

Package ‘soccermatics’

June 8, 2018

Version 0.9.0

Title Visualise spatial data from soccer matches

Description Provides tools to visualise x,y-coordinates of soccer players in the manner presented in David Sumpter's eponymous book. Uses ggplot to draw soccer pitch and overplot player trajectories, average player positions, heatmaps of player position, flow fields to show binned player movement or passing, and more.

Depends R (>= 3.4.1)

Imports dplyr, magrittr, ggplot2, ggforce, zoo

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Encoding UTF-8

LazyData true

Collate 'soccerPitchFG.R' 'soccerPitchBG.R' 'soccerDirection.R'
'soccerFlipHoriz.R' 'soccerHeatmap.R' 'soccerSpokes.R'
'soccerFlow.R' 'soccerPath.R' 'soccerNormXY.R'
'soccerPositionMap.R' 'tromso.R' 'tromso_extra.R'

RoxygenNote 6.0.1

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RemoteType github

RemoteHost https://api.github.com

RemoteRepo soccermatics

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RemoteRef master

RemoteSha 6a3f6d94086159e685cc814e30cc8aa1300ea710

GithubRepo soccermatics

GithubUsername jogall

GithubRef master

GithubSHA1 6a3f6d94086159e685cc814e30cc8aa1300ea710

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soccerDirection	<i>Add an arrow showing the direction of play to a soccer pitch ggplot.</i>
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Description

Draws an arrow showing the direction of play at the top of an existing soccer pitch ggplot.

Usage

```
soccerDirection(plot, direction = c("right", "left"), lengthPitch = 105,
  widthPitch = 68, arrow_col = "black", grass = FALSE, topBuffer = 0)
```

Arguments

- plot an existing ggplot object to add arrow to.
- direction character, direction of arrow ("right" or "left").
- lengthPitch, widthPitch numeric, length and width of pitch in metres.
- arrow_col character, colour of arrow (defaults to "black").
- grass if TRUE, draws pitch background in green and lines in white. If FALSE, draws pitch background in white and lines in black.
- topBuffer numeric, modify y-position of arrow

Value

a ggplot object

See Also

[soccerPitchBG](#) and [soccerPitchFG](#) for drawing a soccer pitch

Examples

```
data(tromso)
# draw heatmap of player #9's position
p <- soccerHeatmap(subset(tromso, id == 9), bins = 15, lengthPitch = 105, widthPitch = 68)
# add arrow showing direction of play to the right
soccerDirection(p, "right", lengthPitch = 105, widthPitch = 68)
```

soccerFlipHoriz	<i>Flips x,y-coordinates horizontally in one half to account for changing sides at half-time</i>
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Description

Normalises direction of attack in both halves of both teams by flipping x,y-coordinates horizontally in either the first or second half; i.e. teams attack in the same direction all game despite changing sides at half-time.

Usage

```
soccerFlipHoriz(dat, periodVar = "period", periodToFlip = 1,
  pitchLength = 105, pitchWidth = 68)
```

Arguments

dat	= dataframe containing unnormalised x,y-coordinates named 'x' and 'y'
periodVar	= name of variable containing period labels
periodToFlip	= which period to flip
pitchLength, pitchWidth	= length, width of pitch in metres

Value

a dataframe

Examples

```
# to flip coordinates in 2nd half of a dataframe with 1st/2nd half identity labelled by variable named `period`
soccerFlipHoriz(df, "period", 2, 105, 68)
```

soccerFlow

Draw a flow field on a soccer pitch.

Description

Draws a flow field showing the mean direction of movement made in each sector of the pitch and adds pitch outlines. Note: This function is prototypical and intended to eventually visualise pass and shot event data, but there are no open-source samples of such data available as yet.

Usage

```
soccerFlow(df, xBins, yBins = NULL, lengthPitch = 105, widthPitch = 68,
  grass = FALSE, line_col = "black", lwd = 1, plot = NULL)
```

Arguments

df	dataframe containing x,y-coordinates of player position in columns named 'x' and 'y' and angular information (in radians, ranging between $-\pi$ and π) in a column 'direction'.
xBins, yBins	integer, the number of horizontal (length-wise) and vertical (width-wise) bins the soccer pitch is to be divided up into. If no value for yBins is provided, it will take the value of xBins.
lengthPitch, widthPitch	numeric, length and width of pitch in metres.
grass	if TRUE, draws pitch background in green and lines in white. If FALSE, draws pitch background in white and lines in black.
line_col	colour of pitch lines.
lwd	thickness of arrow lines.
plot	optional, adds wagon wheels to an existing ggplot object if provided

Value

a ggplot object of a heatmap on a soccer pitch.

