate and generation of messages for the patient to remind the therapy

CHRONIC PATIENTS MONITORING
- Chronic cardiovascular disease
- Monitoring: heart rate and blood oxygenation, ECG, breath frequency, body temperature
IoT sensors for the movement detection

GPS: sensor to monitor the patient position all the time (the data have a different meaning depending on the position of the patient)

ACCELEROMETER: 6-axis accelerometer with integrated pedometer to monitor the movement (possible falls and steps)
IoT sensors for the vital parameters collection

Blood oxygenation and heart rate

2-lead ECG
Main problem: inappropriateness of medical procedures
→ total reimbursement of medical treatment

Solution: Value-Based Healthcare
→ different approach to medical treatment reimbursement

Secondary problems: PROMs collection
→ the tool behind the VBHC

Solution: Automate PROMs collection
→ brief and more frequent questionnaires
Development of a mobile application to administer the EQ-5D-5L questionnaire for orthopedic patients to evaluate the mobility and the autonomy in the post surgery

5 dimensions evaluation:
1. MOBILITY
2. SELF-CARE
3. USUAL ACTIVITIES (work, study...)
4. PAIN
5. ANXIETY AND DEPRESSION
Monitoring system
- Objective parameters: detection of vital parameters and motion with IoT sensors
- Subjective parameters: administration of standardized questionnaires to collect PROMs

Medical images analysis
- Automatic analysis of medical images through deep learning to support clinicians during the spine deformity surgery
- Calculation of relevant parameters of the spine (angles and distances)
The problem to be solved

Pre-operative images
Optimal angles and distances to be achieved during the surgery

Surgery
Qualitative estimation of achievement with fluoroscopic images

Post operative images
Achievement of target corrections assessed only after the surgery
The solution

Pre/intra operative images → Deep Learning → Detection and localization of vertebrae → Vertebral corners → Calculation of relevant parameters → For example L1-L5 angle
Example of L1-L5 lordosis angle calculation:
1. Detect and identify vertebrae
2. Predict the vertebral corners
3. Calculate a straight line between the 2 points of interest both for real and predicted corners (in this case top of L1 and bottom of L5)
4. Calculate the angle between the lines
5. Evaluate the prediction
Early test to predict L3 centroid coordinates
8 worst predictions according to distance between the predicted centroid and the actual centroid

<table>
<thead>
<tr>
<th>x</th>
<th>y</th>
</tr>
</thead>
<tbody>
<tr>
<td>MAE (pixel)</td>
<td>1.27</td>
</tr>
<tr>
<td>MAPE (%)</td>
<td>0.9</td>
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</tbody>
</table>

![Diagram showing the 8 worst predictions](Image)
Thank you!

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