

IMPECT

OPEN DATA DOCUMENTATION

This document provides information about the open-data repository of Impect

The uploaded data is an exact match to the files obtained from the Impect API.

The repository contains files from the following endpoints:

| | |
|-----------------|--|
| events | event data. The filename contains the match ID |
| event_kpis | event level KPIs. The filename contains the match ID |
| player_kpis | KPI aggregates per player per position per match. The filename contains the match ID |
| lineups | formations, line-ups, substitutions and tactical changes. The filename contains the match ID |
| matches | match meta data. The filename contains the iteration ID |
| squads | squad meta data. The filename contains the iteration ID |
| players | player meta data. The filename contains the iteration ID |
| countries | country names and ISO Codes |
| iterations | competition meta data (iteration = one season of one competition) |
| kpi_definitions | names and definitions of the KPIs |

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Events

Event level data is available in the **/data/events** directory. All data is provided in the json format. The filenames have the prefix “events_” followed by the match ID. The json file has the following structure (each attribute is explained below):

JSON

```
[
  {
    "index": 0,
    "id": 0,
    "gameTime": {
      "gameTime": "string",
      "gameTimeInSec": 0
    },
    "squadId": 0,
    "player": {
      "id": 0,
      "position": "BANK",
      "positionSide": "LEFT"
    },
    "pressure": 0,
    "actionType": "SHOT",
    "start": {
      "coordinates": {
        "x": 0,
        "y": 0
      },
      "adjCoordinates": {
        "x": 0,
        "y": 0
      },
      "packingZone": "GKR",
      "pitchPosition": "OWN_BOX",
      "lane": "LEFT_WING"
    },
    "end": {
      "coordinates": {
        "x": 0,
        "y": 0
      },
      "adjCoordinates": {
        "x": 0,
        "y": 0
      },
      "packingZone": "GKR",
      "pitchPosition": "OWN_BOX",
      "lane": "LEFT_WING"
    },
  },
]
```



```
"action": "LOW_PASS",
"phase": "SECOND_BALL",
"duel": {
  "duelType": "GROUND_DUEL",
  "playerId": 0
},
"shot": {
  "distance": 0,
  "angle": 0,
  "targetPoint": {
    "y": 0,
    "z": 0
  },
  "gk": {
    "coordinates": {
      "x": 0,
      "y": 0
    },
    "adjCoordinates": {
      "x": 0,
      "y": 0
    },
    "divePoint": {
      "y": 0,
      "z": 0
    }
  },
  "woodwork": "LEFT_POST"
},
"pass": {
  "distance": 0,
  "angle": 0,
  "receiver": {
    "playerId": 0,
    "type": "TEAMMATE"
  }
},
"currentAttackingSquadId": 0,
"bodyPart": "FOOT",
"bodyPartExtended": "FOOT",
"previousPassHeight": "LOW",
"duration": 0,
"opponents": 0,
"pxT": {
  "team": 0,
  "opponent": 0
},
"distanceToGoal": 0,
"result": "SUCCESS",
```



```

    "periodId": 0,
    "pressingPlayerId": 0,
    "fouledPlayerId": 0,
    "distanceToOpponent": "LESS_THAN_ONE_METER",
    "formation": {
      "team": "string",
      "opponent": "string"
    },
    "opponent": {
      "coordinates": {
        "x": 0,
        "y": 0
      },
      "adjCoordinates": {
        "x": 0,
        "y": 0
      }
    },
    "setPiece": {
      "id": 0,
      "subPhaseId": 0,
      "mainEvent": true
    },
    "dribble": {
      "distance": 0,
      "type": "ONE_VS_ONE",
      "result": "WINNER",
      "playerId": 0
    },
    "sequenceIndex": 0,
    "inferredSetPiece": true
  }
]

```

The table below lists each key (and its child keys) along with a brief description. Additional details about certain attributes can be found in the appendix. Attributes marked with an * are not included in the sample data and are only available for all seasons starting from summer 2024.

| Key | Child | Description |
|----------|----------|---|
| index | | The number of the event, starting with zero for each match. |
| id | | A unique ID for each event in the database. |
| gameTime | gameTime | The gameTime in a string format "MM:SS:MS(+AddedTime)". |



| | | |
|------------|----------------|---|
| | gameTimeInSec | A decimal number the game time in seconds. The first half starts at 0 seconds, the second half starts at 10,000 seconds. In case of extra time, the two extra-halves start at 20,000 or 30,000 seconds. |
| squadId | | SquadId of the player who touches the ball. Unique ID for each squad in our database. |
| player | id | Player ID of the player who touches the ball. |
| | position | Live position of the player on the ball (updated on event level). The following positions are used: GOALKEEPER, CENTRAL_DEFENDER, RIGHT_WINGBACK_DEFENDER, LEFT_WINGBACK_DEFENDER, DEFENSE_MIDFIELD, CENTRAL_MIDFIELD, RIGHT_WINGER, LEFT_WINGER, ATTACKING_MIDFIELD, CENTER_FORWARD. |
| | positionSide | Live positionSide of the player on the ball (updated on event level). For all central positions (CENTRAL_DEFENDER, DEFENSE_MIDFIELD, CENTRAL_MIDFIELD, CENTER_FORWARD) we use an algorithm to detect the side a player played on (only for >= 2 players on one position). |
| pressure | | A scale of the pressure on the ball carrying player that ranges from 0% (no pressure) to 100% (no ball control). This scale is created by considering the distance to the nearest opponent and the body part used (including the previous trajectory of the pass). |
| actionType | | The type of an event (see appendix 4). |
| periodId | | The ID of the game period in which the action was performed. 1 = 1st half, 2 = 2nd half, 3 = 1st half (extra time) and 4 = 2nd half (extra time). |
| start | coordinates | An object containing the x- and y- coordinates of the start location of the event. |
| | adjCoordinates | An object containing the adjusted x- and y- coordinates of the start location of the event. |
| | packingZone | The start Packing Zone for the given event (see appendix 2). |
| | pitchPosition | The start location of an event based on dividing the pitch into 5 vertical zones. PitchPositions are 'OWN_BOX', 'FIRST_THIRD', 'MIDDLE_THIRD', 'FINAL_THIRD' and 'OPPONENT_BOX'. |
| | lane | The start location of an event based on dividing the pitch into 5 horizontal zones. The lanes are 'CENTER', 'RIGHT_HALF_SPACE', 'LEFT_HALF_SPACE', 'RIGHT_WING', 'LEFT_WING'. The lanes are delimited on the sides by the lines of the 18-yard box and the 6-yard box. |
| end | coordinates | An object containing the x- and y- coordinates of the end location of the event. |
| | adjCoordinates | An object containing the adjusted x- and y- coordinates of the end location of the event. |