See Also

[soccerHeatmap](#) for drawing a heatmap of player position, or [soccerSpokes](#) for drawing spokes to show all directions in each area of the pitch.

Examples

```
data(tromso_extra)
# draw flow field showing mean direction of player #8's movement
soccerFlow(subset(tromso_extra, id == 8), xBins = 5, grass = TRUE)
# draw flow field over player heatmap
p <- soccerHeatmap(subset(tromso_extra, id == 8), xBins = 5)
soccerFlow(subset(tromso_extra, id == 8), xBins = 5, plot = p)
```

soccerHeatmap

Draw a heatmap on a soccer pitch.

Description

Draws a heatmap showing player position frequency in each area of the pitch and adds soccer pitch outlines.

Usage

```
soccerHeatmap(df, xBins, lengthPitch = 105, widthPitch = 68, yBins = NULL,
               colLow = "white", colHigh = "red")
```

Arguments

df	dataframe containing x,y-coordinates of player position in columns named 'x' and 'y'.
xBins, yBins	integer, the number of horizontal (length-wise) and vertical (width-wise) bins the soccer pitch is to be divided up into. If no value for yBins is provided, it will take the value of xBins.
lengthPitch, widthPitch	numeric, length and width of pitch in metres.
colLow, colHigh	character, colours for the low and high ends of the heatmap gradient.

Details

uses `ggplot2::geom_bin2d` to map 2D bin counts

Value

a ggplot object of a heatmap on a soccer pitch.

See Also

[soccerPitchBG](#) for a background soccer pitch for the purpose of drawing position maps, player trajectories, etc..

Examples

```
data(tromso)
# simple heatmap of player #9's position
soccerHeatmap(subset(tromso, id == 8), xBins = 10)

# draw heatmap with approximately 5m x 5m bins (pitchLength / 5 = 21, pitchWidth / 5 = 13.6)
soccerHeatmap(subset(tromso, id == 8), xBins = 21, yBins = 14)
```

soccerNormXY	<i>Normalises x,y-coordinates to metres units for use with soccermatics functions</i>
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Description

Normalises x,y-coordinates from between any arbitrary bounds to metre units bounded by $[0 < x < \text{pitchLength}, 0 < y < \text{pitchWidth}]$

Usage

```
soccerNormXY(dat, xMin, xMax, yMin, yMax, pitchLength, pitchWidth)
```

Arguments

dat = dataframe containing unnormalised x,y-coordinates named 'x' and 'y'
 xMin, xMax, yMin, yMax = range of x,y-coordinates possible in the raw dataset
 pitchLength, pitchWidth = length, width of pitch in metres

Value

a dataframe

Examples

```
# Three examples with true pitch dimesions (in metres):
lengthPitch <- 101
widthPitch <- 68

# Example 1. Opta-style -----
# limits = [0 < x < 100, 0 < y < 100]
# centre of pitch = [50,50]

df <- data.frame(t = 1:12,
  x = c(50,55,61,66,62,58,51,44,45,42,41,32),
  y = c(50,48,47,40,42,45,49,51,59,75,88,100))

df <- soccerNormXY(df, 0, 100, 0, 100, lengthPitch, widthPitch)

soccerPath(df, lengthPitch = lengthPitch, widthPitch = widthPitch)

# Example 2. StrataBet-style -----
# limits = [0 < x < 420, -136 < y < 136]
# centre of pitch = [210,0]

df <- data.frame(t = 1:12,
  x = c(210,222,201,192,178,170,143,122,104,91,75,60),
  y = c(0,-5,-20,-12,-8,-2,4,8,13,20,30,45))

df <- soccerNormXY(df, 0, 420, -136, 136, lengthPitch, widthPitch)
```

```

soccerPath(df, lengthPitch = lengthPitch, widthPitch = widthPitch)

# Example 3. Other -----
# limits = [-5250 < x < 5250, -3400 < y < 3400]
# centre of pitch = [0,0]

xMin <- -5250
xMax <- 5250
yMin <- -3400
yMax <- 3400

df <- data.frame(x = c(0,-452,-982,-1099,-1586,-2088,-2422,-2999,-3200,-3857),
                 y = c(0,150,300,550,820,915,750,620,400,264))

df <- soccerNormXY(df, -5250, 5250, -3400, 3400, lengthPitch, widthPitch)

soccerPath(df, lengthPitch = lengthPitch, widthPitch = widthPitch)

```

soccerPath

Draw a path of player trajectory on a soccer pitch.

Description

Draws a path connecting consecutive x,y-coordinates of a player on a soccer pitch.

