Spatial-temporal data.

Napoleon's march on Moscow - C. J. Minard (1781-1870)

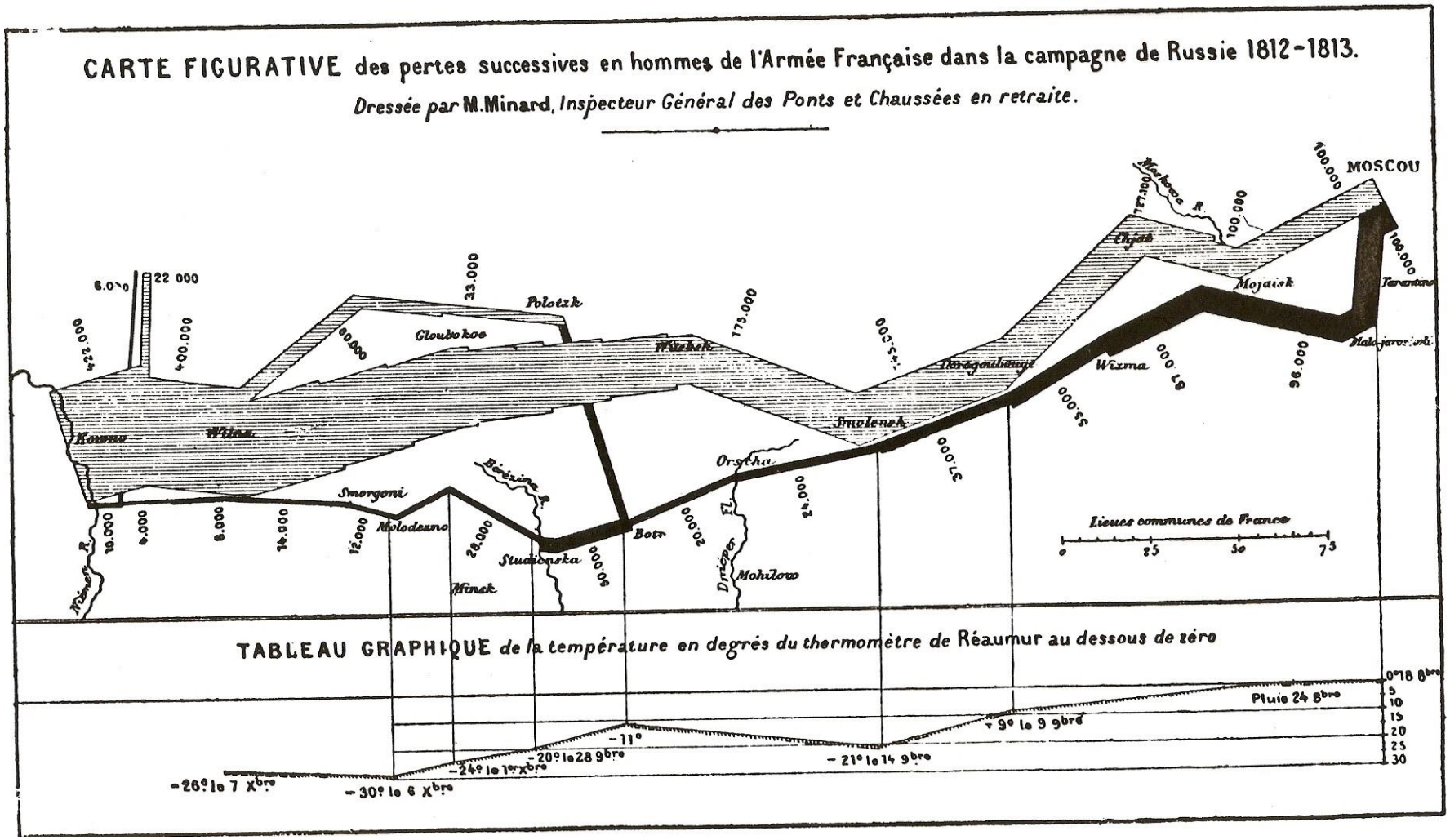
Tufte "It may be the best statistical graphic ever drawn."

There are 6 variables: army size

location (2)

direction of movement (2)

temperature



thickness: army size, retreat: dark band

movements of auxiliary troops

Spatial-temporal field.

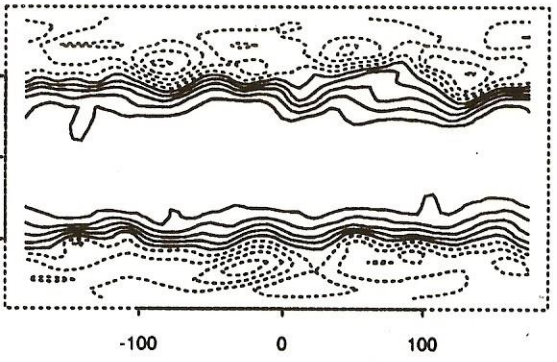
$Y(x,y,t)$: $0 \leq x \leq X-1$, $0 \leq y \leq Y-1$, $0 \leq t \leq T-1$

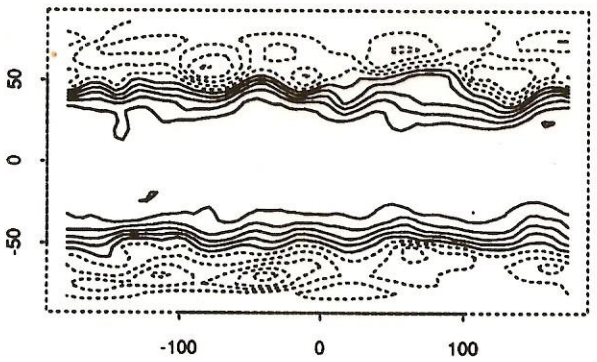
$Y(\mathbf{r},t)$

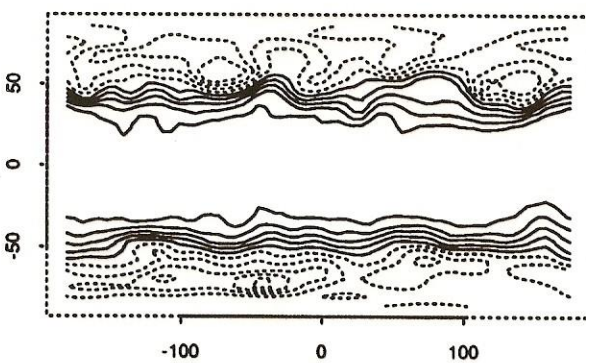
1200 GMT, 1 Jan 86, every 12 hrs

data 5300m and below dashed linee

speed and direction of moving depression?



