# Exploring Spatio-Temporal Patterns in Sport Movement Observations

<table>
<thead>
<tr>
<th>Name</th>
<th>Email</th>
<th>Affiliation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kimia Amouzandeh</td>
<td><a href="mailto:Amouzandeh.kimia@ut.ac.ir">Amouzandeh.kimia@ut.ac.ir</a></td>
<td>Department of Surveying and Geomatics Engineering, University of Tehran, Iran</td>
</tr>
<tr>
<td>Farid Karimipour</td>
<td><a href="mailto:fkarimipr@ut.ac.ir">fkarimipr@ut.ac.ir</a></td>
<td>Department of Surveying and Geomatics Engineering, University of Tehran, Iran</td>
</tr>
<tr>
<td>Seyed Hossein Chavoshi</td>
<td></td>
<td>Department of Mathematical Sciences and Technology, Norwegian University of Life Sciences</td>
</tr>
<tr>
<td>Havard Tveite</td>
<td></td>
<td>Department of Mathematical Sciences and Technology, Norwegian University of Life Sciences</td>
</tr>
</tbody>
</table>
Exploring Spatio-Temporal Patterns in Sport Movement Observations
Kimia Amouzandeh, Farid karimipour, Seyed Hossein Chavoshi and Havard Tveite
Problem definition

Analyses of Sport Movement Data

Orienteering

Conclusion and future work

Extracting meaningful movement information

Discovering interesting movement patterns

Exploring the dynamic behavior of moving objects

Require new exploratory tools and knowledge discovery techniques for analysis of movement observations
Exploring Spatio-Temporal Patterns in Sport Movement Observations

Kimia Amouzandeh, Farid karimipour, Seyed Hossein Chavoshi and Havard Tveite
Exploring Spatio-Temporal Patterns in Sport Movement Observations
Kimia Amouzandeh, Farid karimipour, Seyed Hossein Chavoshi and Havard Tveite

Problem definition
Analyses of Sport Movement Data
Orienteering
Conclusion and future work
Exploring Spatio-Temporal Patterns in Sport Movement Observations
Kimia Amouzandeh, Farid Karimipour, Seyed Hossein Chavoshi and Havard Tveite

Problem definition
Analyses of Sport Movement Data
Orienteering
Conclusion and future work
Spatial and temporal data of a trajectory → Representation, and consequently analysis, of geospatial lifelines.

---

**Problem definition**

Analyses of Sport Movement Data

Orienteering

Conclusion and future work

---

- **Dodge (2011)**
  - Detecting movement similarities

- **Demsar (2015)**
  - Reviewing some methods for analysis and visualization of trajectory data
**Problem definition**

**Analyses of Sport Movement Data**

**Orienteering**

**Conclusion and future work**

---

**Focusing on spatial aspects of the movement to extract some movement characteristics**

- **Gudmundsson and Wolle (2010)**
  - Studying frequent movements of an individual football player and groups of players

- **Taki and Hasegawa (2000)**
  - Extracting the players’ dominant regions (the area where a player has priority over others)

- **Fujimura and Sugihara (2005)**

- **Kang et al. (2006)**

---

**Exploring Spatio-Temporal Patterns in Sport Movement Observations**

Kimia Amouzandeh, Farid karimipour, Seyed Hossein Chavoshi and Havard Tveite
**Coupling Temporal and spatial data with field observations enable extraction of movement patterns.**

**Hollman et al. (2007)** Examined the effect of age on gait velocity and stride-to-stride variability during normal and dual task walking conditions.

**Bert-Losier et al. (2015 and 2014)** Exploring the effect of different situations on runners' biomechanics.
Problem definition

Analyses of Sport Movement Data

Orienteering

Conclusion and future work

Orienteering: Family of sports that require navigational skills using a map and compass.