Usage

```

soccerPath(dat, id_var = NULL, lengthPitch = 105, widthPitch = 68,
           col = "black", fillPitch = "white", colPitch = "grey60",
           grass = FALSE, lwd = 1, legend = TRUE, plot = NULL)

```

Arguments

dat	dataframe containing x,y-coordinates of player position in columns named 'x' and 'y'
id_var	character, the name of the column containing player identity. Only required if 'dat' contains multiple players
lengthPitch, widthPitch	length and width of pitch in metres
col	colour of path if no 'id_var' is provided. If an 'id_var' is present, colours from ColorBrewer's 'Paired' palette are used
grass	if TRUE, draws a more realistic looking pitch
lwd	player path thickness

Value

a ggplot object

Examples

```
data(tromso)
# draw path of player #8 over first 1200 frames
subset(tromso, id == 8)[1:1200,] %>%
  soccerPath(col = "red", grass = TRUE)
# draw path of all players over first 1200 frames
tromso %>%
  dplyr::group_by(id) %>%
  dplyr::slice(1:1200) %>%
  soccerPath("id")
```

soccerPitchBG

Draw a soccer pitch.

Description

Draws a soccer pitch as a ggplot object for the purpose of adding layers such as player positions, player trajectories, etc..

Usage

```
soccerPitchBG(lengthPitch = 105, widthPitch = 68, fillPitch = "white",
  colPitch = "grey60", grass = FALSE, lwd = 1, border = c(4, 4, 4, 4))
```

Arguments

lengthPitch, widthPitch	length and width of pitch in metres
fillPitch	pitch fill colour
colPitch	pitch line colour
grass	if TRUE, draws a more realistic looking pitch
lwd	pitch line width
border	size of border drawn around pitch perimeter (t,r,b,l)

Value

a ggplot object

See Also

[soccerPitchFG](#) for drawing a soccer pitch as foreground over an existing ggplot object

Examples

```
# get x,y-coords of player #8 during first 10 minutes
data(tromso)
dd <- subset(tromso, id == 9)[1:1200,]
# draw player path on pitch
soccerPitchBG(lengthPitch = 105, widthPitch = 68, grass = TRUE) +
  geom_path(data = dd, aes(x, y), lwd = 1.2)
```

soccerPitchFG	<i>Add soccer pitch outlines to an existing ggplot</i>
---------------	--

Description

Draws soccer pitch outlines (with transparent fill) over an existing ggplot object to provide context for heatmaps, passing maps, etc..

Usage

```
soccerPitchFG(plot, lengthPitch = 105, widthPitch = 68,
  colPitch = "black", lwd = 1)
```

Arguments

`plot` an existing ggplot object to add layers to.
`lengthPitch`, `widthPitch` numeric, length and width of pitch in metres.

Value

a ggplot object

See Also

[soccerPitchBG](#) for a background soccer pitch for the purpose of drawing position maps, player trajectories, etc..

Examples

```
data(tromso)
# draw heatmap of player #9's position
p <- soccerHeatmap(subset(tromso, id == 8), bins = 15, lengthPitch = 105, widthPitch = 68)
# add pitch lines to plot
soccerPitchFG(p, lengthPitch = 105, widthPitch = 68)
```

soccerPositionMap	<i>Plot average player position on a soccer pitch.</i>
-------------------	--

Description

Draws the average x,y-positions of all players in a dataframe and plots over a soccer pitch.

Usage

```
soccerPositionMap(df, id_var = "id", group_var = NULL, lengthPitch = 105,
  widthPitch = 68, fill1 = "red", col1 = "white", fill2 = "blue",
  col2 = "white", node_size = 6, label_size = 3, label = TRUE,
  fillPitch = "white", colPitch = "grey60", grass = FALSE)
```

Arguments

<code>df</code>	dataframe containing x,y-coordinates of player position in columns named 'x' and 'y'.
<code>id_var</code>	character, the name of the column containing player identity. Defaults to 'id'.
<code>lengthPitch, widthPitch</code>	numeric, length and width of pitch in metres.
<code>col1</code>	character, fill colour of position points.
<code>col2</code>	character, border colour of position points.
<code>grass</code>	if TRUE, draws pitch background in green and lines in white. If FALSE, draws pitch background in white and lines in black.
<code>size</code>	numeric, size of position points and text.

See Also

[soccerPitchBG](#) for a background soccer pitch for the purpose of drawing position maps, player trajectories, etc..

