Creation of a Graphical User Interface with R

Sensitivity study of a model

Application to a Dairy Farm Model

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Parts of the talk

1. Dairy farm model
2. Graphical User Interfaces with R

Methods and objectives

1. Simulation 1 cow $\Leftarrow$ par.sim
2. Profit of 1 cow $\Leftarrow$ par.cost & par.prtcl
3. Replications to estimate the profit of a farm
4. GUI

Aim

Maximize the profit

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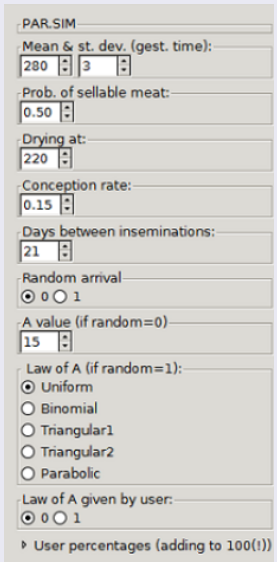
Simulating 1 cow

code `simvaca.R`

INPUTS: PAR.SIM



RANDOM

- Gestation time (μ, σ)
- Sellable meat ($p = 0.5$)
- Time of natural death ($\emptyset$)
- Number of failed inseminations ($p = 0.15$)
- Laws (random farm composition)$\longrightarrow$ next

DETERMINISTIC

- Production curve (Wood)$\longrightarrow$ next
- Days between inseminations
- Drying time

Simulating 1 cow

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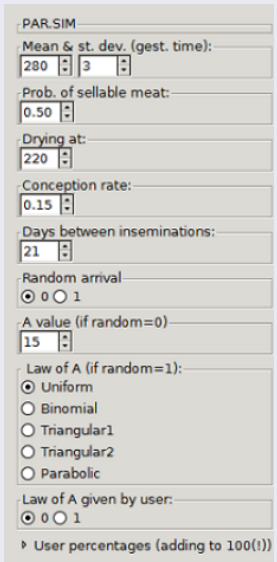

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- Laws (random farm composition) → next

DETERMINISTIC

- Production curve (Wood) → next
- Days between inseminations
- Drying time

OUTPUT

- Simulated cow: milk production, gestation length and others

Simulating 1 cow: milk production curve

Wood in 1st, 2nd and other lactations: deterministic function depending on 2 fixed value parameters (B and C) and 1 free parameter A.

Wood function

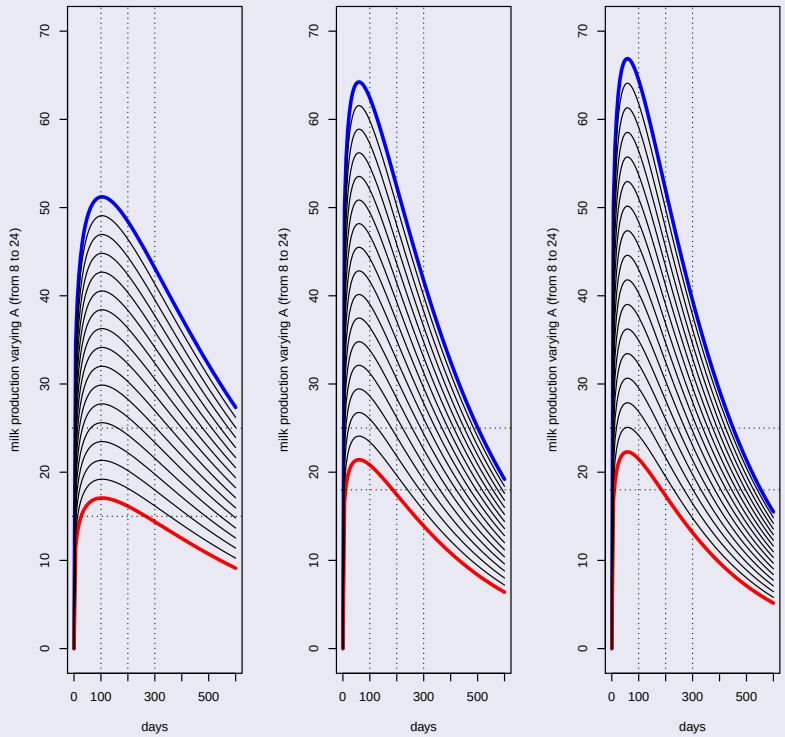
$$f(x) = Ax^B e^{-Cx}$$

	1st	2nd	others
A	$A_1 \in \{8, \ldots, 24\}$	$A_2 = 1.54 \cdot A_1$	$A_3 = 1.47 \cdot A_1$
B	$B_1 = 0.208$	$B_2 = 0.179$	$B_3 = 0.209$
C	$C_1 = 0.002$	$C_2 = 0.003$	$C_3 = 0.0036$