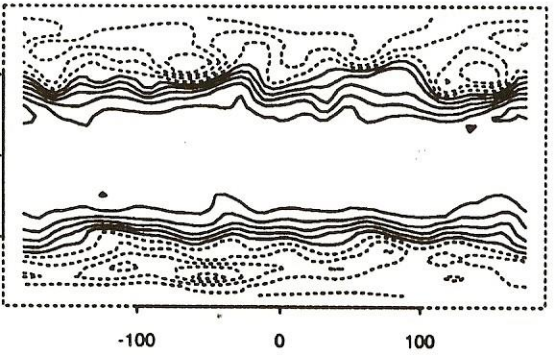


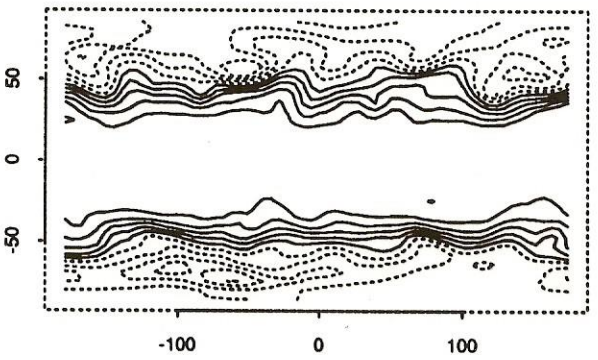


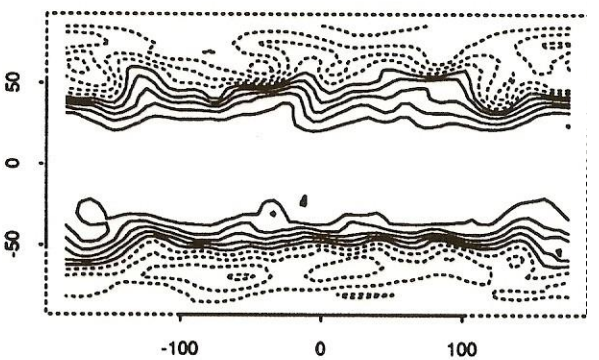
Map 4

Map 5

Map 6



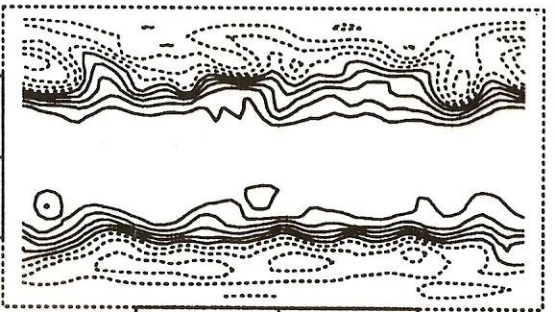


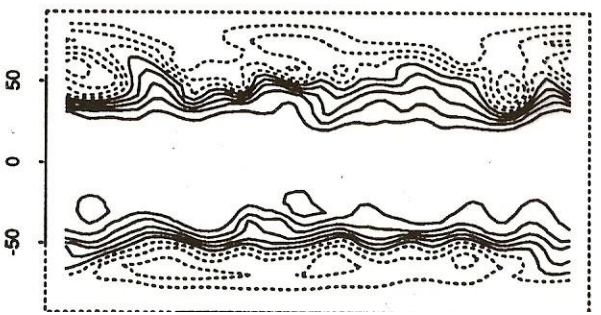


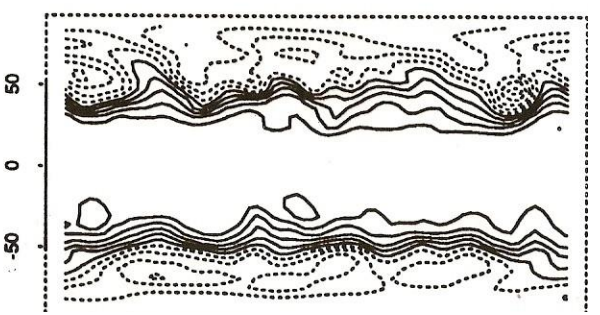
Map 7

Map 8

Map 9





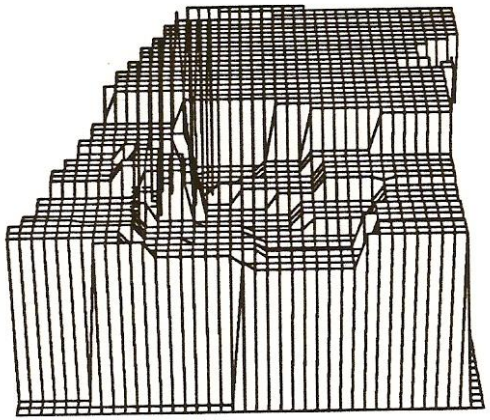


Aggregated regional data.

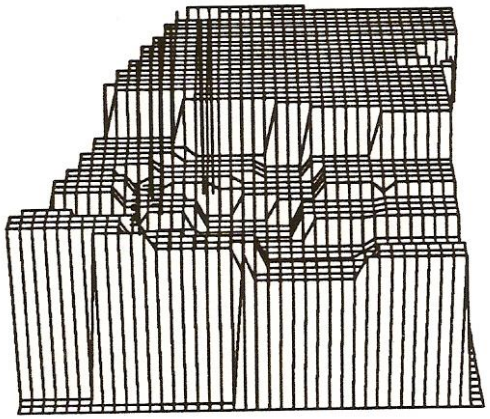
Y_j (t): j census division - vertices given