| | | |
|-------------------------|---------------|---|
| | packingZone | The end Packing Zone for the given event (see appendix 2). |
| | pitchPosition | The end location of an event based on dividing the pitch into 5 vertical zones. |
| | lane | The end location of an event based on dividing the pitch into 5 horizontal zones. |
| action | | The action of a player. A more precise form of the attribute actionType (see appendix 3) |
| phase | | The phase of play of the event referring to the team that is tagged (see appendix 5). |
| duel | duelType | The type of the duel (air vs ground). |
| | playerId | The ID of the opponent's player faced in the duel (loser of the duel). |
| shot | distance | The radial distance to the middle of the goal from the shooting location in meters. |
| | angle | The angle towards the middle of the opponents goal that the shot was taken from on a scale from 0° to 90°. |
| | targetPoint | the targetPoint where the shot would have ended on the goal mouth. See appendix 6 to find information about the goal map that is used. |
| | gk* | This object provides the coordinates of the goalkeeper at the moment of the shot. It is only available for dataV4. |
| | woodwork* | The attribute woodwork is only available for dataV4+ and indicates whether the ball has touched the post (LEFT_POST, RIGHT_POST), the crossbar (CROSSBAR) or the corner post (CROSSBAR_LEFT_POST, CROSSBAR_RIGHT_POST). |
| pass | distance | The radial distance between ball release and ball reception in meters. |
| | angle | The pass angle in a polar notation (0°-360°). A pass straight towards the opponent goal has an 0° angle, passes to the right 270°, passes to the left 90° and passes to the back 180°. |
| | receiver | An object containing the receiving player's id and team type (teammate or opponent). |
| currentAttackingSquadId | | The team that is in ball control. Events with high pressure and low ball control are ignored, so that the resulting variable can be interpreted as a "ball possession sequence". |
| bodyPart | | The bodyPart used by the player including the previous pass height (see appendix 7 for more information). |
| bodyPartExtended* | | As of dataV4, a distinction is made between FOOT_RIGHT and FOOT_LEFT for each action and the value HAND is added for goalkeeper actions. Furthermore, a distinction is no longer made between FOOT_LOW and |



| | | |
|--------------------|-----------------------------|---|
| | | FOOT_HIGH - the information as to whether a high or flat pass was received has been moved to the attribute previousPassHeight. |
| previousPassHeight | | For ball receptions and actionType.OUT, it is specified whether the previous pass or shot was played flat or high (above chest height). |
| duration | | The duration of an event (difference in time between current event and next event). |
| opponents | | The number of opponents that are able to defend their own goal. A player counts as an opponent, if the radial distance between him and his own goal is smaller than the radial distance of the ball and the own goal. |
| pxT | team | The goal threat of the team on the ball. The value is derived from the Packing Expected Threat (pxT) Model (See Appendix 8). |
| | opponent | The goal threat of the team off the ball. The value is derived from the Packing Expected Threat (pxT) Model (See Appendix 8). |
| distanceToGoal | | The radial distance between the ball and the middle of the opponent's goal in meters. |
| result | | Result of a pass, dribble or shot. For passes, the result can be NEUTRAL if the receiver is under high pressure or if a foul follows. The result of a pass is SUCCESS if the pass reaches a teammate with pressure below 80. Passes to an opponent with pressure below 80 and passes that go out of play or offside are considered as FAIL. Dribbles and shots can only be SUCCESS or FAIL. |
| pressingPlayerId | | The ID of an opponent player is captured when he is (1) attacking the player on the ball with the intention to win the ball or (2) when his distance to the ball carrying player is below one meter. |
| fouledPlayerId | | If the event is a 'FOUL', the playerId of the player who gets fouled is captured. When no player is mentioned, it is likely that the foul was due to hand play. |
| distanceToOpponent | | The distance to the next opponent. When a player receives or releases the ball within an open-play situation, the distance to the next opponent is captured. The dimensions are: 'MORE_THAN_FOUR_METERS', 'FOUR_METERS', 'THREE_METERS', 'TWO_METERS', 'ONE_METER' and 'LESS_THAN_ONE_METER'. |
| formation | team | Live formation of both teams. formation.team is the live formation of the team on the ball, |
| | opponent | formation.opponent is the formation of the team off the ball. |
| opponent* | coordinates, adjCoordinates | From dataV4, the coordinates of the nearest opponent are given for all cases where the opponent is ≤ 4 meters away. The coordinates are given from the perspective of the active player/team on the ball. |
| setpiece* | id | The id of the set piece phase the event is a part of. |



| | | |
|------------------|------------|---|
| | subPhaseId | The id of the set piece sub phase the event is a part of. |
| | mainEvent | Whether the event is the main event of a set piece sub phase. |
| dribble* | type | Whether the dribble is a "ONE_VS_ONE", "CARRY", "PROGRESSIVE_CARRY", "STEPPING_IN", on "ESCAPE_PRESSURE". |
| | result | For "ONE_VS_ONE" dribbles: The result of the dribbling ("WINNER," "NEUTRAL," "LOSER"). |
| | playerId | For "ONE_VS_ONE" dribbles: The playerId of the opponent. |
| | distance | The distance for each dribble. |
| sequenceIndex | | This index divides the match into sequences. A new sequence begins whenever a team gains control of the ball (a change in the CurrentAttackingSquadId attribute) or when a set piece is executed. |
| inferredSetPiece | | This attribute indicates when a set piece was not visible in the footage and was automatically inserted based on the preceding event (FOUL, OFFSIDE, OUT). |

Event KPIs

Event level KPIs are available in the **/data/events_kpis** directory. Provides all KPIs on the event level. The KPIs can be mapped to the event attributes using the event ID. The definitions of the KPIs are available in the **kpi_definitions.json**.

```
JSON
[
  {
    "position": "BANK",
    "playerId": 0,
    "eventId": 0,
    "kpiId": 0,
    "value": 0
  }
]
```

| Key | Description |
|----------|---|
| position | The current position of the player who recorded the KPI value. |
| playerId | The player ID of the player who recorded the KPI value. |
| eventId | The event ID where the KPI value was recorded. Based on this ID, the KPIs |



| | |
|-------|---|
| | can be mapped to the event attributes. |
| kpid | The KPI ID. More information about the KPIs can be found in the <code>kpi_definitions.json</code> (KPI name, definition, etc.). |
| value | The value of the KPI. |

Player KPIs

Player level KPIs are available in the `/data/player_kpis` directory. Provides KPI aggregates per player per position per match. Also includes the match level KPIs *playDuration* and *matchShare*. The *playDuration* is supplied in seconds. One full match including injury time equals one match share. The definitions of the other KPIs are available in the `kpi_definitions.json` file.