Examples

```
data(tromso)
# draw average player position of players
p <- soccerPositions(tromso, lengthPitch = 105, widthPitch = 68, grass = TRUE)
# draw arrow showing direction of play
soccerDirection(p, "right", lengthPitch = 105, widthPitch = 68, grass = TRUE)
```

soccerSpokes

Draw spokes on a soccer pitch.

Description

Draws spokes showing the direction of all movements made in each sector of the pitch. Note: This function is prototypical and intended to eventually visualise pass and shot event data, but there are no open-source samples of such data available as yet.

Usage

```
soccerSpokes(df, xBins, lengthPitch = 105, widthPitch = 68,
  angleBins = 16, yBins = NULL, grass = FALSE, line_col = "black",
  lwd = 0.5, minLength = 0.6, minAlpha = 0.4, legend = TRUE,
  plot = NULL)
```

Arguments

<code>df</code>	dataframe containing x,y-coordinates of player position in columns named 'x' and 'y' and angular information (in radians, ranging between -pi and pi) in a column 'direction'.
<code>xBins, yBins</code>	integer, the number of horizontal (length-wise) and vertical (width-wise) bins the soccer pitch is to be divided up into. If no value for yBins is provided, it will take the value of xBins.

lengthPitch, widthPitch	numeric, length and width of pitch in metres.
angleBins	integer, the number of angle bins movement directions are divided up into. For example, a value of 4 clusters directions in each bin into north, east, south and west.
grass	if TRUE, draws pitch background in green and lines in white. If FALSE, draws pitch background in white and lines in black.
line_col	colour of pitch lines
lwd	thickness of arrow lines
minLength	numeric, ratio between size of shortest arrow and longest arrow depending on number of events.
minAlpha	numeric, minimum alpha of the arrow with the lowest number of events.
legend	if TRUE, adds legend showing relationship between arrow transparency and number of events
plot	optional, adds spokes to an existing ggplot object if provided

Value

a ggplot object of a heatmap on a soccer pitch.

See Also

[soccerHeatmap](#) for drawing a heatmap of player position, or [soccerSpokes](#) for summarising mean direction in each pitch sector

Examples

```
data(tromso_extra)
# resample movement dataset to plot 100 movement directions
# (in absence of pass / shot event data as yet)
id8 <- tromso_extra %>%
  dplyr::filter(id == 8) %>%
  dplyr::sample_n(100)
# 10x10 x,y-bins, 8 angle-bins, grass pitch
soccerSpokes(id8, xBins = 5, angleBins = 8, grass = TRUE, minLength = 0.3, minAlpha = 0.7)
# 5x5 x,y-bins, 16 angle-bins, blank pitch w/ grey lines
soccerSpokes(id8, xBins = 5, angleBins = 16, line_col = "grey40")
# draw spokes over player heatmap
p <- soccerHeatmap(id8, xBins = 5)
soccerSpokes(id8, xBins = 5, plot = p)
```

tromso

x,y-coordinates of 11 soccer players over 12000 frames each

Description

x,y-coordinates of 11 soccer players over 10 minutes (Tromsø IL vs. Anzhi, 2013-11-07), captured at 20 Hz using the ZXY Sport Tracking system and made available in the publication [ZXY Sport Tracking](#).

Usage

```
data(tromso)
```

Format

A dataframe containing 12000 frames of x,y-coordinates and timestamps from 11 players.

Source

[ZXY Sport Tracking](#)

References

Pettersen et al. (2014) Proceedings of the International Conference on Multimedia Systems (MM-Sys) ([pdf](#))

Examples

```
data(tromso)
# draw path of player #8 on a soccer pitch
soccerPitchBG(lengthPitch = 105, widthPitch = 68, grass = TRUE) +
  geom_path(data = subset(tromso, id == 8), aes(x, y), lwd = 2)
```

tromso_extra	<i>x,y-coordinates and additional positional information on 11 soccer players over 12000 frames each</i>
--------------	--

Description

x,y-coordinates of 11 soccer players over 10 minutes (Tromsø IL vs. Anzhi, 2013-11-07), plus additional information on player heading, direction, energy, speed, and total distance. Data captured at 20 Hz using the ZXY Sport Tracking system and made available in the publication [ZXY Sport Tracking](#).

Usage

```
data(tromso_extra)
```

Format

A dataframe containing 12000 frames of x,y-coordinates and timestamps from 11 players.

Source

[ZXY Sport Tracking](#)

References

Pettersen et al. (2014) Proceedings of the International Conference on Multimedia Systems (MM-Sys) ([pdf](#))

Examples

```
data(tromso_extra)
# draw flow field showing mean direction of player #8's movement
soccerFlow(subset(tromso_extra, id == 8), bins = 5, grass = TRUE)
```

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