t time - 1986, 1987

1986 births - ages 25 to 29



1987 births - ages 25 to 29



Array data

$Y(x_j , y_j ,t), j=1,...,J$ $Y(\mathbf{r}_j ,t)$ $\mathbf{r}_j = (x_j , y_j)$

Often for measuring direction and speed

SMART 1 array in Taiwan

seismomenters in concentric circles, picked 9 here

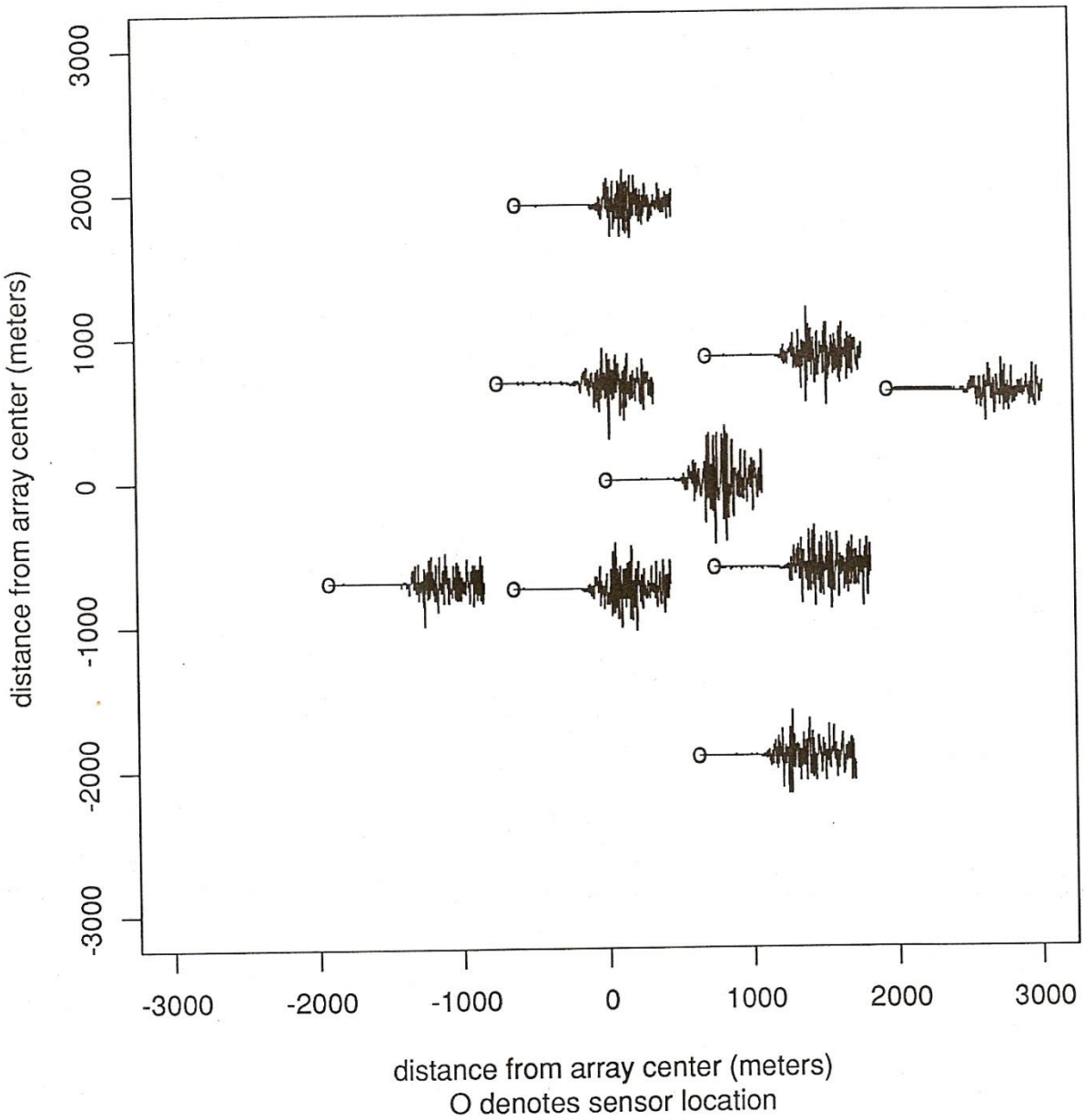
data 3D - x-, y-, z- components

noise in buffer

epicenter 30km SE

P wave

Taiwan Array and Event of 29 January 1981



EEG data. W. Freeman

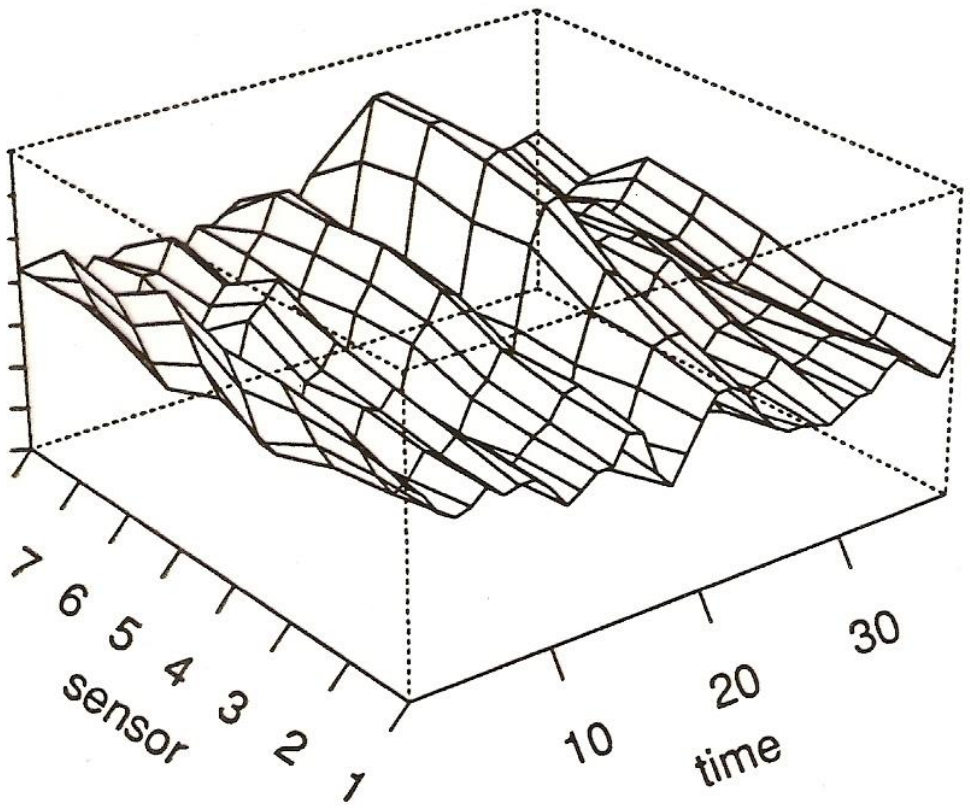
evoked response

8 by 8 array of sensors

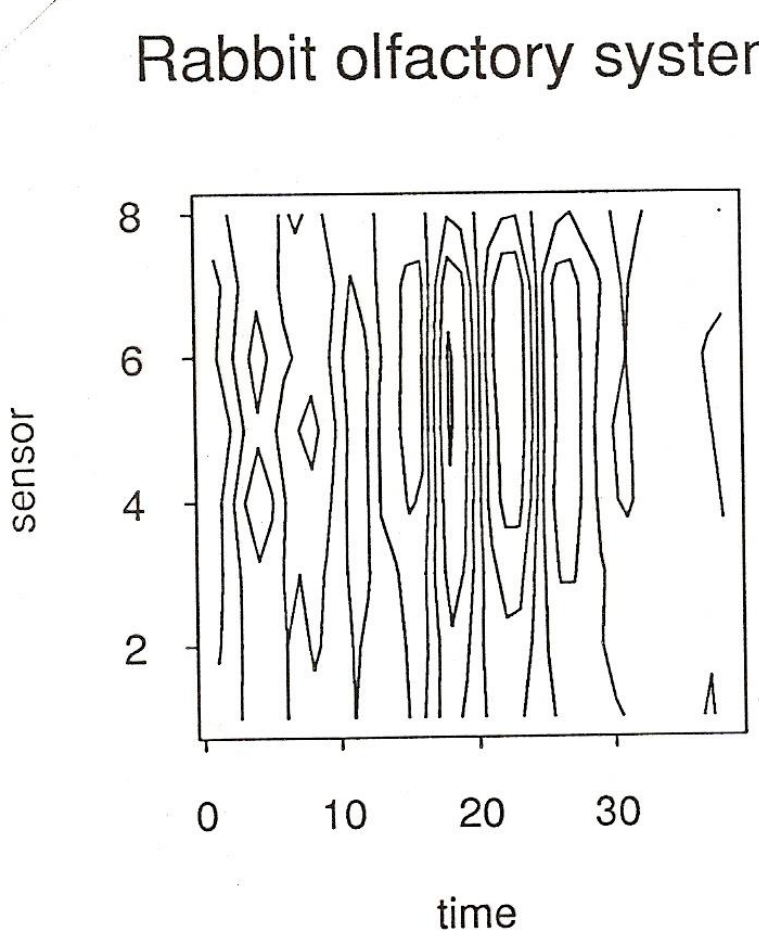
studying outside row - a linear array (oceanography)

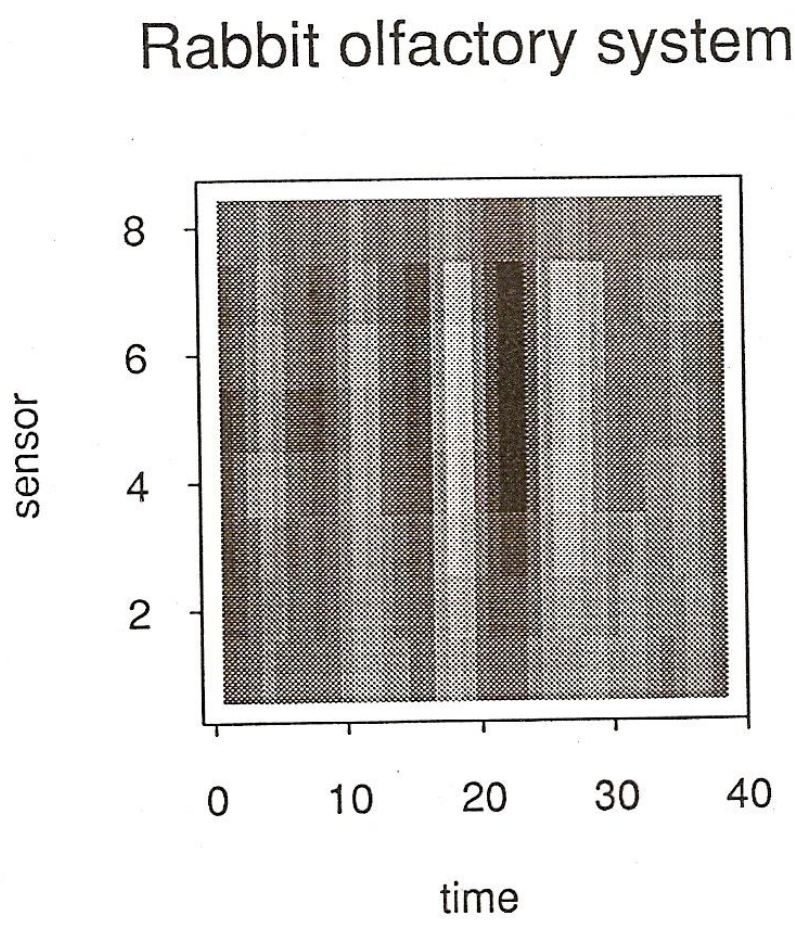
$Y(x,t) \quad 0 \le x \le X-1 \quad 0 \le t \le T-1$

Rabbit olfactory system



contour and image displays





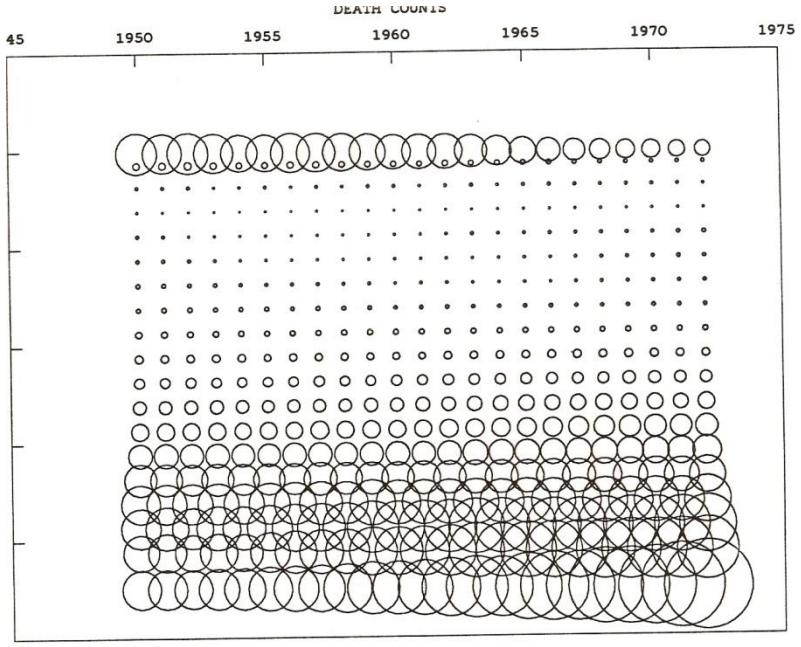
Death counts and rates

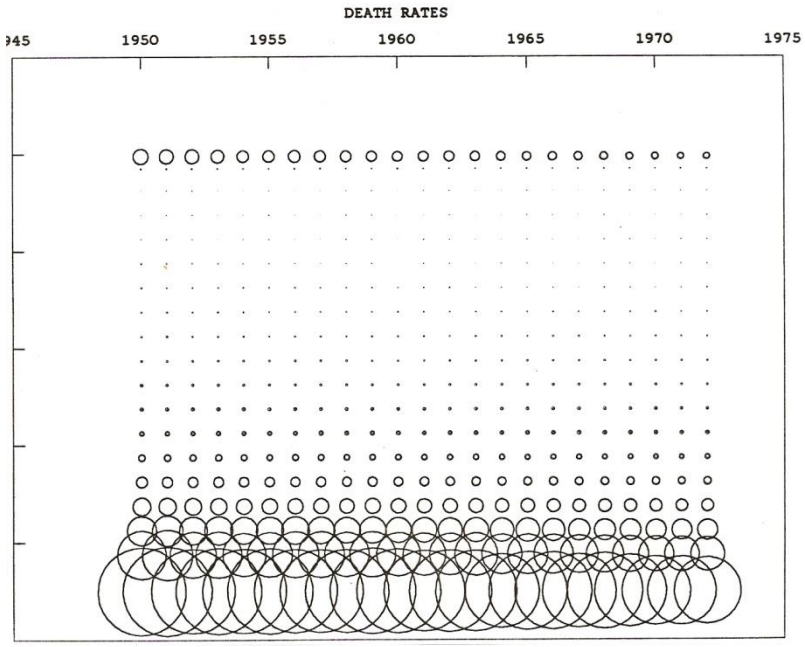
Y(x,t): t year, x age

linear array

circle radius ~ count or rate

symbols()


