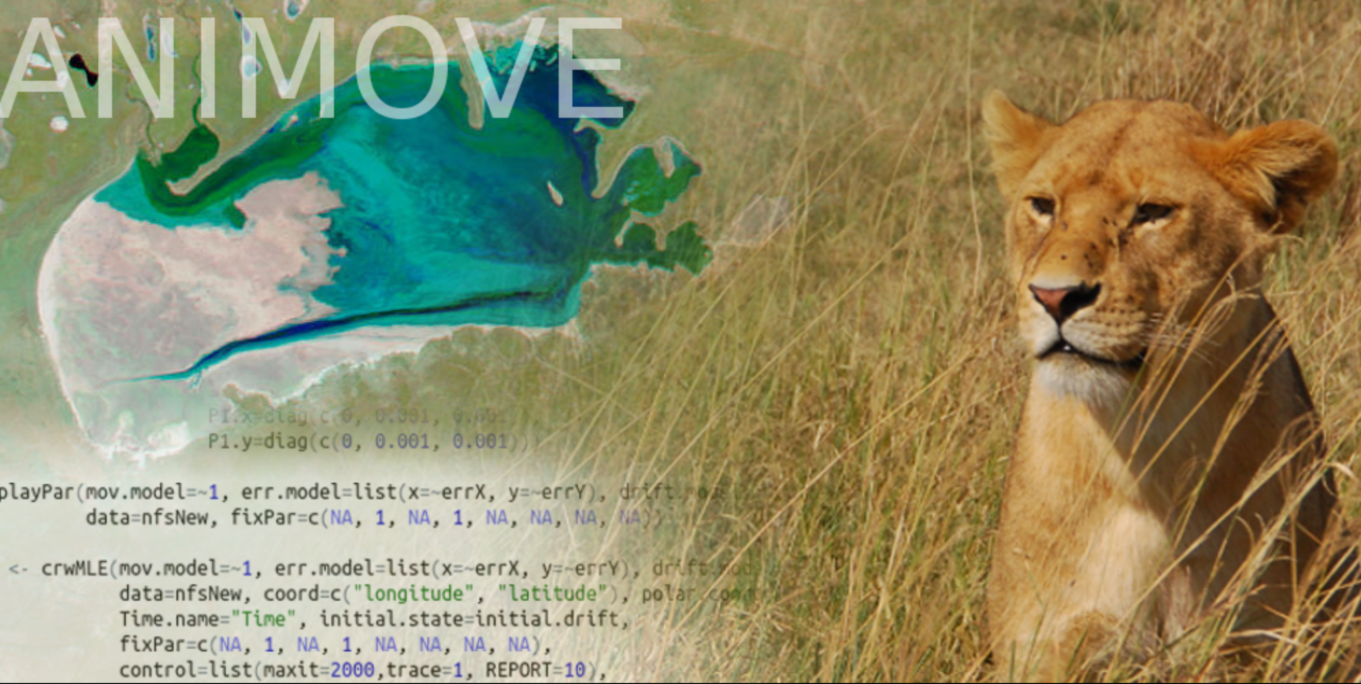
ANIMOVE
P1.y=diag(c(0, 0.001, 0.001))
playPar(mov.model=~1, err.model=list(x=~errX, y=~errY),
data=nfsNew, fixPar=c(NA, 1, NA, 1, NA, NA, NA, NA))
<- crwMLE(mov.model=~1, err.model=list(x=~errX, y=~errY),
data=nfsNew, coord=c("longitude", "latitude"),
Time.name="Time", initial.state=initial.drift,
fixPar=c(NA, 1, NA, 1, NA, NA, NA, NA),
control=list(maxit=2000,trace=1, REPORT=10),

August 2023

Movement data in R

Trajectory centered analysis

Within track analysis

- Information of geometry of tracks without context
- Most methods are scale sensitive and sensitive to sampling schedule
- Data should be in an equidistant projection

Within track analysis: methods

- **Azimuth and turning angles**:
  - direction of travel, directionality of movement, and relation to speed
  - recommended to exclude stationary segments from analysis
- **Net square displacement (NSD)**:
  - quantifies the net squared distance traveled over time compared to an point of reference (calculates distance from each location to the point of reference)
  - point of reference (nest, den, colony) needed. If there is no point of reference, or animal is nomadic, use e.g. FPT
- **First passage time (FPT)**:
  - calculates the time it takes to cross a circle of a given radius, i.e. time the animal spends in a given area at a certain spatial scale ("draws" circle around each point and calculates how long it takes to leave the circle)
  - the variance of log(fpt) can inform about the scales at which processes are likely to be changing
  - the slopes of the log(meanFPT) $\sim$ log(radii), can indicate the type of movement at each scale. Flatter slopes indicate more directional movement, steeper slopes more brownian movement

Within track analysis: methods (cont.)

- **Variance components of movement**:

- variance component of the dynamic brownian bridge movement model (dBBMM)
- variance component of the dynamic bi-gaussian bridge movement model (dBGB)

Variance estimation is based on a leave-one-out method where from 3 consecutive locations the 2nd one is omitted. Based on the timestamp of the 2nd location, a location is estimated on a straight line between location 1 and 3. The distance between the actual and the estimated location represents the amount of variance.
Estimated variances of the movement process can change over a trajectory.

* **variance of dBBMM**: changes in speed and/or deviation from straight line
* **variances of dBGB**: parallel (changes in speed) and orthogonal (deviation from the straight line)

Simulating walks

Very useful to test methods and be able to interpret results

- **bi-variate normal random distribution around a mean of 0**: uncorrelated and unbiased random walk, movement in any direction is equally likely (brownian motion)
- **uniform random distribution**: same probability to do all types of movement, it's unrealistic
- **multivariate normal distribution**: can maintain the variance/covariance structure of e.g. speed and turning angle from a real animal (i.e. more realistic).
- **correlated random walk**: considered to be a more natural movement process, as empirical tracks show some degree of consistency in direction
- **randomized track**: randomized order of segments connect start and end point. Maintains distribution of step length and heading. Breaks up the auto-correlation in speed, heading and turning angle. Represents the alternative routs the animal could have taken

Auto-correlation structure

The correlation structure can inform about the underlying processes in the movement and changes in these processes.

Auto-correlation is calculated and quantified based on correlation of values of e.g. speed, dependent on the distance in the sequence of appearance (lag), between any two observations

Fundamental assumption: lag represents equal distances in time (regular sampling). But most trajectories have gaps and shifts.

Two solutions:
- reduce data to largest gap in time. Problem: dropping data removes auto-correlation and affects speed and turning angle
- interpolate positions in gapy sections. Problem: underestimating speed, variance in azimuth and turning angle. Interpolation has to be used with care!