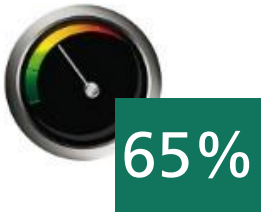
DEFENSIVE COMPACTNESS AS A PERFORMANCE INDICATOR FOR GAME ANNOTATION

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

Fraunhofer IIS

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

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- **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

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Goal

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

Scene	Total	Start	Mid	End
1	90 %	100 %	90%	80 %
2	10 %	5 %	10 %	15 %
…	…	…	…	…

Our Solution

Tracking Data

Scene Selection → Features → Classification → Scoring

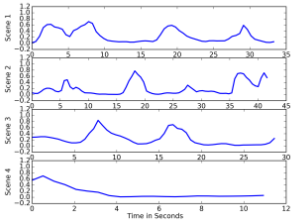
Scenes Team A

Scenes Team B

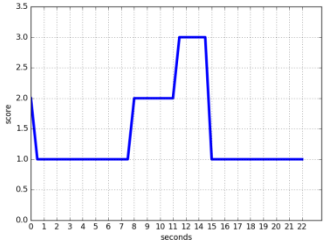
Szene	Total	Start	Mid	End
1	60 %	40 %	60%	6 %
…	…	…	…	…

Defensive Scenes

Features per Frame



Compactness per Frame



Tracking Data

Tracking Data

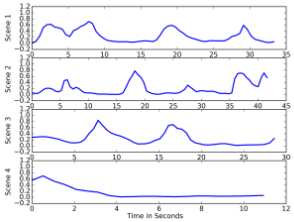
Scene Selection → Features → Classification → Scoring

Scenes Team A

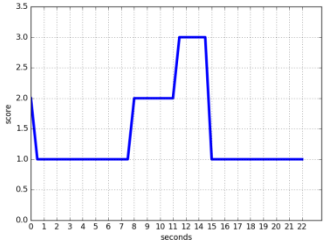
Scenes Team B

Defensive Scenes

Features per Frame



Classification per Frame



Scene	Total	Start	Mid	End
1	60 %	40 %	60%	6 %
…	…	…	…	…

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

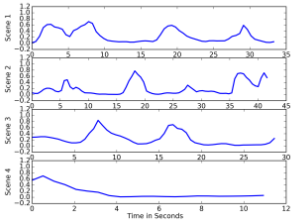
Scenes Team A

Scene Selection → Features → Classification → Scoring

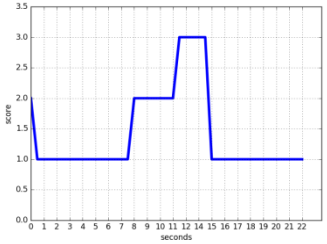
Scenes Team B

Defensive Scenes

Features per Frame



Classification per Frame



Scene	Total	Start	Mid	End
1	60 %	40 %	60%	6 %
…	…	…	…	…

Scene Selection

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

- **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

Tracking Data

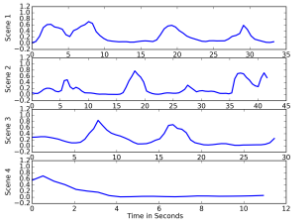
Scene Selection → Features → Classification → Scoring