DEATH COUNTS
45
1950
1955
1960
1965
1970
1975


DEATH RATES
945
1950
1955
1960
1965
1970
1975

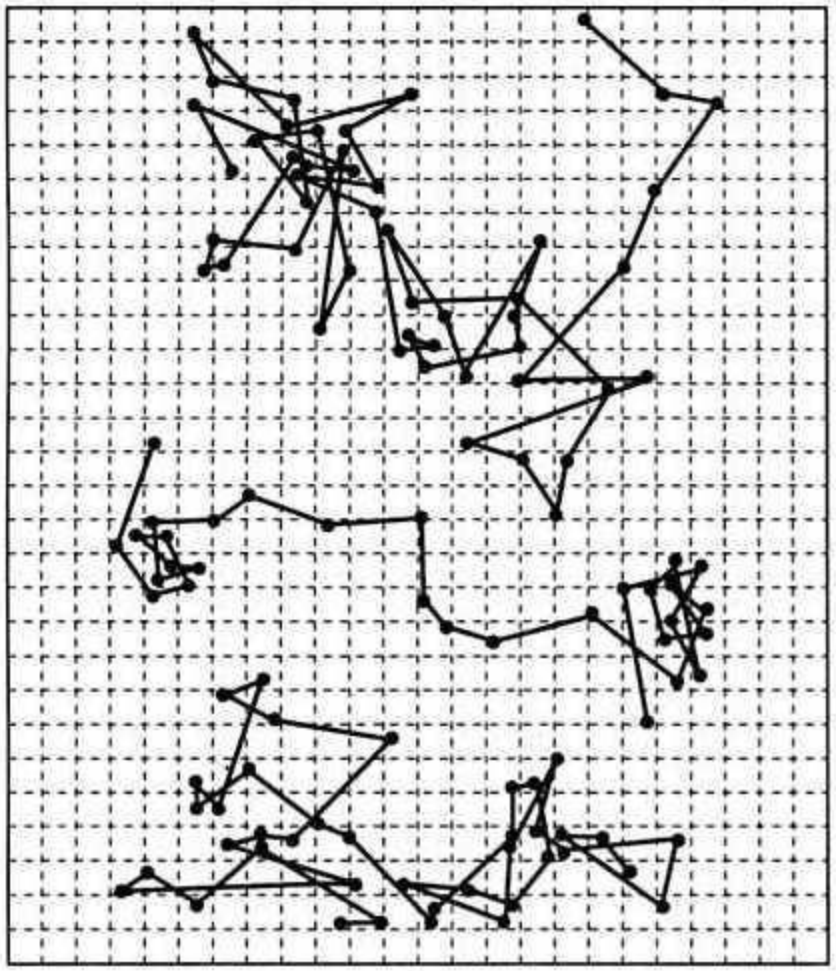
Moving particles, trajectories. motility