JSON

```
{
  "matchId": 0,
  "squadHome": {
    "id": 0,
    "players": [
      {
        "id": 0,
        "position": "BANK",
        "playDuration": 0.0,
        "matchShare": 0.0,
        "kpis": [
          {
            "kpiId": 0,
            "value": 0.0
          }
        ]
      }
    ]
  },
  "squadAway": {
    "id": 0,
    "players": [
      {
        "id": 0,
        "position": "BANK",
        "playDuration": 0.0,
        "matchShare": 0.0,
        "kpis": [
          {
            "kpiId": 0,
```



```

        "value": 0.0
      }
    ]
  }
}

```

| Key | Child | Description |
|-------------------------|---------|---|
| matchId | | The match ID of the match. |
| squadHome/ squadAway | id | The squad ID of the home/away squad.. |
| | players | id: The player ID of the player who recorded KPIs. position: The position the player recorded the KPIs at. playDuration: The duration the player played at the position in seconds.. matchShare: The share of the match the player played at the position (1= Full Match incl. Injury Time)) kpis: List of KPIs incl. the KPI ID and the aggregated value. |

Lineups

Lineups and substitutions are available in the **/data/lineups** directory. Lists all the lineups, substitutions, tactical changes, formations and formation changes.

```

JSON
{
  "id": 0,
  "dateTime": "2025-03-14T09:43:50.555Z",
  "lastCalculationDate": "2025-03-14T09:43:50.555Z",
  "iterationId": 0,
  "squadHome": {
    "id": 0,
    "players": [
      {
        "id": 0,
        "shirtNumber": 0
      }
    ],
    "startingPositions": [
      {
        "playerId": 0,

```



```

        "position": "BANK",
        "positionSide": "LEFT"
    }
],
"substitutions": [
    {
        "gameTime": {
            "gameTime": "string",
            "gameTimeInSec": 0
        },
        "playerId": 0,
        "toPosition": "BANK",
        "positionSide": "LEFT",
        "fromPosition": "BANK",
        "fromPositionSide": "LEFT",
        "exchangedPlayerId": 0,
        "substitutionType": "SUB_ON"
    }
],
"startingFormation": "string",
"formations": [
    {
        "gameTime": "string",
        "gameTimeInSec": 0,
        "formation": "string"
    }
]
},
"squadAway": {
    "id": 0,
    "players": [
        {
            "id": 0,
            "shirtNumber": 0
        }
    ],
    "startingPositions": [
        {
            "playerId": 0,
            "position": "BANK",
            "positionSide": "LEFT"
        }
    ],
    "substitutions": [
        {
            "gameTime": {
                "gameTime": "string",
                "gameTimeInSec": 0
            },

```



```

        "playerId": 0,
        "toPosition": "BANK",
        "positionSide": "LEFT",
        "fromPosition": "BANK",
        "fromPositionSide": "LEFT",
        "exchangedPlayerId": 0,
        "substitutionType": "SUB_ON"
    }
],
"startingFormation": "string",
"formations": [
    {
        "gameTime": "string",
        "gameTimeInSec": 0,
        "formation": "string"
    }
]
}
}

```

| Key | Child Key | Description |
|-------------------------|-------------------|---|
| id | | The ID of the match. |
| dateTime | | Date and time of the match. |
| lastCalculationDate | | The last time the data of the match was changed. |
| iterationId | | The ID of the iteration the match was a part of. |
| squadHome/ squadAway | id | The ID of the squad. |
| | players | Contains all players that were part of the squad. |
| | startingPositions | Contains the starting-11 including their positions and positionSides. |
| | substitutions | Contains all substitutions, tactical changes, position side changes & send offs. For each change in the match the position and positionSide (from and to) are given. The attributes exchangedPlayerId* and substitutionType* are only available for data version 4 or higher. |
| | startingFormation | The formation that a team used at the start of the game. |



| | | |
|--|------------|--|
| | formations | The changes of formations during a match including the gameTime and gameTimeinSec. |
|--|------------|--|

Matches

Match meta data is available in the **/data/matches** directory. Lists all matches within an iteration. Contains information about the competing teams, the scheduled date, the lastCalculationDate and more.

JSON

```
[
  {
    "iterationId": 0,
    "id": 0,
    "homeSquadId": 0,
    "awaySquadId": 0,
    "scheduledDate": "2025-03-14T09:47:58.793Z",
    "lastCalculationDate": "2025-03-14T09:47:58.793Z",
    "matchDay": {
      "index": 0,
      "name": "string"
    },
    "available": true,
    "idMappings": [
      {
        "additionalProp1": [
          "string"
        ],
        "additionalProp2": [
          "string"
        ],
        "additionalProp3": [
          "string"
        ]
      }
    ]
  }
]
```

| Key | Description |
|-------------|---|
| iterationId | The ID of the iteration the match is a part of. |
| id | The ID of the match. |



| | |
|---------------------|--|
| homeSquadId | The squad ID of the home team. |
| awaySquadId | The squad ID of the away team. |
| scheduledDate | The date and time of the kick off. |
| lastCalculationDate | The last time the data of the match was changed. |
| matchDay | Contains the name of the matchday (in German) and the index of the matchday (starting with 0). |
| available | The status of the match. If the value is "TRUE", data of this match is available. |
| idMappings | The IDs of the match from other data providers. |

Squads

Squad meta data is available in the **/data/squads** directory. Contains information about the squad name, the squad country (ID), the type of a team, gender, and mappings to other providers. The Attribute "access" is only relevant for API customers.

JSON

```
[
  {
    "id": 0,
    "name": "string",
    "countryId": 0,
    "type": "NATIONAL_TEAM",
    "gender": "MALE",
    "idMappings": [
      {
        "additionalProp1": [
          "string"
        ],
        "additionalProp2": [
          "string"
        ],
        "additionalProp3": [
          "string"
        ]
      }
    ],
    "access": true
  }
]
```



]

| Key | Description |
|------------|--|
| id | The ID of the squad. |
| name | The name of the squad. |
| countryId | The ID of the country of the squad. |
| type | The type of the squad (national team, club, etc.). |
| gender | The gender of the squad. |
| idMappings | The IDs of the squad from other data providers. |
| access | Whether data for this squad is accessible. |

Players

Players meta data is available in the **/data/players** directory. Contains meta data about the players. All players that were at least once in a squad of an iteration are listed here.

```
JSON
[
  {
    "id": 0,
    "firstname": "string",
    "lastname": "string",
    "commonname": "string",
    "birthdate": "2025-03-14",
    "birthplace": "string",
    "leg": "LEFT",
    "countryIds": [
      0
    ],
    "gender": "MALE",
    "idMappings": [
      {
        "additionalProp1": [
          "string"
        ]
      }
    ]
  }
]
```




```

        "additionalProp2": [
            "string"
        ],
        "additionalProp3": [
            "string"
        ]
    }
}
]