Scenes Team A

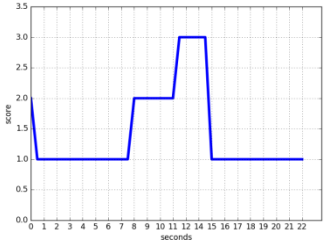
Scenes Team B

Defensive Scenes

Features per Frame



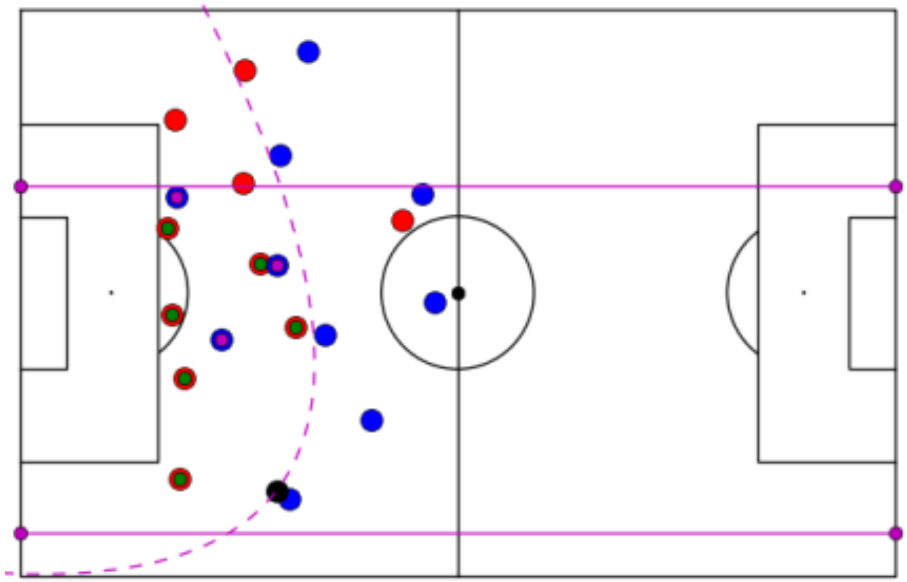
Classification per Frame



Scene	Total	Start	Mid	End
1	60 %	40 %	60%	6 %
…	…	…	…	…

Features of Compactness

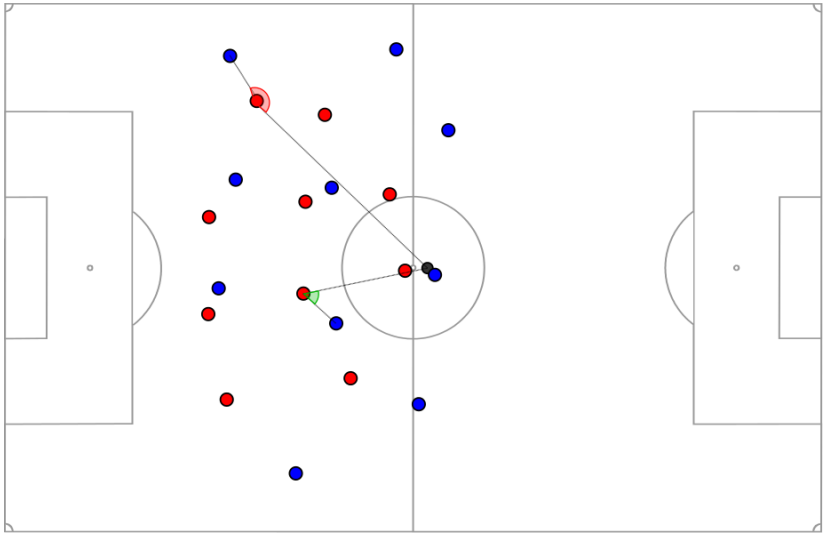
- „Compact Area“:
  - Number of defensive players in the compact area
  - Ratio of players in the compact area

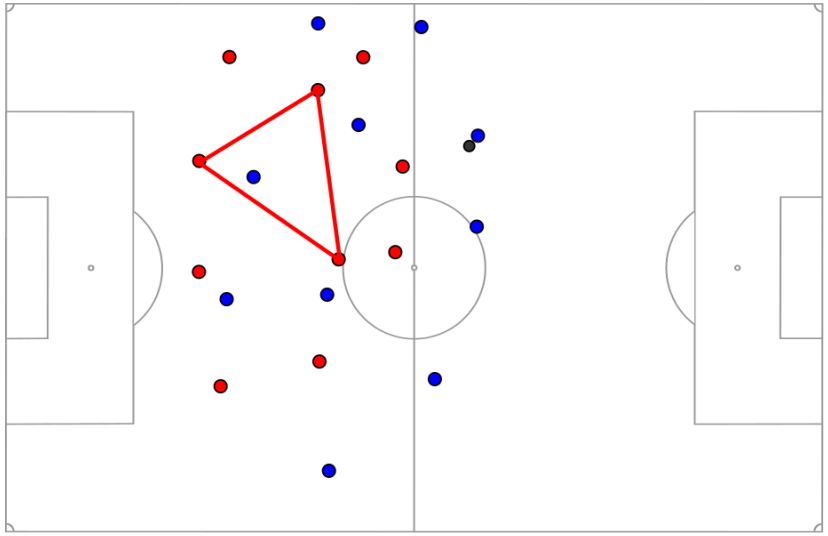


Features of Compactness

Triangles:

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

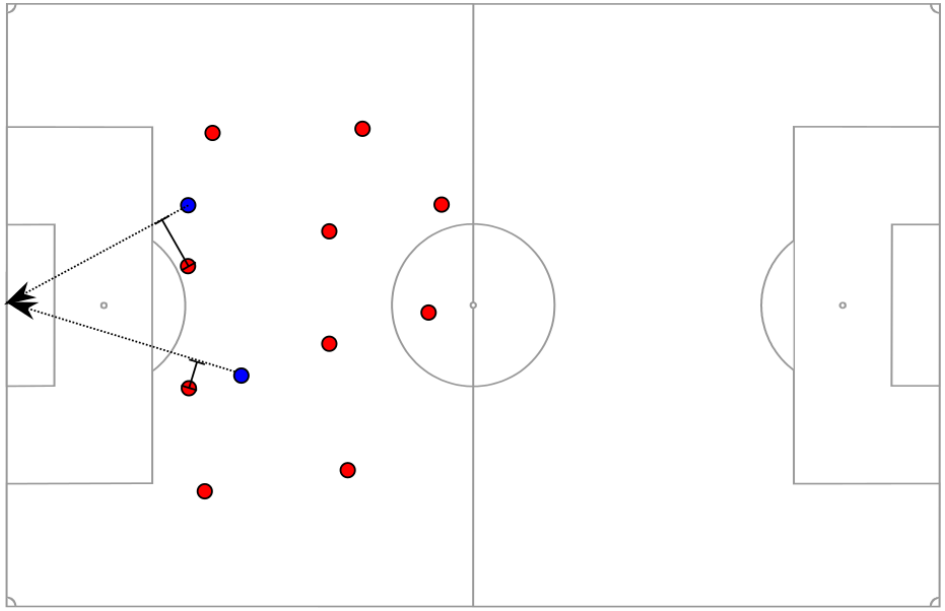




Features of Compactness

Free paths:

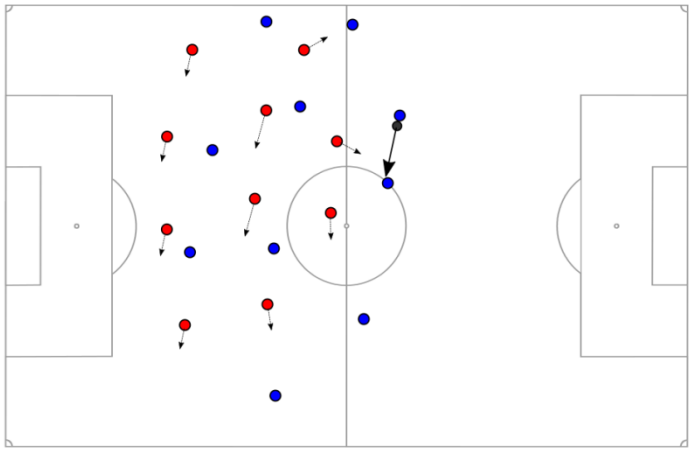
- Ratio of free paths to the goal



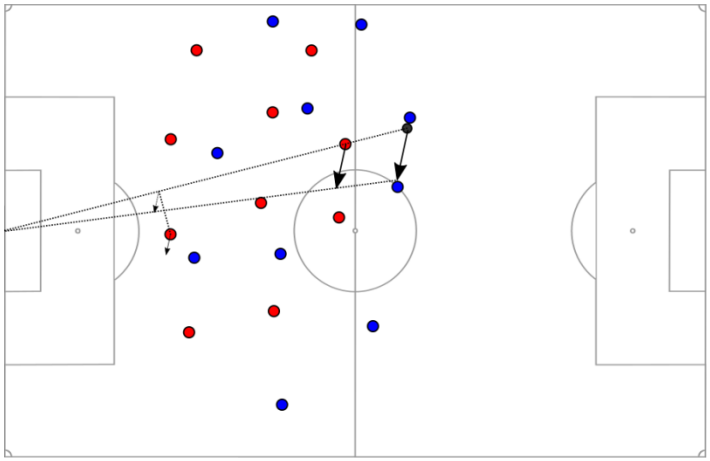
Features of Compactness

Team Synchronisation:

- Variance of directions

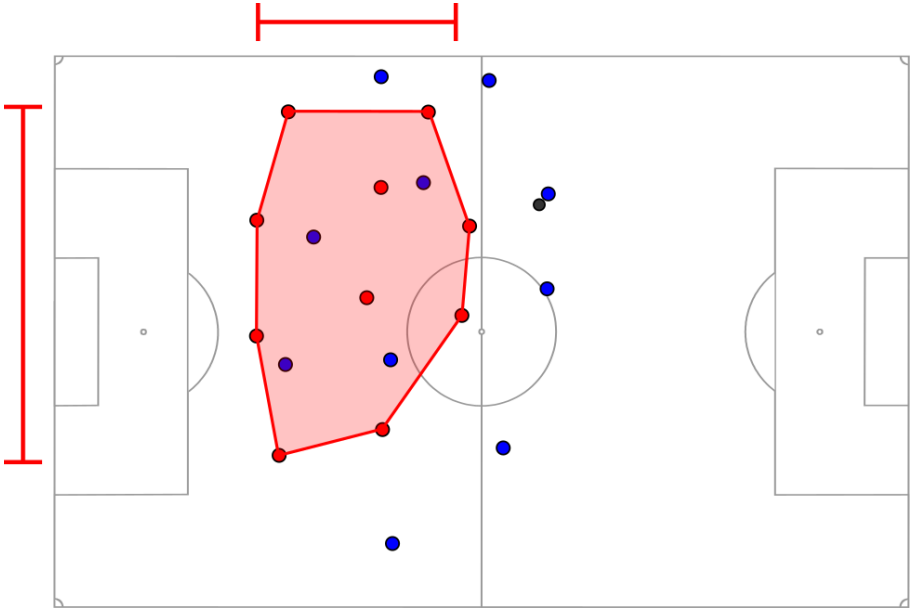


- Shift according to ball

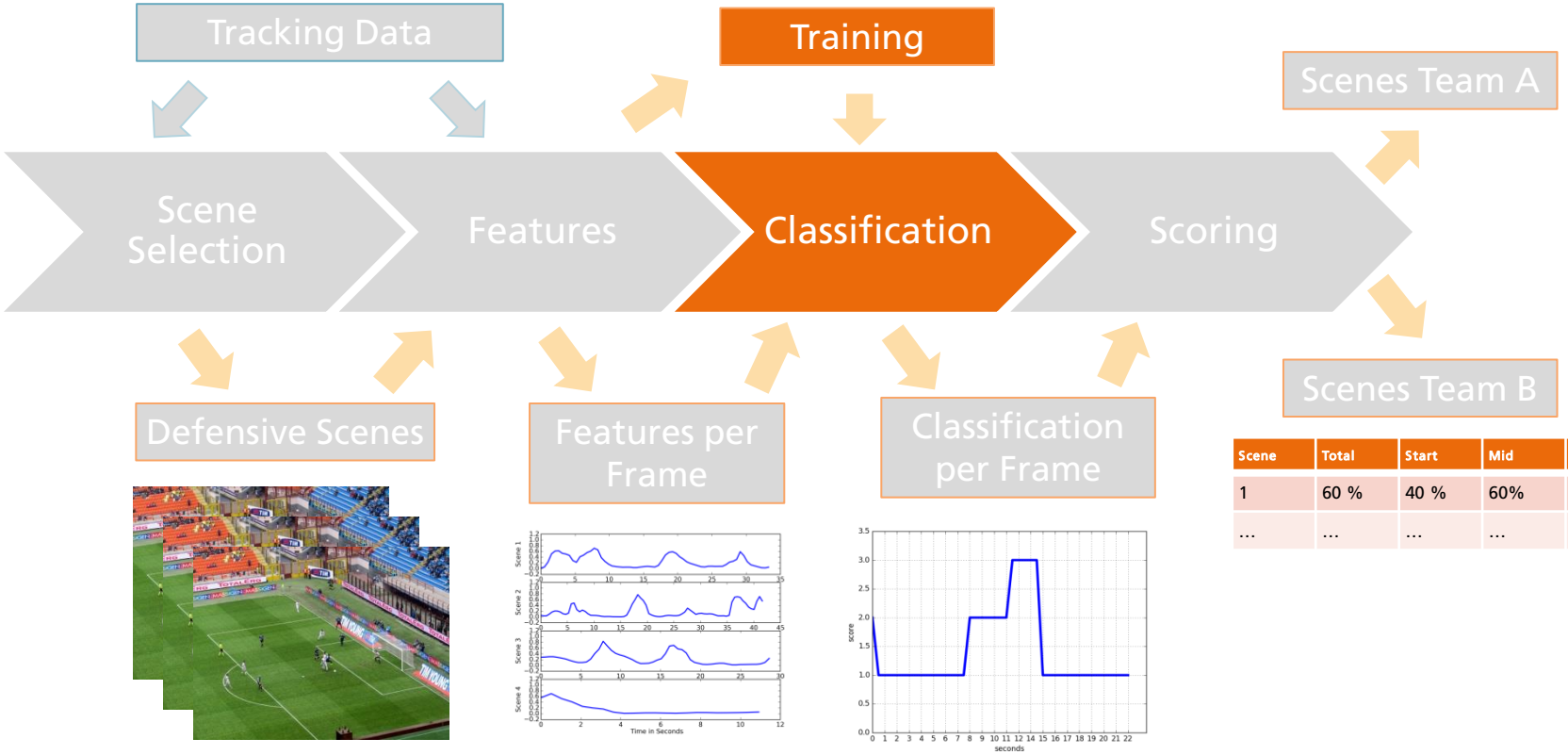


Features of Compactness

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



Classification: Training



Scene	Total	Start	Mid	End
1	60 %	40 %	60%	6 %
…	…	…	…	…

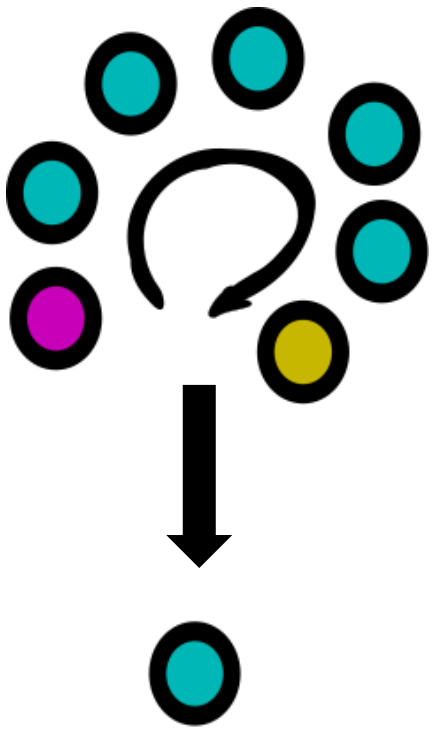
Training Data

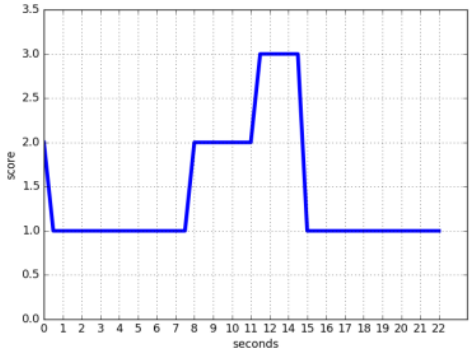
- **Test and Training data:**
  - **1 = low, 2 = medium, 3 = high compactness**
  - Five games of the season 2015/2016
  - 96 defensive scenes with 3 segments [Start + 4s, Mid, End - 4s]
  - 288 annotated scenes