$\mathbf{r}(t) = (x(t),y(t)),\ t = 0, 1, ..., T-1$

$Y(x,y,t) = \delta(x-x(t),y-y(t))$

$Y(\mathbf{r},t) = \delta(\mathbf{r} - \mathbf{r}(t)) \qquad \mathbf{r} = (x,y)$

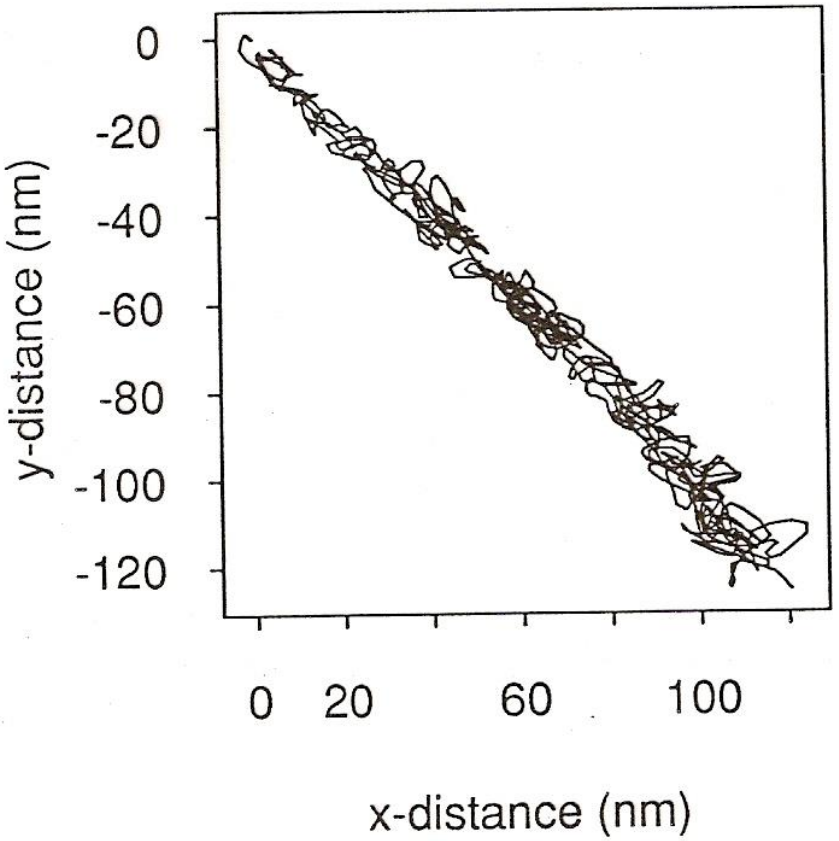
"Brownian" motion



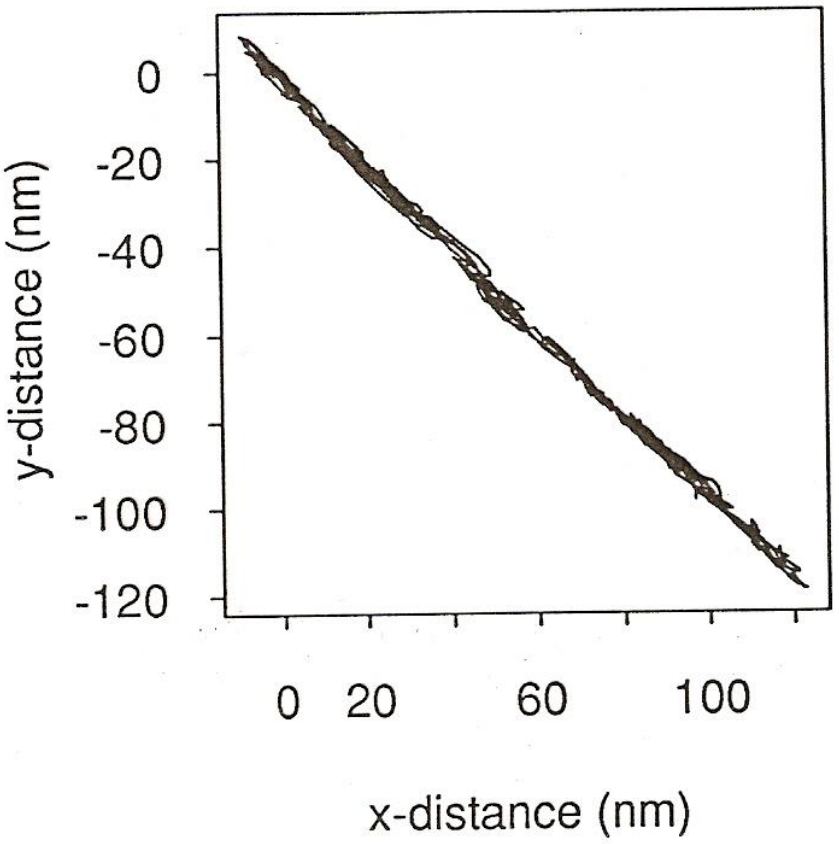
Perrin (1913) Guttorp book

microtubules

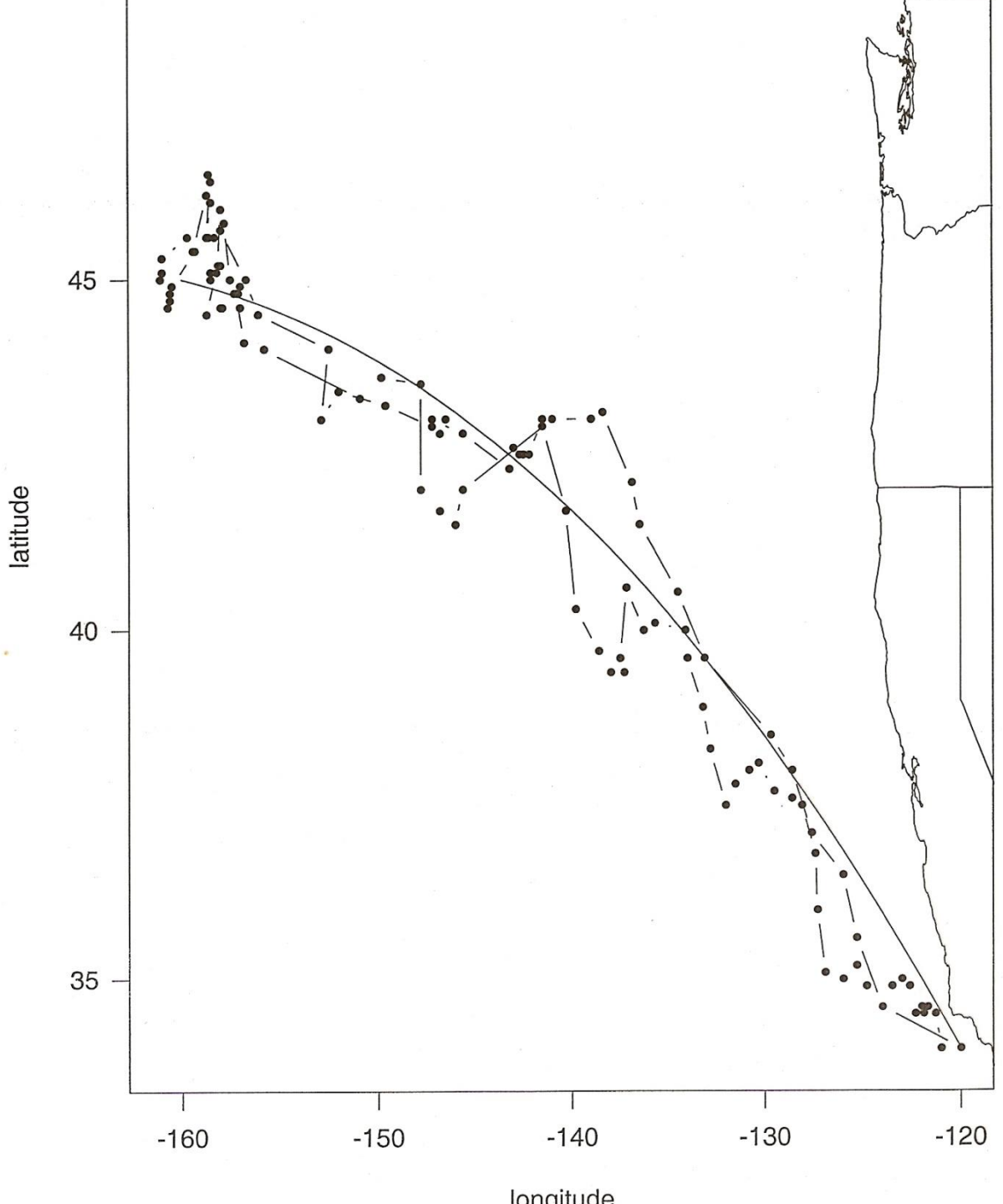
2 D track, case 1023



2 D track, case 1639



Elephant seal



Moving particle in 3 D

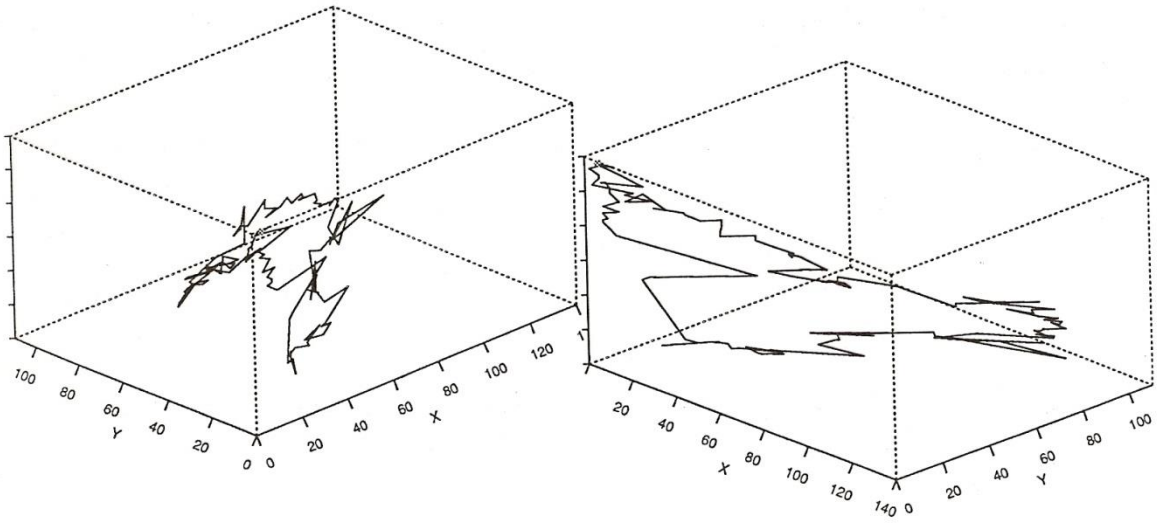
ringed seal Barrow Strait, NWT

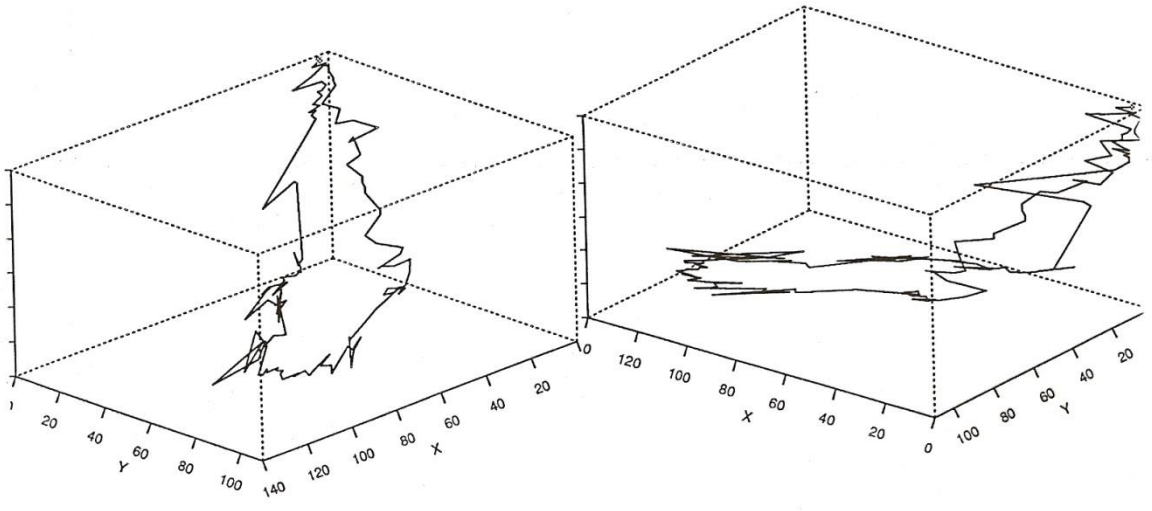
position estimated by an array of 5 sensors