```

| Key | Description |
|------------|--|
| id | The ID of the player. |
| firstname | The first name of the player. |
| lastname | The last name of the player. |
| commonname | The full name of the player. |
| birthdate | The birthdate of the player. |
| birthplace | The place of origin of the player. |
| leg | The player's strong leg ("RIGHT", "LEFT", "BOTH"). |
| countryIds | The list of countries of the player. |
| gender | The gender of the player. |
| idMappings | The IDs of the player from other data providers. |

Countries

Country data is available in the **/data/countries.json** file. Contains the country IDs and the respective ISO names, ISO codes, FIFA names, FIFA codes and a German name. Depending on the use case it can sometimes make sense to use the FIFA codes, e.g. Scotland has the ISO code "GBR" (ISO name "United Kingdom") and the FIFA code "SCO" (FIFA name "Scotland").

```

JSON
[

```



```
{
  "id": 0,
  "name": "string",
  "isoName": "string",
  "isoCode": "string",
  "fifaName": "string",
  "fifaCode": "string"
}
```

| Key | Description |
|----------|--|
| id | The ID of the country. |
| name | The name of the country. |
| isoName | The ISO country name. |
| isoCode | The ISO country code (ISO 3166-1 alpha-3). |
| fifaName | The FIFA country name. |
| fifaCode | The FIFA country code. |

Iterations

Available iteration meta data is available in the **/data/iterations.json** file. Contains information about the iterations, where iteration always means one season of one competition.

```
JSON
[
  {
    "id": 0,
    "season": "string",
    "competition": {
      "name": "string",
      "id": 0,
      "type": "string",
      "countryId": 0,
      "gender": "MALE"
    },
    "dataVersion": "V1",
  },
]
```

```
"lastChangeTimestamp": "2025-03-14T09:52:11.118Z",
"idMappings": [
  {
    "additionalProp1": [
      "string"
    ],
    "additionalProp2": [
      "string"
    ],
    "additionalProp3": [
      "string"
    ]
  }
]
}
```

| Key | Child Key | Description |
|---------------------|-----------|---|
| id | | The ID of the iteration. |
| season | | The season (e.g. "23/24") of the iteration. |
| competition | name | The name of the competition. |
| | id | The ID of the competition. |
| | type | The type of the competition. |
| | countryId | The country of the competition. |
| | gender | The gender of the competition. |
| dataVersion | | The dataVersion of the iteration. |
| lastChangeTimestamp | | The last time a match within the iteration was changed. |
| idMappings | | The IDs of the iteration from other data providers. |

KPI Definitions

KPI definitions are available in the **/data/kpis_definitions.json** file. Contains information about the KPIs: While other endpoints only use the KPI IDs, you can find more information about the KPIs in here, such as the name, the label, the



definition and the meaning. The two fields “parentKpi” and “context” are always null for event level KPIs.

JSON

```
[
  {
    "id": 0,
    "name": "string",
    "details": {
      "label": "string",
      "definition": "string",
      "meaning": "string"
    },
    "parentKpi": {
      "id": 0,
      "label": "string",
      "name": "string",
      "definition": "string",
      "meaning": "string"
    },
    "context": {
      "label": "string",
      "name": "string",
      "definition": "string",
      "meaning": "string"
    }
  }
]
```

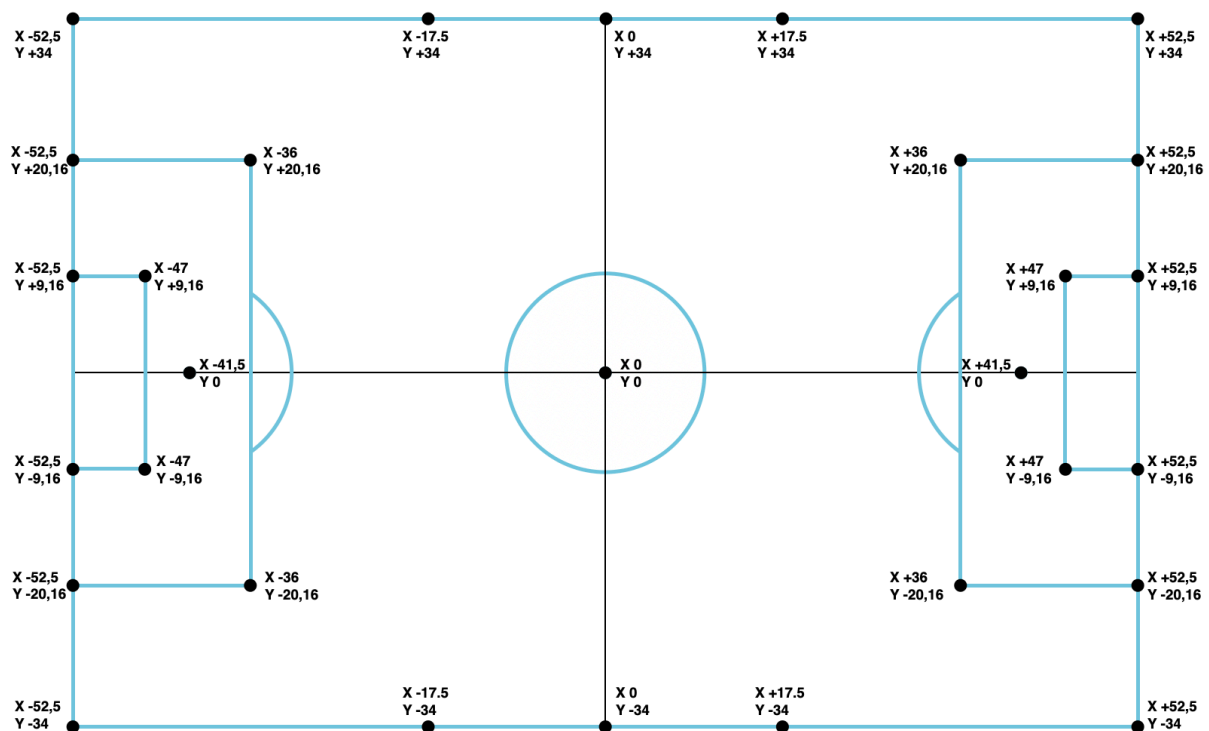
| Key | Child Key | KPI ID |
|------------|------------|---|
| name | | The name of the KPI. |
| details | label | The detailed label of the KPI. |
| | definition | The definition of the KPI. |
| | meaning | The meaning of the KPI. |
| parentKpi* | | For aggregated data: The KPI this KPI is a sub-KPI of. |
| context* | | For aggregated data: The type of context that was used to compute this KPI (e.g. action, packing zone, etc.). |