Possible challenges:
- Terrain barriers or obstacles
- Artificial features
- Level of physical fitness

Competitors choose their route around the course.
Exploring Spatio-Temporal Patterns in Sport Movement Observations
Kimia Amouzandeh, Farid karimipour, Seyed Hossein Chavoshi and Havard Tveite
### Problem definition

Analyses of Sport Movement Data

**Orienteering**

Conclusion and future work

<table>
<thead>
<tr>
<th>Time</th>
<th>Distance (Meters)</th>
<th>Altitude (Meters)</th>
<th>HeartRate (BPM)</th>
<th>Speed (Normal)</th>
<th>Land Cover</th>
</tr>
</thead>
<tbody>
<tr>
<td>10:24:58 AM</td>
<td>447.4815979</td>
<td>89.0593262</td>
<td>135</td>
<td>149.1291807</td>
<td>road</td>
</tr>
<tr>
<td>10:25:03 AM</td>
<td>467.3476257</td>
<td>88.5787354</td>
<td>135</td>
<td>133.6714482</td>
<td>road</td>
</tr>
<tr>
<td>10:25:08 AM</td>
<td>484.8355408</td>
<td>88.0980225</td>
<td>134</td>
<td>106.1720784</td>
<td>road</td>
</tr>
<tr>
<td>10:25:11 AM</td>
<td>492.7898865</td>
<td>87.1365967</td>
<td>134</td>
<td>128.2955777</td>
<td>road</td>
</tr>
<tr>
<td>10:25:16 AM</td>
<td>509.4507446</td>
<td>87.1365967</td>
<td>133</td>
<td>159.5234685</td>
<td>road</td>
</tr>
<tr>
<td>10:25:17 AM</td>
<td>513.7437744</td>
<td>87.1365967</td>
<td>133</td>
<td>172.9914094</td>
<td>road</td>
</tr>
<tr>
<td>10:25:23 AM</td>
<td>541.9883423</td>
<td>83.7719727</td>
<td>131</td>
<td>143.6176297</td>
<td>road</td>
</tr>
<tr>
<td>10:25:27 AM</td>
<td>557.2028198</td>
<td>81.8493652</td>
<td>131</td>
<td>128.4179688</td>
<td>road</td>
</tr>
<tr>
<td>10:25:32 AM</td>
<td>573.8825073</td>
<td>81.8493652</td>
<td>132</td>
<td>116.3772583</td>
<td>road</td>
</tr>
<tr>
<td>10:25:36 AM</td>
<td>585.7443237</td>
<td>82.3300781</td>
<td>133</td>
<td>133.1304422</td>
<td>road</td>
</tr>
<tr>
<td>10:25:42 AM</td>
<td>606.6299438</td>
<td>82.3300781</td>
<td>134</td>
<td>119.2292405</td>
<td>grass</td>
</tr>
<tr>
<td>10:25:46 AM</td>
<td>618.8427734</td>
<td>80.8881836</td>
<td>134</td>
<td>118.2253523</td>
<td>grass</td>
</tr>
<tr>
<td>10:25:52 AM</td>
<td>636.9766846</td>
<td>78.4847412</td>
<td>134</td>
<td>130.7715603</td>
<td>grass</td>
</tr>
<tr>
<td>10:25:58 AM</td>
<td>657.4268188</td>
<td>76.5621338</td>
<td>135</td>
<td>119.3629715</td>
<td>grass</td>
</tr>
<tr>
<td>10:26:04 AM</td>
<td>675.770752</td>
<td>74.1588135</td>
<td>135</td>
<td>108.1143949</td>
<td>grass</td>
</tr>
<tr>
<td>10:26:08 AM</td>
<td>686.6156006</td>
<td>71.7554932</td>
<td>135</td>
<td>125.0437928</td>
<td>grass</td>
</tr>
</tbody>
</table>

**Exploring Spatio-Temporal Patterns in Sport Movement Observations**

Kimia Amouzandeh, Farid karimipour, Seyed Hossein Chavoshi and Havard Tveite
Exploring Spatio-Temporal Patterns in Sport Movement Observations
Kimia Amouzandeh, Farid Karimipour, Seyed Hossein Chavoshi and Havard Tveite
Exploring Spatio-Temporal Patterns in Sport Movement Observations
Kimia Amouzandeh, Farid karimipour, Seyed Hossein Chavoshi and Havard Tveite
Exploring Spatio-Temporal Patterns in Sport Movement Observations
Kimia Amouzandeh, Farid karimipour, Seyed Hossein Chavoshi and Havard Tveite
Exploring movement observations to discover movement patterns

Analyzing the orienteering movement observations

More exploration of the patterns needs sophisticated computational analyses

Investigating and exploring transformed movement data into time-dependent sequences
Thank you for your attention!