DEFENSIVE COMPACTNESS AS A PERFORMANCE INDICATOR FOR GAME ANNOTATION

Nicolas Witt, 27.07.2016
PROJECT

Funder & Data Provider:
- DFL (Deutsche Fußball Liga)

Topic:
- Game Data Based Performance Indicators for Professional Soccer

Objectives:
- Interdisciplinary development
- Connection to practitioners
- For the Clubs

Indicator for Compactness
TEAM

- Locating Systems Department
  - Nicolas Witt
  - Matthias Völker
  - Dominik Spandler

- Institute for Sport Science and Sport Medicine
  - Prof. Dr. Dr. Matthias Lochmann
  - Dino Poimann

- Chair for Pattern Recognition (Digital Sports)
  - Prof. Dr. Björn Eskofier
  - Stefan Gradl
Goal

Tracking Data → Compactness Indicator → Defensive Scenes Team A → Defensive Scenes Team B

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<thead>
<tr>
<th>Scene</th>
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<th>Start</th>
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Our Solution

Scene Selection → Features → Classification → Scoring

Tracking Data

Defensive Scenes

Features per Frame

Compactness per Frame

Scenes Team A

Scenes Team B

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Tracking Data

- Scene Selection
- Features
- Classification
- Scoring

Defensive Scenes

Features per Frame

Classification per Frame

Scenes Team A

Scenes Team B

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Official Video Tracking Data

- Videotracking @ 25 Hz
- 22 Players & 1 Ball
- Frame = Instance in time
- Indicator for Active Game
- Indicator for Possession
Scene Selection

- Tracking Data
- Scenes Team A
- Scenes Team B
- Defensive Scenes
- Features per Frame
- Classification per Frame

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- Scene Selection
- Features
- Classification
- Scoring

- Features per Frame
- Classification per Frame

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Scene Selection

- Defensive Scenes:
  - Active game status
  - Opponent in possession
  - Duration > 10 seconds
  - Allow Interruptions in possession < 2 seconds

- Reasons:
  - Allow development of compactness
  - Allow fast changes of possession in one scene
Compactness

- **Definition of Compactness:**
  - Difficult

- **Connect to Experts:**
  - Several Interviews (Licensed trainers & DFB)
  - Workshop with analysts (Bundesliga)

- **Result / Challenge:**
  - The more you ask, the more opinions there are
  - Different aspects
Machine Learning Approach

- **Our Solution**
  - Machine Learning approach
  - Cover many aspects = Compute many features

- **In Practice:**
  - 18 features computed every 0.5 second
  - Train a classifier with all features

- **Result:**
  - Decision on many aspects
Features

Scene Selection → Features → Classification → Scoring

Tracking Data

Defensive Scenes

Features per Frame

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Scenes Team A

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Features of Compactness

„Compact Area“:
- Number of defensive players in the compact area
- Ratio of players in the compact area
Features of Compactness

Triangles:

- Ratio of players with good (< 90 degree) triangle view
- Area of the biggest delaunay triangle
Features of Compactness

Free paths:
- Ratio of free paths to the goal
Features of Compactness

Team Synchronisation:

- Variance of directions
- Shift according to ball
Features of Compactness

- **Team Spread:**
  - Horizontal and vertical team distance
  - Convex Hull area
Classification: Training

- Scene Selection
- Features
- Classification
- Scoring
- Tracking Data
- Defensive Scenes
- Features per Frame
- Classification per Frame
- Scoring

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Test and Training data:
- 1 = low, 2 = medium, 3 = high compactness
- Five games of the season 2015/2016
- 96 defensive scenes with 3 segments [Start + 4s, Mid, End - 4s]
- 288 annotated scenes

Annotation:
- Every scene by two to three analysts (1st, 2nd league)
- Final annotation through majority vote
- Interrater reliability (only 1 and 3 confusion) = 89 %
- Analysts feedback: Level 2 was hard to annotate
Classification

- **Random Forrest Classifier:**
  - Majority vote on many decision trees

- **Input:**
  - Features

- **Output:**
  - Level of compactness 1, 2 or 3
Classification

Tracking Data → Scene Selection

Scene Selection → Features

Features → Classification

Classification → Scoring

Scoring → Scenes Team A

Scenes Team A → Scenes Team B

Features per Frame

Defensive Scenes

Features per Frame

Classification per Frame

Training

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Classification Results

- Results from a 10-fold crossvalidation

- **3 classes** (low / medium / high)
  - All Features: 90 %
  - 8 Features: 86 %

- **2 classes** (low / high)
  - All Features: 96 %
  - 8 Features: 95 %
  - 2 Features: 84 %
Feature Selection

- **Effective Features:**
  - Number of players in the compact area
  - Area of the convex hull
  - Free paths to the goal
  - Area of biggest triangle
  - Good triangle view
  - Ratio of players in compact area
  - Vertical team distance
  - ...

- **Ineffective Features:**
  - Variance of directions
  - Shift according to the ball
  - Horizontal team distance
Classification: Training

Scene Selection → Features → Classification → Scoring

Tracking Data → Scenes Team A → Scenes Team B

Defensive Scenes → Features per Frame → Classification per Frame

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Scoring

Scoring in %:
- Mean of levels normalized to 0-100 %
- Start (4 seconds)
- Mid
- End (4 seconds)
- Total (overall)

<table>
<thead>
<tr>
<th>Score</th>
<th>Start = 100 %</th>
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<th>Mid = 90 %</th>
<th></th>
<th>End = 0 %</th>
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<tbody>
<tr>
<td>Level</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
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Processing Pipeline

Tracking Data

Scene Selection

Features

Classification

Scoring

Defensive Scenes

Features per Frame

Compactness per Frame

Scenes Team A

Scenes Team B

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Human versus Computer

Automatic Scores vs. Human Scores:
- 171 Scores for 52 Scenes (halftime of unknown game)
- Low / med. / high compactness: 60 % agreement
- Low / high compactness: 97 % agreement
Filtering by low compactness at the end

- **Red Team**

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<tr>
<td>Szene 1</td>
<td>100 %</td>
<td>92 %</td>
<td>0 %</td>
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- **Yellow Team**

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<tr>
<td>Scene 2</td>
<td>100 %</td>
<td>89 %</td>
<td>0 %</td>
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Scene 1 (Red)
Scene 2 (Yellow)
Thank you for your attention