Appendix

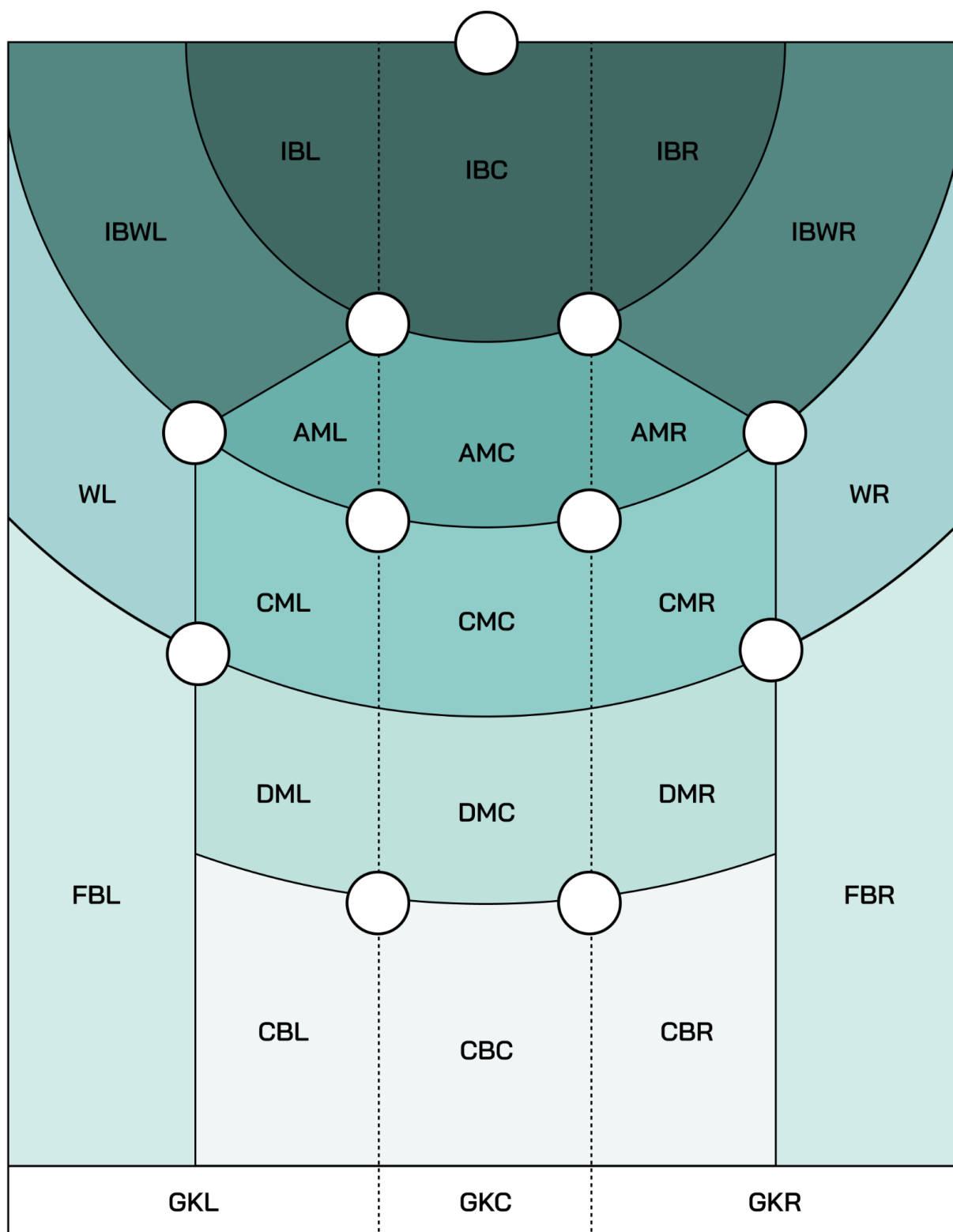
Appendix 1: Pitch Coordinates

We use a standardized pitch with a size of 105 x 68 meters with the origin in the middle of the pitch. The coordinates are always provided in two ways: Once the raw coordinates that just shows the coordinates from the view of the TV footage. On top we also provide the adjusted coordinates (adjCoordinates) where both teams play from the left to the right.



Appendix 2: Packing Zones

Zones are a big issue in modern football. All previous approaches from the data field have referred to the pitch ("1st third", "half track") and were thus static. Therefore, the football-related questions could only be partially answered. Packing-zones are fluid zones that are mainly oriented towards the opposing field players. Packing zones therefore provide much more insights into the current match situation and provide an answer to the following questions: In which zones does a player move? Which zones does the opponent like to play in? In which zones can the opponent be broken?



| Packing Zone | Shortcut | Definition | Meaning |
|-----------------|---------------|--|---|
| Goalkeeper Zone | GKR, GKC, GKL | The goalkeeper zone is determined solely by the player position of the goalkeeper. Horizontal and vertical points are not relevant here. | When the goalkeeper has the ball - regardless of where exactly. |

| | | | |
|----------------------|---------------|--|---|
| Centre-Back Zone | CBR, CBC, CBL | The CB zone is located in front of the opposing forwards, usually with all opponents between the ball and the opposing goal. It borders laterally the two FB zones, depending on whether one is inside or outside the opponent's formation. To the front, the CB zone borders on the DM zone, to the back on the GK zone. | Neutral zone in which play is built from the centre. |
| Full-Back Right Zone | FBR | The FBR zone is adjacent to the CB zone and is defined by the player's position being outside of the opponent's formation. To the front, the RB zone borders on the wide right zone. The decisive factor is the number of opponents between the ball and the opposition goal. | Deep zone to the right of the CB zone where the outside right player in the defensive line is usually located |
| Full-Back Left Zone | FBL | The LB zone is adjacent to the CB zone and is defined by the player's position being outside of the opponent's formation. To the front, the LB zone borders on the wide left zone. The decisive factor is the number of opponents between the ball and the opposition goal. | Deep zone to the left of the CB zone where the outside left player in the defensive line is usually located. |
| Defensive-Mid Zone | DMR, DMC, DML | The DM zone is the central and semi-central zone behind the opposing strikers and in front of the opposing midfielders. It borders the back of the CB zone and the front of the CM zone. It is bordered to the sides by the two wide zone. | Centrally ahead of the opponent strikers/ first line of defence. |
| Centre-Mid Zone | CMR, CMC, CML | The CM zone is the central and semi-central space within the opponent's midfield, located ahead of the DM zone & behind the AM zone. Vertically, it is located behind the opposing strikers and first midfielders, but not yet directly in front of the last line of defence. Horizontally, it is located between the two wings of the opponent's formation. | Central space ahead of the DM zone and in front of the AM zone. |
| Attacking-Mid Zone | AMR, AMC, AML | The AM zone is the central and semi-central zone immediately in front of the opponent's last line of defence. It is bordered to the back by the CM zone & to the front by the in-behind central zone. Horizontally, it is located inside the opponent's formation. Laterally, it borders the in-behind wide zones. | Central zone directly in front of the opponent's defensive line. |
| Wide Right Zone | WR | The wide-right zone is behind the opposing strikers and often also behind the opposing winger. It is the space to the outside behind the first defensive line and in front of the last defensive line of the opponent. Horizontally, you are outside the opponent's formation. Behind, the zone borders the RB zone and in front the | Space on the outside right behind the first line of defence and in front of the last line of defence of the opponent. |