- **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

Training

Scenes Team A

Scene Selection

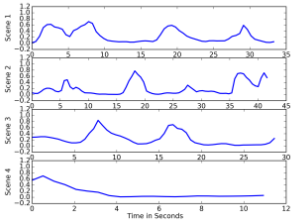
Features

Classification

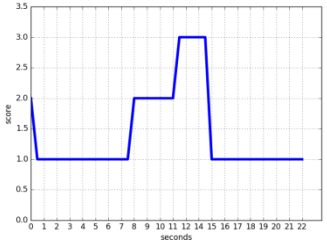
Scoring

Defensive Scenes

Features per Frame



Classification per Frame



Scenes Team B

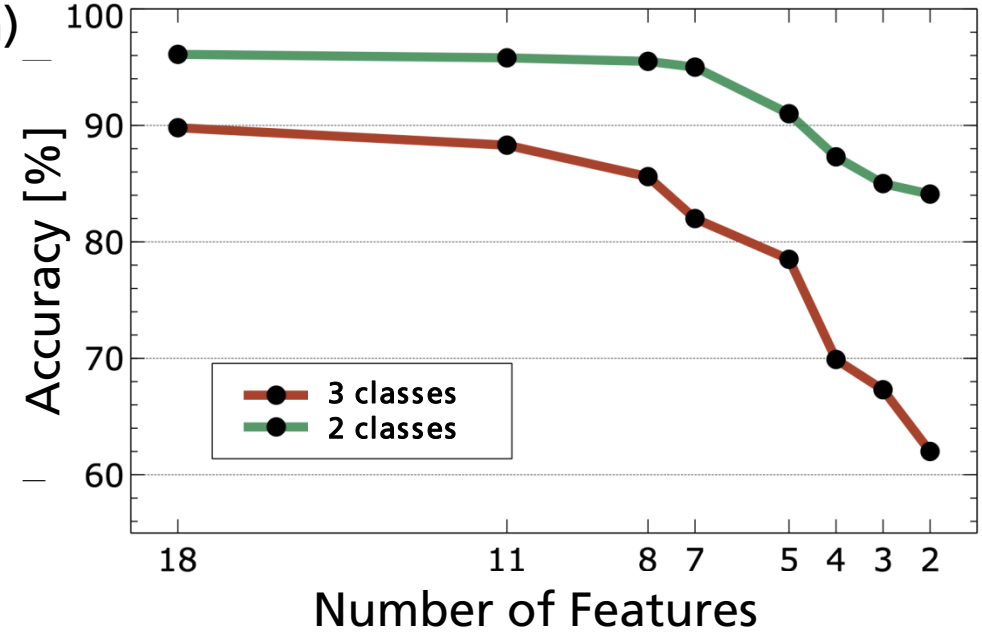
Scene	Total	Start	Mid	End
1	60 %	40 %	60%	6 %
…	…	…	…	…

Classification Results

- Results from a 10-fold crossvalidation

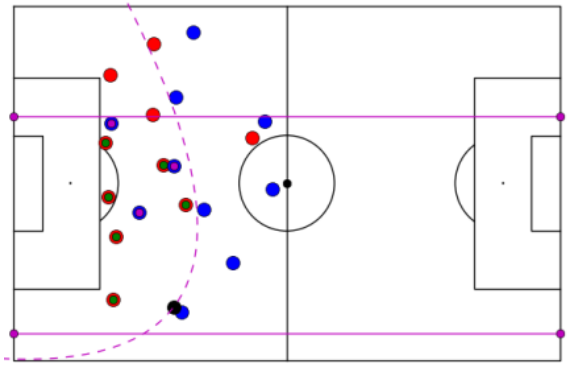
- **3 classes** (low / medium / high)
  - **All Features: 90 %**
  - 8 Features: 86 %

