3.4 First Passage Time (FPT)

Manual of Applied Spatial Ecology

3/11/2022

The first passage time (FPT) is a parameter often used to describe the scale at which patterns occur in a trajectory. For a given scale r, it is defined as the time required by the animals to pass through a circle of radius r. The mean first passage time scales proportionately to the square of the radius of the circle for an uncorrelated random walk (Johnson et al. 1992). Johnson et al. (1992) used this property to differentiate facilitated diffusion and impeded diffusion, according to the value of the coefficient of the linear regression log(FPT) = a * log(radius) + b. Under the hypothesis of a random walk, a should be equal to 2 (higher for impeded diffusion, and lower for facilitated diffusion). Note however, that the value of a converges to 2 only for large values of radius. Another use of the FPT was proposed that, instead of computing the mean of FPT, use the variance of the log(FPT). This variance should be high for scales at which patterns occur in the trajectory (e.g. area restricted search; Fauchald and Tverra 2003). This method is often used to determine the scale at which an animal searches for food.

The value fpt computes the FPT for each relocation and each radius, and for each animal. This function returns an object of class "fipati" (i.e., a list with one component per animal). Each component is a data frame with each column corresponding to a value of radii and each row corresponding to a relocation. An object of class fipati has an attribute named "radii" corresponding to the argument radii of the function fpt. meanfpt and varlogfpt return a data frame giving respectively the mean FPT and the variance of the log(FPT) for each animal (rows) and rach radius (column). These objects also have an attribute "radii".

1. Exercise 3.4 - Download and extract zip folder into your preferred location
2. Set working directory to the extracted folder in R under Session - Set Working Directory…
3. Now open the script "FPTscript.Rmd" and run code directly from the script
4. First we need to load the packages needed for the exercise

```
library(adehabitatLT)
library(chron)
library(sp)
library(rgdal)
```

5. Load in our mule deer dataset from previous exercises

```
muleys <-read.csv("DCmuleysedited.csv", header=T)

#Code to look at number of relocations per animal
table(muleys$id)
```

```
##
##  D12  D15  D16  D19   D4   D6   D8
##  120 2589 2157 1156 1304 1455  971
```

```
#Remove outlier locations
newmuleys <-subset(muleys, muleys$Long > -110.50 & muleys$Lat > 37.3 & muleys$Long < -107)
muleys <- newmuleys
```

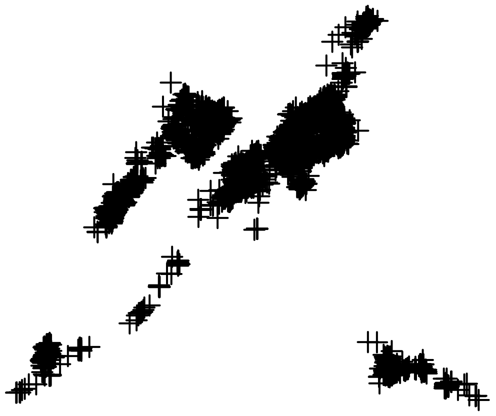
```
#Conversion of the date to the format POSIX as in previous exercise
da <- as.character(muleys$GPSFixTime)
da <- as.POSIXct(strptime(muleys$GPSFixTime,format="%Y.%m.%d %H:%M:%S"))
muleys$da <- da
```

6. Determine the time difference between each relocation for use later

```
timediff <- diff(muleys$da)*60*60
muleys <-muleys[-1,]
muleys$timediff <-as.numeric(abs(timediff))
```

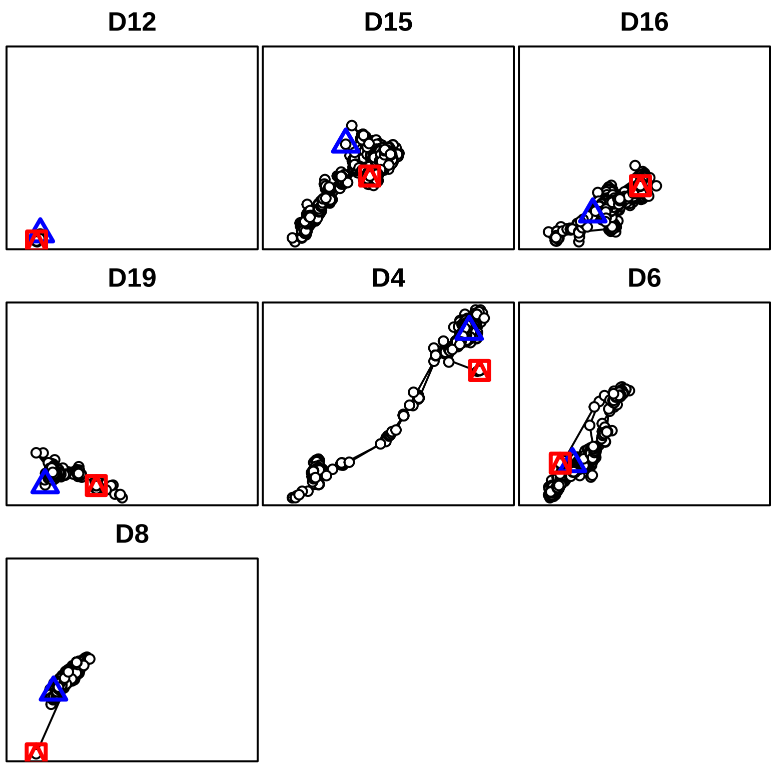
7. Create the spatial data from of xy coordinates and additional information

```
data.xy = muleys[c("X","Y")]
#Creates class Spatial Points for all locations
xysp <- SpatialPoints(data.xy)
#Creates a Spatial Data Frame from
sppt<-data.frame(xysp)
#Creates a spatial data frame of ID
idsp<-data.frame(muleys[2])
#Creates a spatial data frame of dt
dtsp<-data.frame(muleys[24])
#Creates a spatial data frame of Burst
busp<-data.frame(muleys[23])
#Merges ID and Date into the same spatial data frame
merge<-data.frame(idsp,dtsp,busp)
#Adds ID and Date data frame with locations data frame
coordinates(merge)<-sppt
plot(merge)
```