| | | | |
|---------------------------|---------------|---|--|
| | | in-behind right zone. Laterally, it borders both the DM zone and the CM zone & can at time also border the AM zone, depending on the opponent's formation & shape. | |
| Wide Left Zone | WL | The wide-left zone is behind the opposing strikers and often also behind the opposing winger. It is the space to the outside behind the first defensive line and in front of the last defensive line of the opponent. Horizontally, you are outside the opponent's formation. Behind, the zone borders the LB zone and in front the in-behind left zone. Laterally, it borders both the DM zone and the CM zone & can at time also border the AM zone, depending on the opponent's formation & shape. | Space on the outside left behind the first line of defence and in front of the last line of defence of the opponent. |
| In-Behind Wide Right Zone | IBWR | The in-behind right zone is behind or next to the opponent's defensive line. At least two opposing centre-backs can still defend the goal, at least one full-back has been bypassed. To the right side, the zone borders the AM zone and the in-behind central zone. From behind it borders the wide right zone. | Tends to be a wide area with at least one full back bypassed. |
| In-Behind Wide Left Zone | IBWL | The in-behind left zone is behind or next to the opponent's defensive line. At least two opposing centre-backs can still defend the goal, at least one full-back has been bypassed. To the left side, the zone borders the AM zone and the in-behind central zone. From behind it borders the wide left zone. | Tends to be a wide area with at least one full back bypassed. |
| In-Behind Zone | IBR, IBC, IBL | The in-behind central zone is the area behind the opponent's defence. An action here often represents a complete breakthrough on goal. There is a maximum of one opposing centre-back and the opposing goalkeeper between the ball and the goal. Vertically, you are within the boundaries of the opponent's formation. Laterally, the zone reaches the two furthest points of the defence (generally each full-back). To the rear, it borders the AM zone. | Tends to be a central space with at least one central defender bypassed. |

Appendix 3: Action

Actions should provide more information about the "how". How does a player have his actions, what are his weapons? How does a team outplay its opponents?

Actions are often the interaction of several pieces of information. For example, a "high cross" is defined by the fact that A) the trajectory of the ball was higher than



the hip in the meantime and B) the ball was played from a certain field position to a certain field position or direction.

Some variables "compete" with each other. When a player is pinning a ball between the lines, the skills "Between the Lines" compete with "pinning". There is always a decision for one variable, i.e. an either-or. The decision is always in favour of the technical skill. In this case, the ability to tie down a high ball is technically more significant than the location ("Between the Lines"). The latter could also be determined by the packing zones ("DM, CM, AM").

The technical skills include the skills "header", "blocked" and "ground tackle", while the spatial skills include "between the lines", "behind", "outside", "deep runs" and "box occupation".

| action | Definition | Meaning |
|-------------------|---|---|
| LOW_PASS | A flat pass with the foot is when the trajectory of the ball during a pass reaches a maximum of hip height. The ball can land with a teammate, an opponent or out of bounds. | A flat pass with the foot. |
| LOW_CROSS | A low cross is a cross into the opponent's box from wide. The ball must not reach more than hip height during its trajectory, otherwise it is then counted as a high cross. | A low cross is a cross that is a low ball into the opponent's box from the wings. |
| HIGH_CROSS | A high cross is an aerial cross into the opponent's box from wide. The ball must reach waist height at least once during the ball's trajectory. | A high cross is a cross that is a high ball into the opponent's box from the wings. |
| DIAGONAL_PASS | A diagonal ball is a high ball played with the foot from the center or out wide and switches of play to the wing. It is distinguished from the chipped/ lofted pass (as this is usually along the line or through the center), the cross (usually into the box), a clearance (usually under very high pressure) and the short aerial pass (usually a short high passes). | High pass with the foot that changes play to the other side. |
| CHIPPED_PASS | A chipped or lofted pass is a high pass made from the foot where the ball travels a distance of at least 15 meters. These are mainly high passes along the line or in the center of the pitch. It is therefore distinguished from the diagonal ball (usually out to the outside of the pitch), the high cross (usually into the box), a clearance (usually under very high pressure) and a short aerial pas (usually with pass length less than 15 meters). | High pass with the foot with a minimum length of 15 meters. |
| SHORT_AERIAL_PASS | A short aerial pass is a high pass from the foot. These are predominantly short lobes, volleys or chips, e.g. as a result of a throw-in or after a bounce. It differs from the chipped/lofted pass primarily due to the length of the pass (<15 meters). | High pass with the foot with a minimum length of 15 meters. |

| | | |
|--------------------------|---|---|
| CLEARANCE | A clearance is characterized by the need to relieve a high press situation by clearing the ball with a defensive action. These are most frequently clearances with only one contact on the ball. | A defensive action on the ball with the foot under high pressure. |
| DRIBBLE | A player has at least two touches on the ball during a sequence. The action dribbling is defined by a player carrying the ball. | Dribbling, carrying the ball, holding the ball. |
| HEADER | The action header includes all receptions and releases of the ball that are made with the head. This includes passes with the head and goal finishes with the head. | An action with the head. |
| BLOCK | An action is considered blocked if a player touches the ball under such high pressure that he has no possibility of controlling the ball (blocking the shot, deflecting it, being shot at, etc...). | Blocked shots, blocked passes, blocked crosses. |
| AVAILABILITY_IN_THE_BACK | This skill availability at the back illustrates receiving the ball in defensive areas after a pass from a teammate when the ball is received in one of the following zones: GK zone, CB zone, FB zone or DM zone. (A maximum of one opponent has been bypassed in these areas). | Willingness to get on the ball in the back. |
| AVAILABILITY_BTL | Availability Between the Lines. This action describes receiving the ball in one of the following zones: DM zone, CM zone, AM zone. | Willingness to get on the ball in the midfield. Show in between the lines. |
| AVAILABILITY_OUT_WIDE | This action describes receiving the ball in one of the following zones: Wide Left, Wide Right, LB Zone, RB Zone. | Willingness to get the ball in wide areas. |
| AVAILABILITY_FDR | Receiving the ball behind the opponent's defensive chain. The ball must therefore be received in one of the three zones behind the defence (in-behind left, in-behind right, in-behind central), and the pass must be made from one of the zones in front. | Option in-behind, deep runner, getting in behind the opponent's defence. |
| HOLD_UP_PLAY | A player receives & retains possession from a high pass under pressure or a low pass where he has to hold the ball in a one-on-one situation. | Control and secure high balls, maintain possession from a flat pass with the opponent at your back. |
| AVAILABILITY_IN_THE_BOX | A player receives a pass in the opponent's box. | Ball contacts in the opponent's box, presence in the opponent's box. |
| LOOSE_BALL_REGAIN | Winning "free" balls on the pitch, which do not include intercepted passes, clearances or tackles. This occurs mainly after second balls, such as aerial duels and from bouncing balls. | Win second balls, anticipation, being combative and hardworking. |
| INTERCEPTION | An intercepted pass includes all the opponent's pass attempts | Intercept passes, |