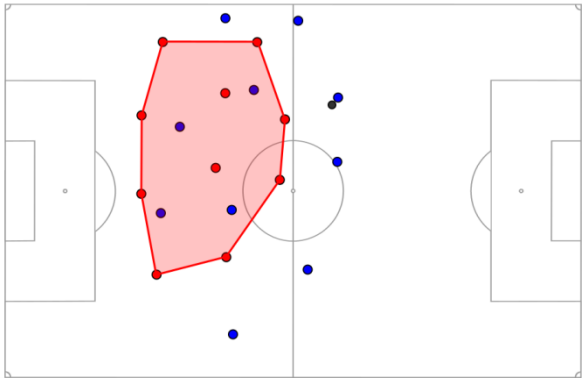
- **2 classes** (low / high)
  - **All Features: 96 %**
  - 8 Features: 95 %
  - **2 Features: 84 %**



Feature Selection

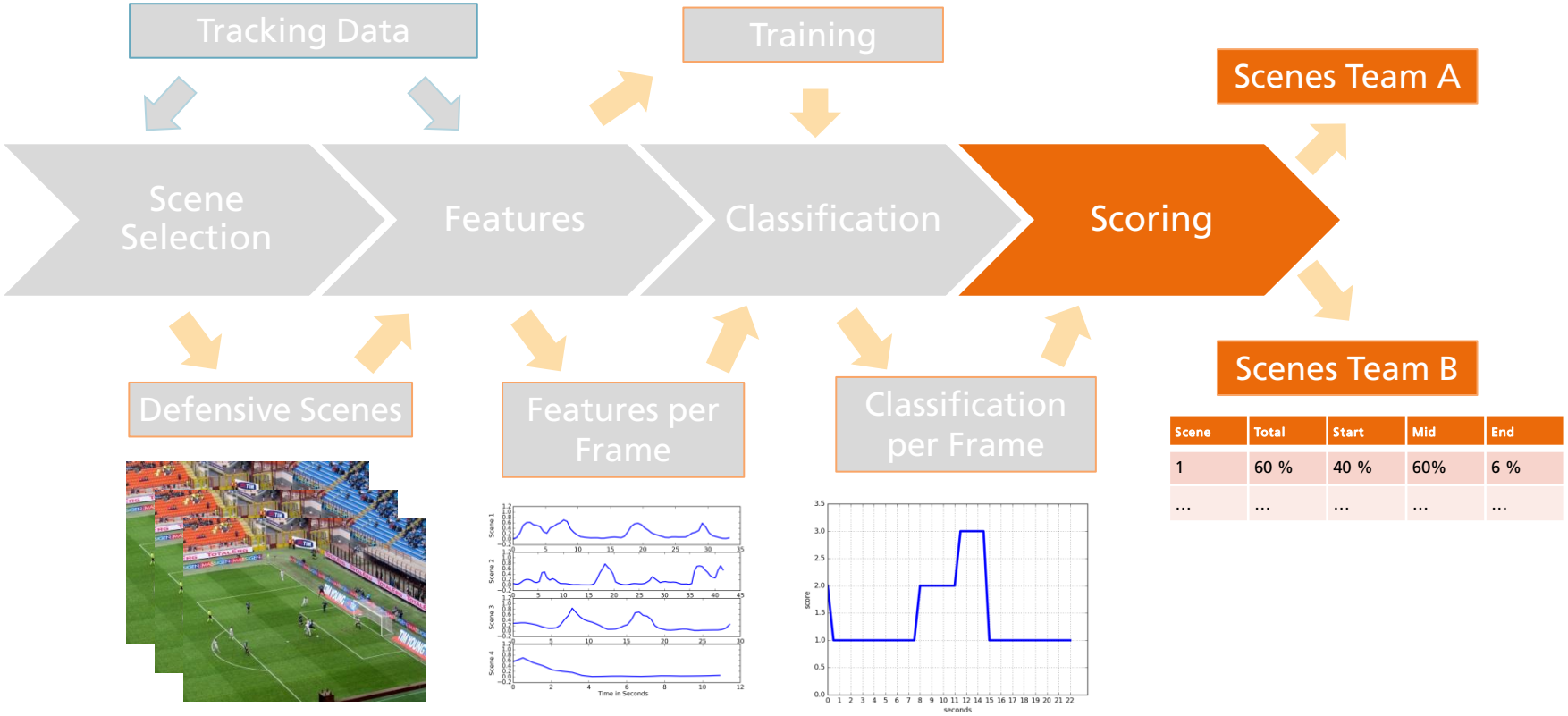
- **Effective Features:**
  - **Number of players in the compact area**
  - **Area of the convex hull**
  - Free paths to the goal
  - Area of biggest triangle
  - Good triangle view
  - Ratio of players in compact area
  - Vertical team distance
  - …