Simulating 1 cow

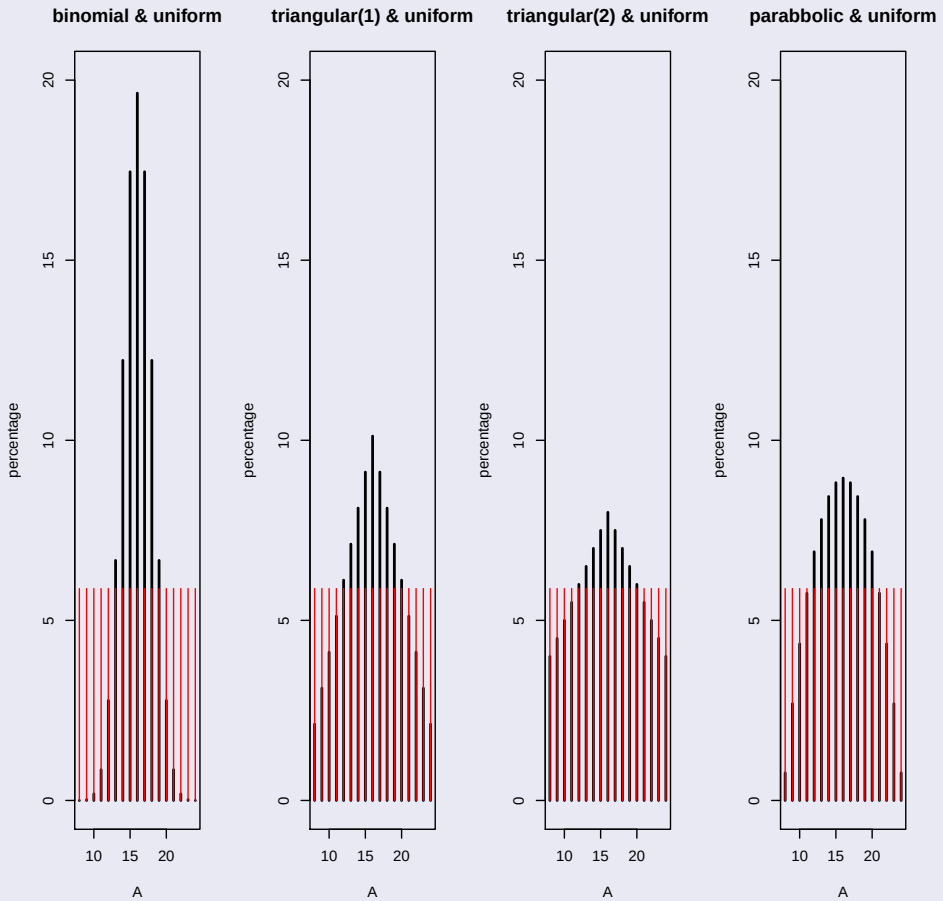
Parameter A determines how productive it is the cow.