$\mathbf{r} = (x,y,z)$

$Y(\mathbf{r},t) = \delta(\mathbf{r} - \mathbf{r}(t))$

$\mathbf{r}(t) = (x(t),y(t),z(t))$

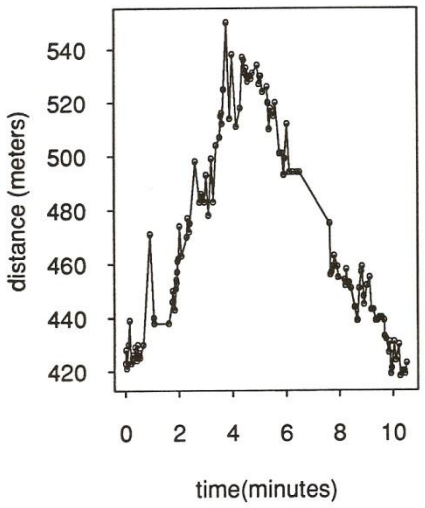

100
80
60
Y
40
20
0
0
20
40
60
X
80
100
120
20
40
60
X
80
100
120
140
0
20
40
Y
60
80
100


20
40
Y
60
80
100
140
120
100
80
X
60
40
20
0
0
120
100
80
60
X
40
20
0
100
80
60
Y
40
20

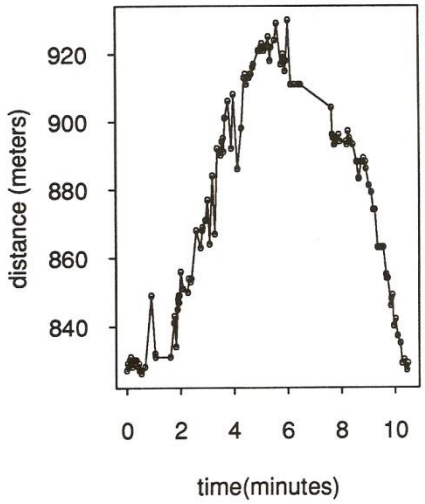
Adding depth to X-Y trajectory

losing identifiability

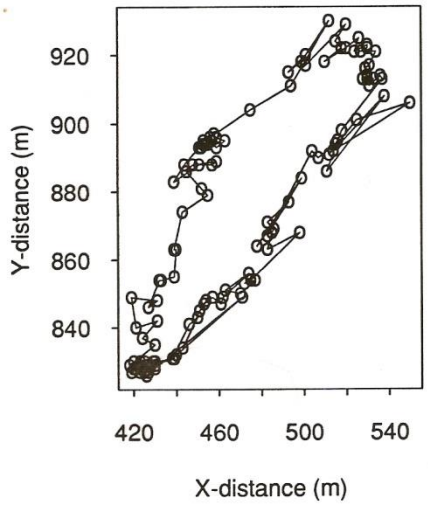
X-coordinate



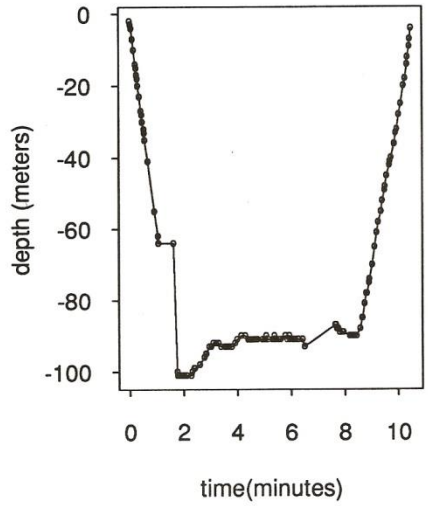
Y-coordinate

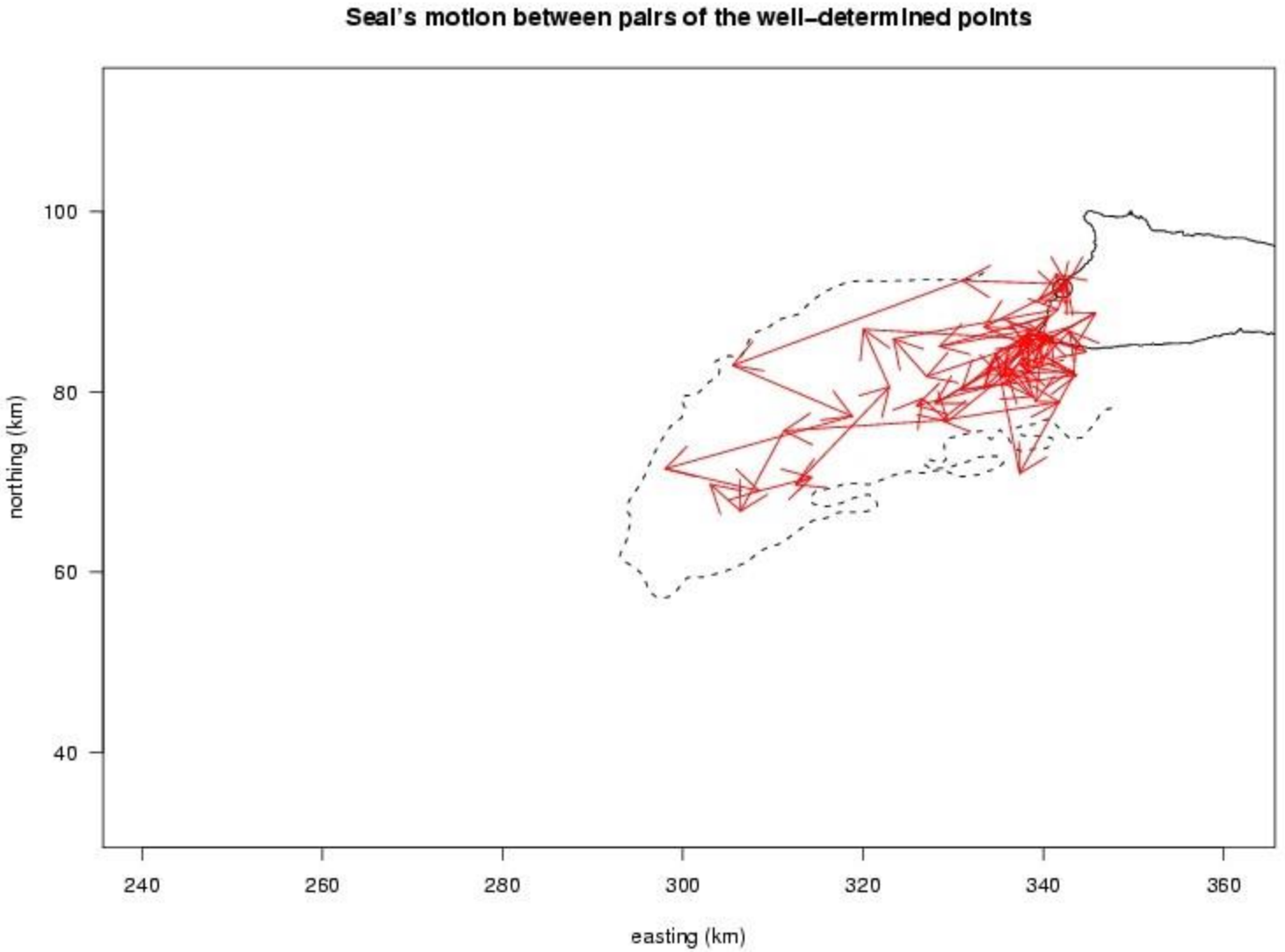


X-Y trajectory