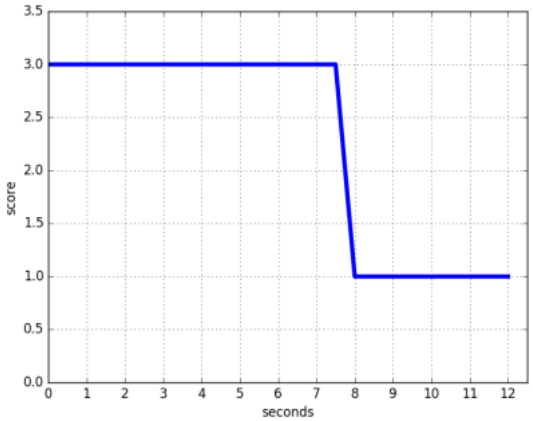
- **Ineffective Features:**
  - Variance of directions
  - Shift according to the ball
  - Horizontal team distance

Classification: Training



Scoring

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



Score	Start = 100 %		Mid = 90 %					End = 0 %	
Level	3	3	3	3	2	2	1	1	1

Processing Pipeline

Tracking Data

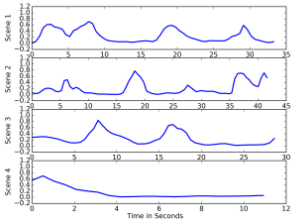
Training

Scenes Team A

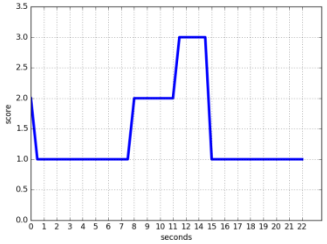
Scene Selection → Features → Classification → Scoring

Defensive Scenes

Features per Frame



Compactness per Frame



Scenes Team B

Szene	Total	Start	Mid	End
1	60 %	40 %	60%	6 %
…	…	…	…	…

Human versus Computer

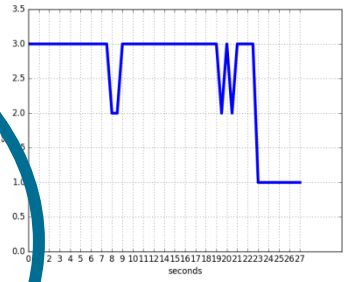
Automatic Scores vs. Human Scores:

- 171 Scores for 52 Scenes (halftime of unknown game)
- Low / med. / high compactness: **60 % aggreement**
- Low / high compactness: **97 % aggreement**

Filtering by low compactness at the end

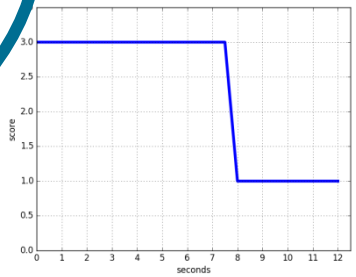
- Red Team

Scene	Start	Mid	End
Szene 1	100 %	92 %	0 %
…	…	…	…



- Yellow Team

Scene	Start	Mid	End
Scene 2	100 %	89 %	0 %
…	…	…	…



Scene 1 (Red)

Scene 2 (Yellow)

Thank you for your attention