| | | |
|-----------------------|--|---------------------------------------|
| | that are picked up. | anticipate the ball. |
| GROUND_DUEL | The action ground duel describes the (temporary) winning of the ball through a duel. The opponent must not have attempted a pass, but start a dribble. | Direct duels, physical strength. |
| LONG_RANGE_SHOT | Shots from over 22 meters out, measured from the center of the goal. | Shooting at goal from a long way out. |
| MID_RANGE_SHOT | Shots from 10-22 meters out, measured from the center of the goal. | Goal finish from a medium distance. |
| CLOSE_RANGE_SHOT | Shots from up to 10 metres away, measured to the centre of the goal that are not a clear 1-on-1 against the goalkeeper. | Shots from close range. |
| ONE_VS_ONE_AGAINST_GK | Goal-scoring situation in which the shooter is free in front of the goalkeeper or the last man. | 1 vs. 1 finish. |
| OPEN_GOAL_SHOT | Shots where all opposing players have already been bypassed and the attacker gets to shoot at an open goal. | Shot at an empty goal. |
| THROW_IN | Set piece situation where the ball is brought into play by a throw-in. | A player throws the ball in. |
| CORNER | Set piece situation where the ball is brought into play by a corner kick. | A player takes a corner. |
| FREE_KICK | Set piece situation where the ball is brought into play by a free kick. | A player takes a free kick. |
| DIRECT_FREE_KICK | Shot from Free Kick. | Shot from Free Kick. |
| PENALTY_KICK | Set piece situation where the ball is brought into play by a penalty kick. | A player takes a penalty. |
| GOAL_KICK | Set piece situation where the ball is brought into play by a goal kick. | A player takes a goal kick. |
| SAVE | The goalkeeper parries the ball without holding on to it. | Parry by the goalkeeper, not caught. |
| CATCH | The goalkeeper intercepts a ball and holds on to the ball. | Kept ball by the goalkeeper, a catch. |
| GOAL | Goal from the player who is tagged in the event. | Goal. |
| OWN_GOAL | Own Goal from the player who is tagged in the event. | Own Goal. |
| RED_CARD | Red Card for the player who is tagged in the event. | Red Card. |
| YELLOW_CARD* | Yellow Card for the player who is tagged in the event. | Yellow Card. |
| KICKOFF_WHISTLE | Kick-off Whistle and Kick-off. | Kick-off. |



| | | |
|-----------------------|---|-----------------------|
| FINAL_WHISTLE | Final Whistle of half-time. | Final Whistle. |
| FOUL | Foul by the player who is tagged in the event. You can find the fouled player in the attribute 'fouledPlayerId'. If no player is mentioned, it is either a hand ball or another type of foul. | Foul. |
| BALL_OUT_OF_GOAL_LINE | Ball out of play at the goal line. | Ball Out. |
| BALL_OUT_OF_SIDE_LINE | Ball out of play at the side line. | Ball Out. |
| BALL_OUT_OF_UNKNOWN | Ball out of play at the goal or side line. | Ball Out. |
| VIDEO_NOT_AVAILABLE | No video footage available. | No Video available. |
| REFERY_INTERCEPTION | Referee decides to interrupt the game (e.g. due to an injured player on the pitch) | Referee interruption. |

Appendix 4: Action Type

Type of the action. The variable `actionType` is a more general form of actions.

| actionType | Description |
|-------------------|--|
| PASS | Consists of low passes, low crosses, high crosses, diagonal passes, chipped passes, short aerial passes, and passes with the head. |
| DRIBBLE | Our data operators have to tag the Event if one of the following rules are met: When the player carries the balls more than 2 steps, when the pressure changes significantly during the player's possession, or when the number of opponents changes during the player's possession. |
| SHOT | When the player has the intention to shoot. |
| RECEPTION | Reception of the ball after an action from the teammate. |
| INTERCEPTION | Reception of the ball within the opponent formation after an action of the opponent. |
| LOOSE_BALL_REGAIN | Reception of the ball within the opponent formation after an action of the opponent. |
| CLEARANCE | Pass under high pressure, most likely after an action of the opponent. |
| GROUND_DUEL | Ball won due to a ground duel. |
| BLOCK | Block of a pass or shot. |
| KICK_OFF | Kick-off. |
| THROW_IN | Throw-in. |



| | |
|----------------------|---|
| FREE_KICK | Free kick. |
| GOAL_KICK | Goal kick. |
| CORNER | Corner. |
| GK_CATCH | Catch of the goalkeeper. |
| GK_SAVE | Save of the goalkeeper. |
| GOAL | Goal. |
| OWN_GOAL | Own Goal. |
| OUT | Ball is out of play. |
| OFFSIDE | Offside. |
| FOUL | Foul. |
| FINAL_WHISTLE | Final whistle of a half time |
| REFEREE_INTERCEPTION | Interception of the match by the referee. |
| NO_VIDEO | No video available. |
| RED_CARD | Red Card. |
| YELLOW_CARD* | Yellow Card. |

Appendix 5: Phase of Play

The phase of play describes the phase of the match a team currently is in. They are calculated algorithmically based on a large amount of information. They are therefore not recorded manually by a data operator. The calculation includes the time interval between actions, the length of the actions, the pressure on the player with the ball, the number of opponents behind the ball and several other parameters.