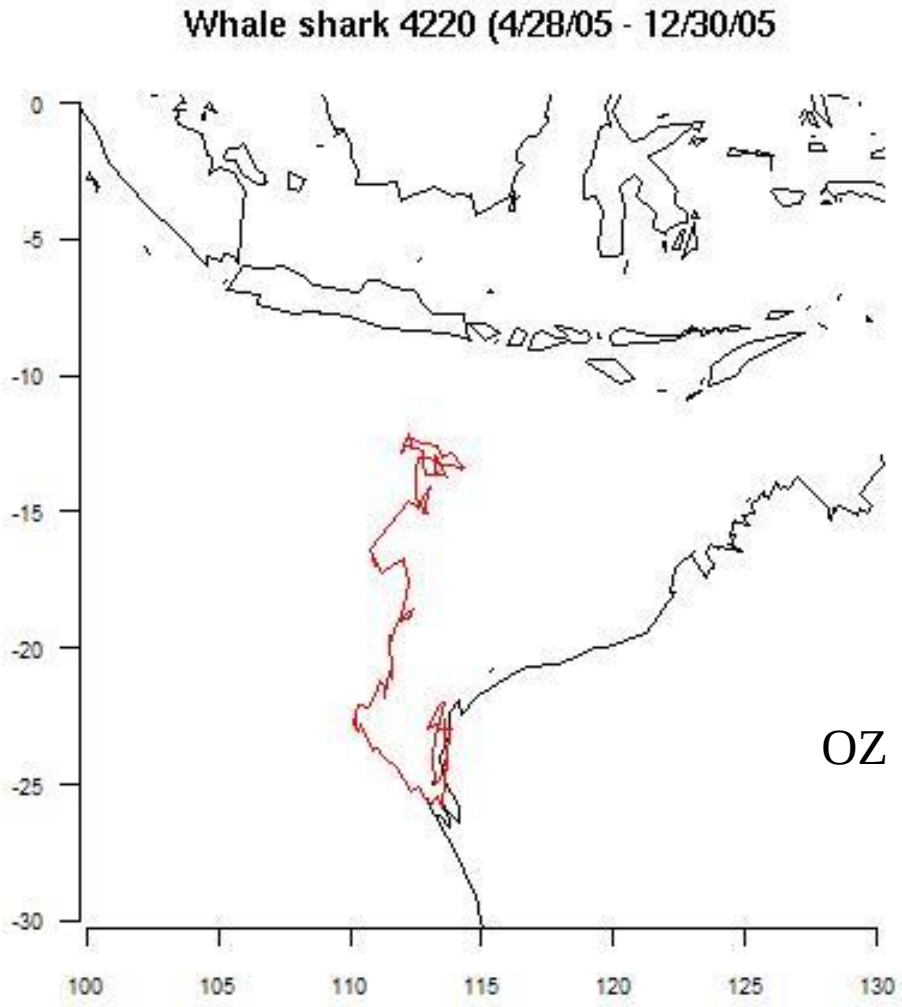
Z-coordinate





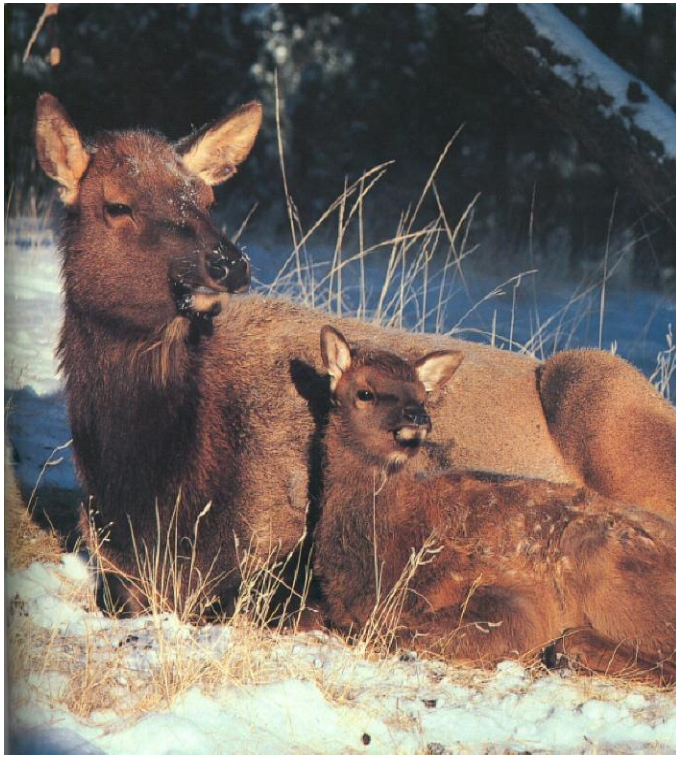
Munk seal, endangered species

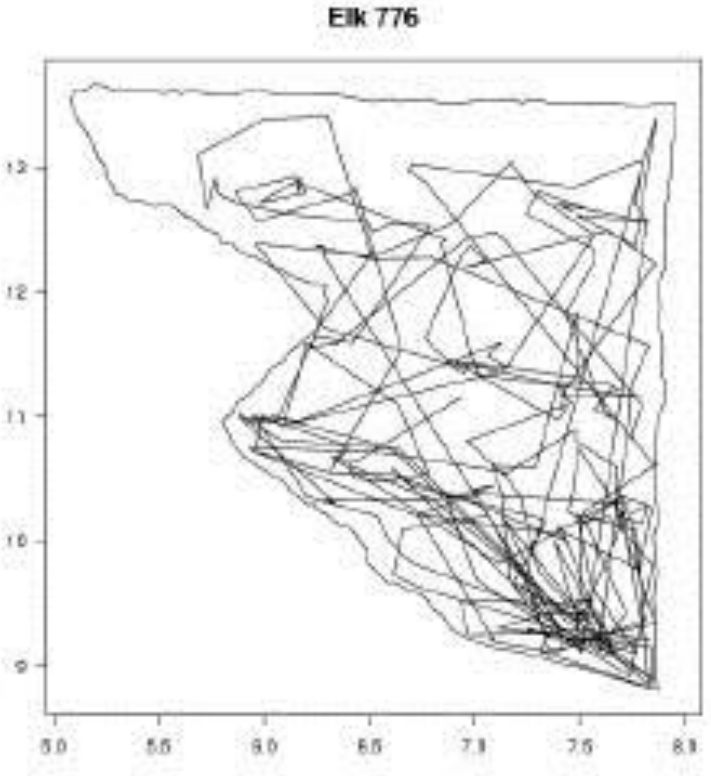
Molokai

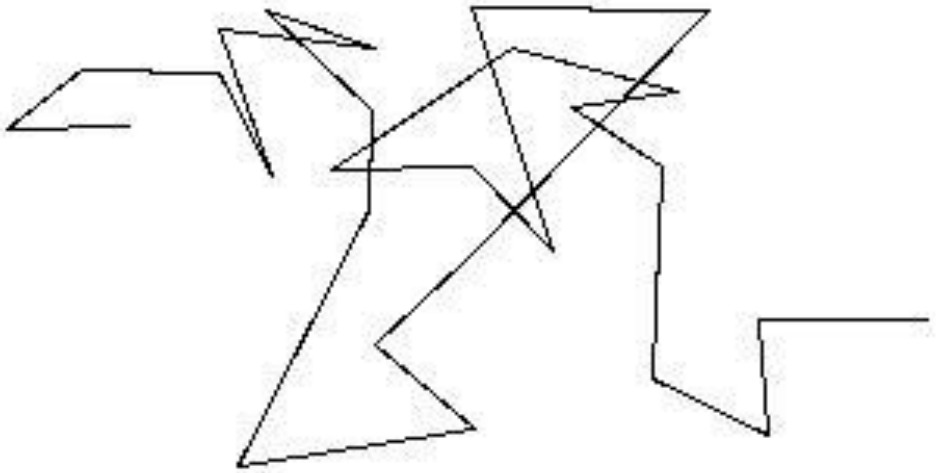

Whale shark 4220 (4/28/05 - 12/30/05
0
-5
-10
-15
-20
-25
-30
100
105
110
115
120
125
130
OZ

Elk. Starkey Reserve**.** Case with explanatory ***x****(t)*

Can elk, deer, cows, humans coexist?







med ex-flickvännen **Claudia** och dottern **Giannina**, se det argentinska landslaget göra inte mindre än sex makalösa mål på Serbien och Montenegro i ödesmatchen i ”Dödens grupp”.