8. Create an object of class “ltraj” (i.e., trajectory) for all animals

```
ltraj <- as.ltraj(coordinates(merge),merge$da,id=merge$id)
plot(ltraj)
```



9. Code below actually creates First Passage Time and mean and variance of fpt

```
plot(ltraj[1])
i1 <- fpt(ltraj[1], seq(300,1000, length=30))
plot(i1, scale = 200, warn = FALSE)

plot(ltraj[2])
i2 <- fpt(ltraj[2], seq(300,1000, length=30))
plot(i2, scale = 500, warn = FALSE)

toto2 <- meanfpt(i2)
toto2
attr(toto2, "radii")

toto2 <- varlogfpt(i2)
toto2
attr(toto2, "radii")

plot(ltraj[3])
i3 <- fpt(ltraj[3], seq(300,1000, length=30))
plot(i3, scale = 500, warn = FALSE)

toto3 <- meanfpt(i3)
toto3
attr(toto3, "radii")
```

```
toto3 <- varlogfpt(i3)
toto3
attr(toto3, "radii")

plot(ltraj[4])
i4 <- fpt(ltraj[4], seq(300,1000, length=30))
plot(i4, scale = 500, warn = FALSE)

toto4 <- meanfpt(i4)
toto4
attr(toto4, "radii")

toto4 <- varlogfpt(i4)
toto4
attr(toto4, "radii")

plot(ltraj[5])
i5 <- fpt(ltraj[5], seq(300,1000, length=30))
plot(i5, scale = 500, warn = FALSE)

toto5 <- meanfpt(i5)
toto5
attr(toto5, "radii")

toto5 <- varlogfpt(i5)
toto5
attr(toto5, "radii")

plot(ltraj[6])
i6 <- fpt(ltraj[6], seq(300,1000, length=30))
plot(i6, scale = 500, warn = FALSE)

plot(ltraj[7])
i7 <- fpt(ltraj[7], seq(300,1000, length=30))
plot(i7, scale = 500, warn = FALSE)

toto7 <- meanfpt(i7)
toto7
attr(toto7, "radii")

toto7 <- varlogfpt(i7)
toto7
attr(toto7, "radii")
```

10. Code to export each trajectory as a shapefile if needed

```
toto1 <-ltraj2sldf(ltraj[1])
plot(toto1)
writeOGR(toto1,dsn=".",layer="D12", driver = "ESRI Shapefile",overwrite=TRUE)
summary(toto1)

#Write lines and points as a shapefile
toto2lines <-ltraj2sldf(ltraj[2],byid=TRUE)
toto2pts <- ltraj2spdf(ltraj[2])
```

```r
#If we want to define projection before making a shapefile
proj4string <- CRS("+proj=utm +zone=13N +ellps=WGS84")
toto2lines@proj4string <- proj4string
toto2pts@proj4string <- proj4string

plot(toto2pts)
plot(toto2lines, add=T)

writeOGR(toto2pts,dsn=".",layer="D15pts", driver = "ESRI Shapefile",overwrite_layer=TRUE)
writeOGR(toto2lines, dsn=".", paste("traj_line_",sep=""),driver = "ESRI Shapefile",overwrite=TRUE)

toto3 <-ltraj2sldf(ltraj[3])
plot(toto3)
writeOGR(toto3,dsn=".",layer="D16", driver = "ESRI Shapefile",overwrite=TRUE)

toto4 <-ltraj2sldf(ltraj[4])
plot(toto4)
writeOGR(toto4,dsn=".",layer="D19", driver = "ESRI Shapefile",overwrite=TRUE)

toto5 <-ltraj2sldf(ltraj[5])
plot(toto5)
writeOGR(toto5,dsn=".",layer="D4", driver = "ESRI Shapefile",overwrite=TRUE)

toto6 <-ltraj2sldf(ltraj[6])
plot(toto6)
writeOGR(toto6,dsn=".",layer="D6", driver = "ESRI Shapefile",overwrite=TRUE)

toto7 <-ltraj2sldf(ltraj[7])
plot(toto7)
writeOGR(toto7,dsn=".",layer="D8", driver = "ESRI Shapefile",overwrite=TRUE)
```