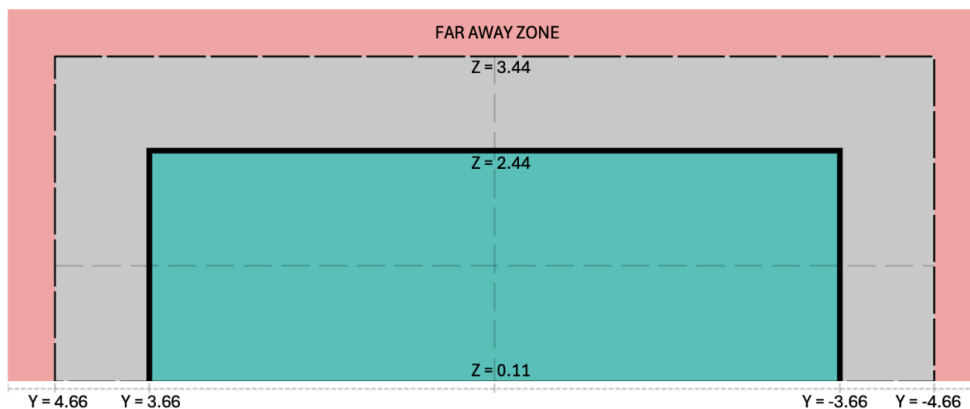
| phase | Definition | Meaning |
|----------------------|---|---|
| IN_POSSESSION | In-Possession phase starts when a team has the ball in a zone at the back (GK, FB or CB zone) for at least 4 seconds. The possession phase ends when the opponent wins the ball, there is a second ball, a set-piece follows, or there is any other interruption in play. | Controlled build-up of an attack. |
| ATTACKING_TRANSITION | Attacking Transition phases of play start when possession of the ball is won where there has been | Direct attack after winning the ball without having |



| | | |
|-------------|--|--|
| | some control of the ball (pressure <40). It ends as soon as the team decides to take speed out of the situation (see possession phase), there is a second ball, a set-piece follows or there is any other interruption to play. | brought the ball under complete control. |
| SET_PIECE | Set piece phases start with the taking of a set piece (throw-in, corner, free kick, goalkeeper kick, penalty kick). While throw-ins, penalty kicks and goalkeeper kicks end after being taken, the set piece phase for corners and free kicks runs until an action with little opponent pressure takes place or the ball has been transported out of the final third. A direct header after a corner therefore also falls into the standard phase. | Attack through a set piece, especially after free kicks and corners. |
| SECOND_BALL | Second Ball phase of the game begins after uncontrollable or extremely hard to control actions, e.g. an aerial duel or blocked pass/shot, when both teams are then in a fight for the ball. You cannot clearly assign possession of the ball to either of the two teams in these phases. The phase ends when one team manages to bring enough control over the ball (pressure <40) or there is a stoppage of play. | Phase in which neither team manages to keep full control of the ball. 'Chaos phase.' |

Appendix 6: Goal Map

The goal map that is used in dataV3. Please make sure that the Y-axis is inverted. The right post is located at $Y = -3.66$ while the left post is located at $Y = 3.66$.



Appendix 7: Body Part

The body part for each event. For shots, we now distinguish between Left and Right:

| bodyPart | Description |
|------------|---|
| FOOT | A release of the ball with foot. |
| FOOT_LOW | A reception of a low ball. For ball receptions, we deliver the information if the previous ball was a high or a low ball. If the ball is higher than chest height, we define it as a high ball. |
| FOOT_HIGH | A reception of a high ball (previous ball was below chest height). |
| BODY | A reception or release with the body (from knee to chest). |
| HEAD | A reception or release with the head |
| FOOT_RIGHT | A shot with the right foot |
| FOOT_LEFT | A shot with the left foot |

Appendix 8: Packing Expected Threat Model

The Packing Expected Threat (pxT) Model is a possession value model in football that quantifies goal threat based on three key attributes: 1) **distance to goal**, 2) **number of opponents** between the ball and the goal and 3) and the **pressure** on the player with the ball.

It uses a **Markov model** trained on over 50 million events to assign state values that indicate the goal-scoring potential of any given game situation. The model provides **offensive and defensive KPIs** that track **changes in goal threat** due to individual players and actions such as passes, dribbles, set pieces, and defensive interventions. The **offensive pxT** model is directly linked to **Post-shot xG**, ensuring that all goal threat changes sum up to the total Post-shot xG of a team. The defensive pxT model attributes **responsibility** to defenders based on packing zones, evaluating **both active and passive contributions** to reducing goal threat.

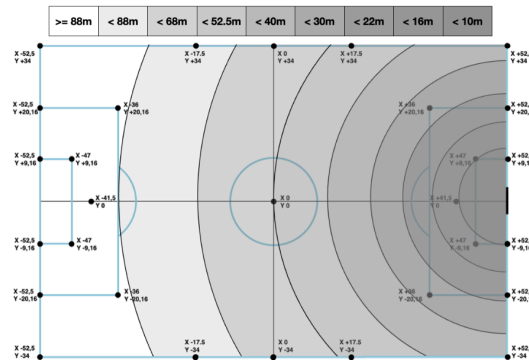


opponents
11 groups

| |
|-----|
| 11 |
| 10 |
| 9 |
| 8 |
| 7 |
| 6 |
| 5 |
| 4 |
| 3 |
| 2 |
| 0-1 |



distanceToGoal
9 groups



pressure
3 groups

| |
|---------------------|
| low 0% - 10% |
| medium 20% - 40% |
| high 50% - 100% |



A key differentiator of the pxT model is its consideration of pressure and opponent positioning, which allows it to assess game situations beyond traditional position- or action-based models. It also accounts for a team's goal threat even when the opponent has possession, recognizing the potential for defensive actions to influence scoring chances. The pxT model provides a **holistic view** of both offensive and defensive contributions, making it a valuable tool for analyzing player and team performance.

The total **threat created** by a team is equal to the team's Post-Shot xG:

$$\Delta \text{PXT} = \text{POSTSHOT_XG} = \text{PXT_PASS} + \text{PXT_DRIBBLE} + \text{PXT_SETPIECE} + \text{PXT_SHOT} + \text{PXT_BALL_WIN} + \text{PXT_FOUL} + \text{PXT_BLOCK} + \text{PXT_FOULED} + \text{PXT_PASSIVE} + \text{PXT_NOVIDEO} + \text{PXT_OTHER}$$

The total **threat conceded** by a team is equal to the opponent's Post-Shot xG:

$$\Delta \text{DEF_PXT} = \text{OPP.POSTSHOT_XG} = \text{DEF_PXT_PASS} + \text{DEF_PXT_DRIBBLE} + \text{DEF_PXT_SETPIECE} + \text{DEF_PXT_SHOT} + \text{DEF_PXT_BALL_WIN} + \text{DEF_PXT_BALL_LOSS} + \text{DEF_PXT_BLOCK} + \text{DEF_PXT_FOUL} + \text{DEF_PXT_ACTIVE} + \text{DEF_PXT_NOVIDEO} + \text{DEF_PXT_OTHER}$$

At the player level, it is recommended to exclude **PXT_NOVIDEO**, **PXT_OTHER**, **DEF_PXT_SHOT**, **DEF_PXT_NOVIDEO**, **DEF_PXT_OTHER** as these KPIs cannot be directly attributed to an individual player.