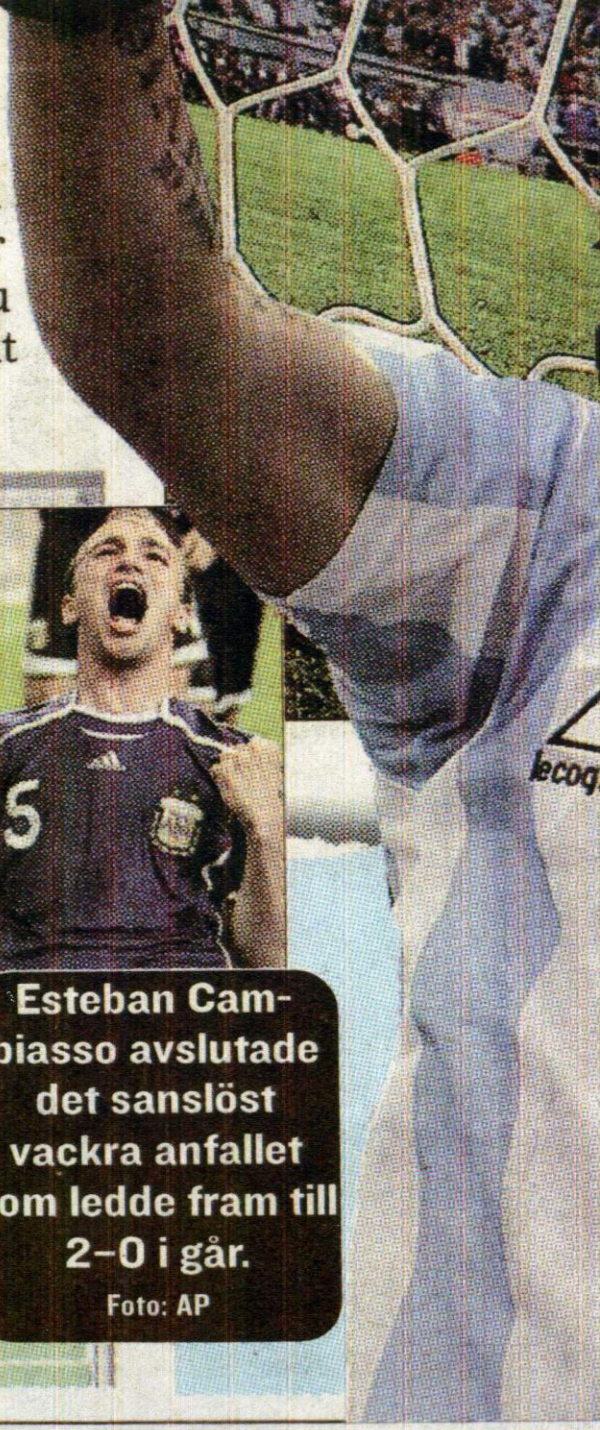
Efter varje mål skrek

Jonas Esbjörnsson
jonas.esbjornsson
@expressen.se

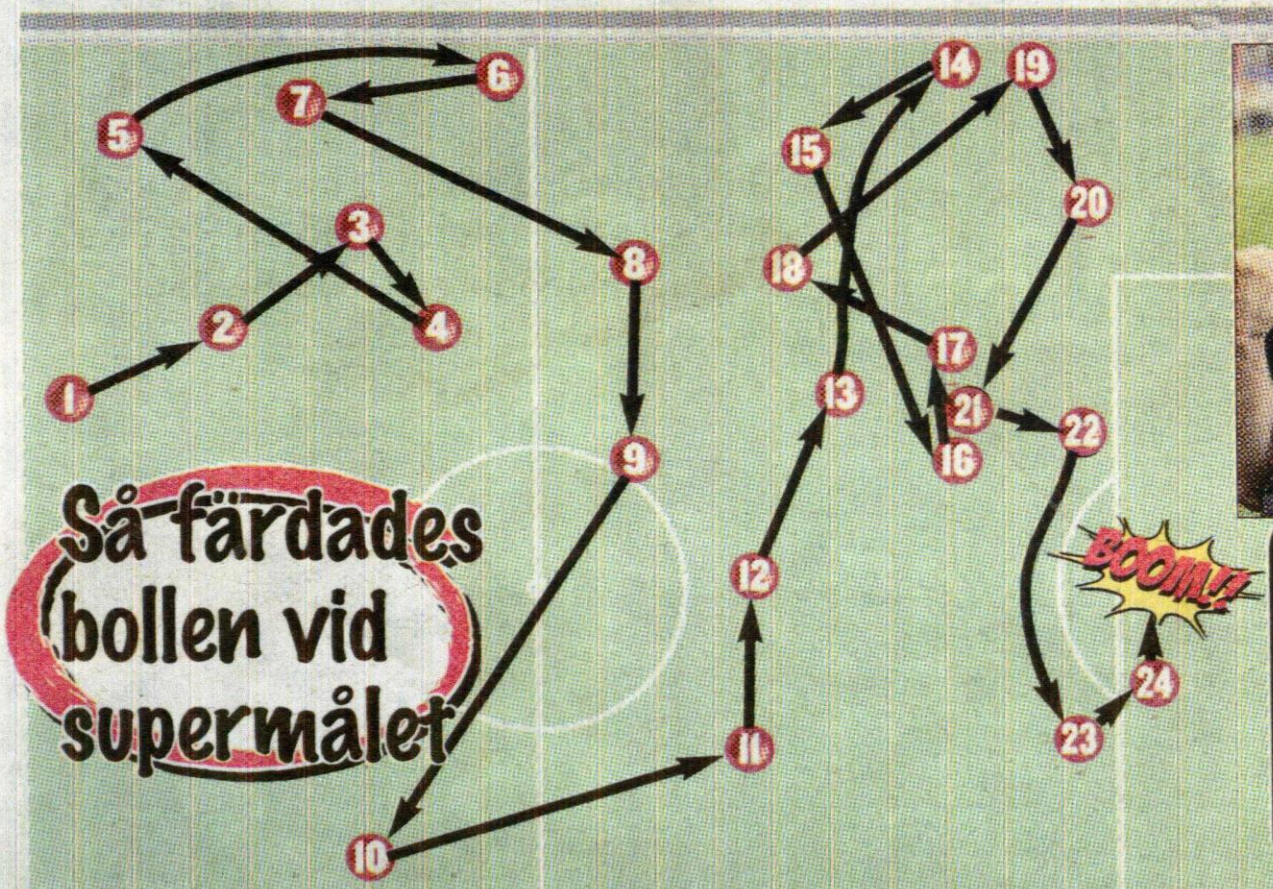
man instämde:

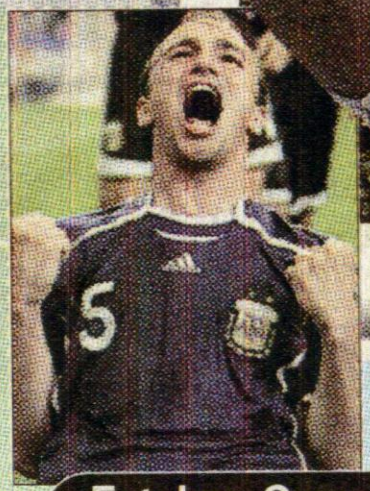
– Vi gjorde en fantastisk match.

Efter åtta mål på två matcher är Argentina nu plötsligt storfavorit till guldet.



Så färdades bollen vid supermålet





Esteban Cambiasso avslutade det sanslöst vackra anfallet som ledde fram till 2–0 i går.

Foto: AP

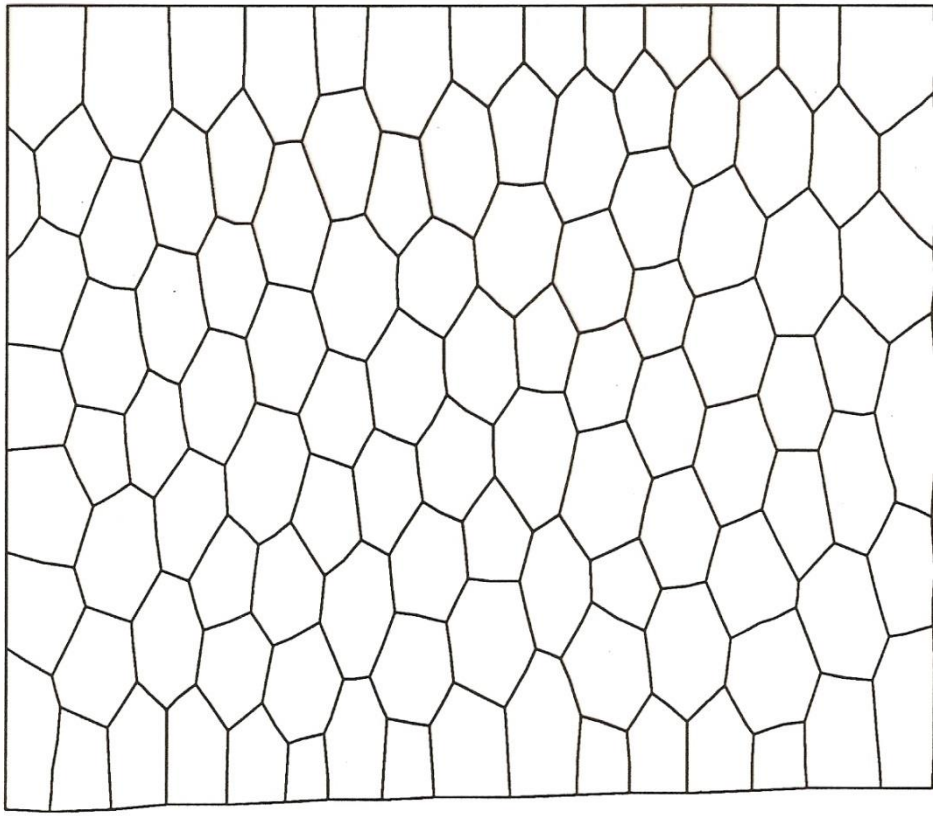
Moving cells.

chicken embryo

described by polygons, $\mathbf{P}_j$ (t)

part of tesselation

Cell Boundaries



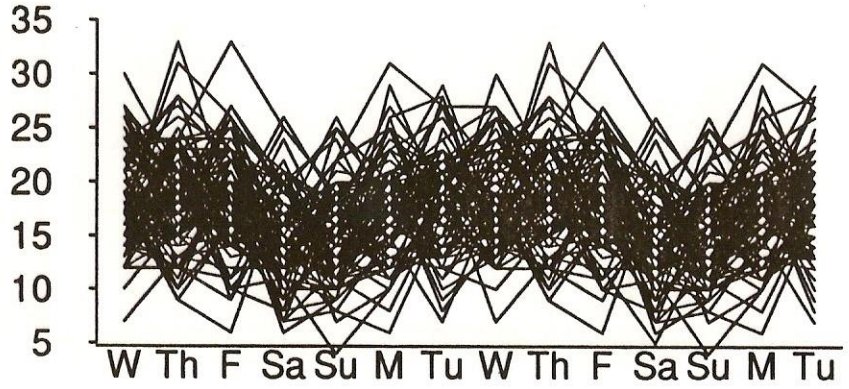
Moving granules

Separation of variables

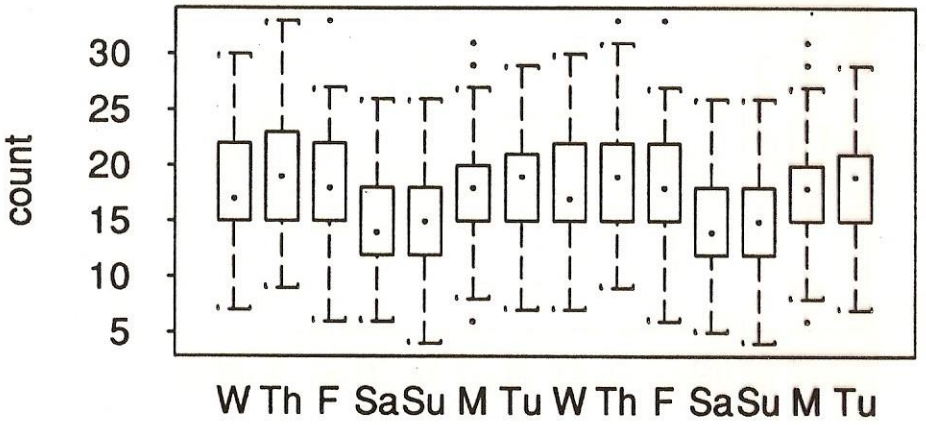
Look at Y(x,y), Z(t) separately

Daily births in Saskatchewan

Daily births stacked by fortnight



Daily births in Saskatchewan, 1986-1



1986 births and populations, ages 25 to 29