Wood function: milk production curve



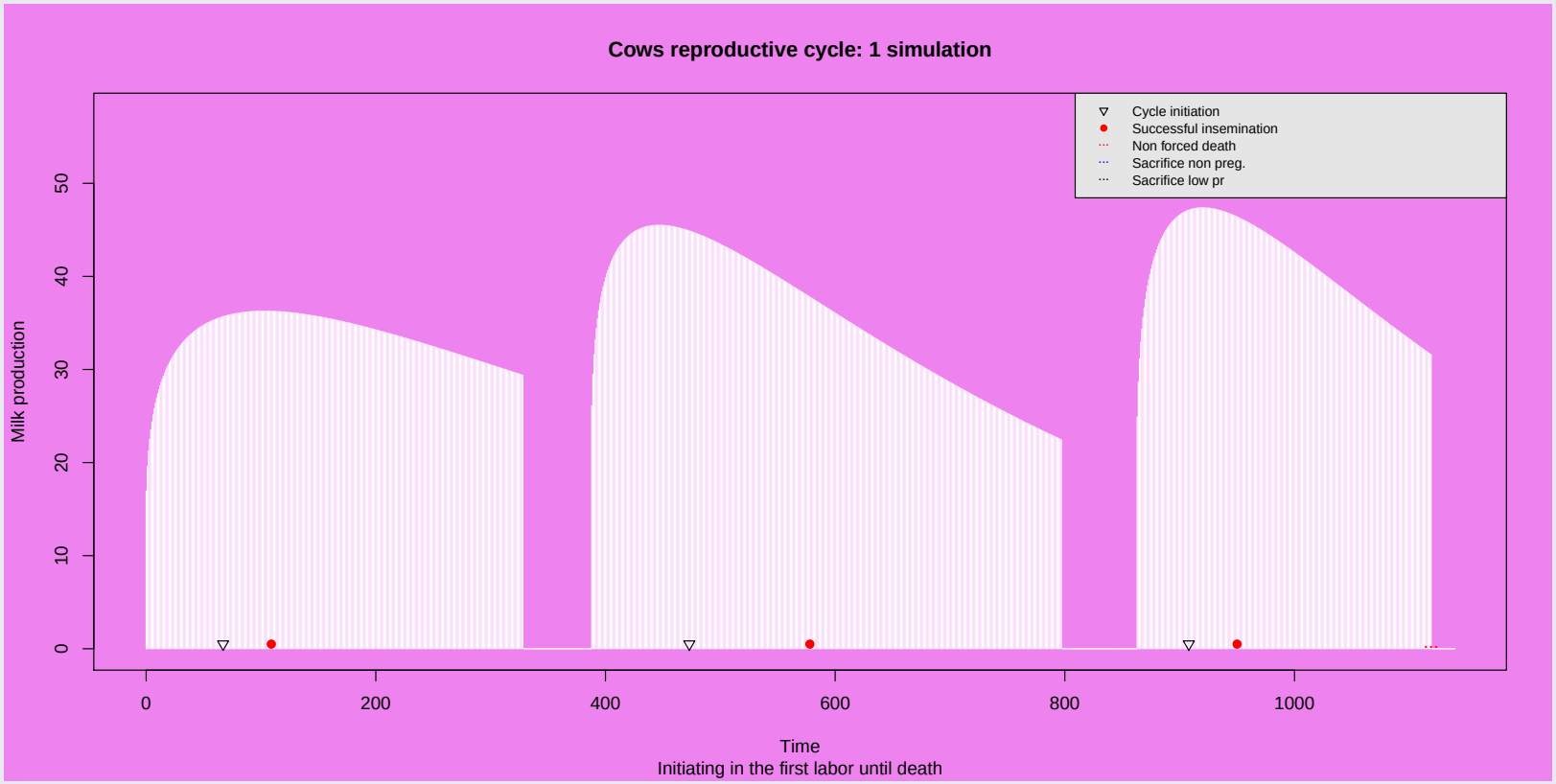
Simulating 1 cow

Laws: Random farm composition ($\%A = 8, 9, ...$)



Simulating 1 cow

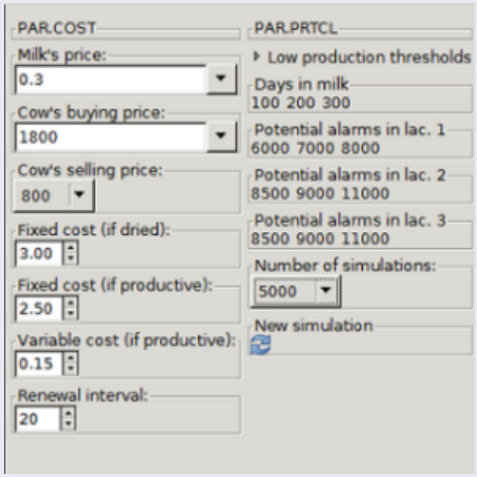
Simulating 1 cow: 3 lactations, production, gestation time...



Profit of 1 cow

code `fbp.R`

INPUTS: PAR.COST + PAR.PRTCL



- Data simulated cow
- Prices and costs
- PROTOCOLS →

  next

Profit of 1 cow

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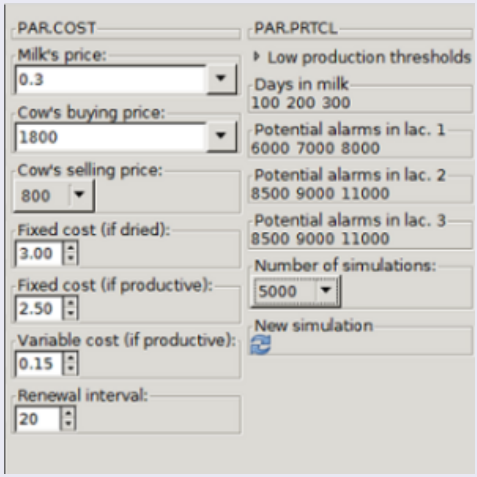


- Data simulated cow
- Prices and costs
- PROTOCOLS →

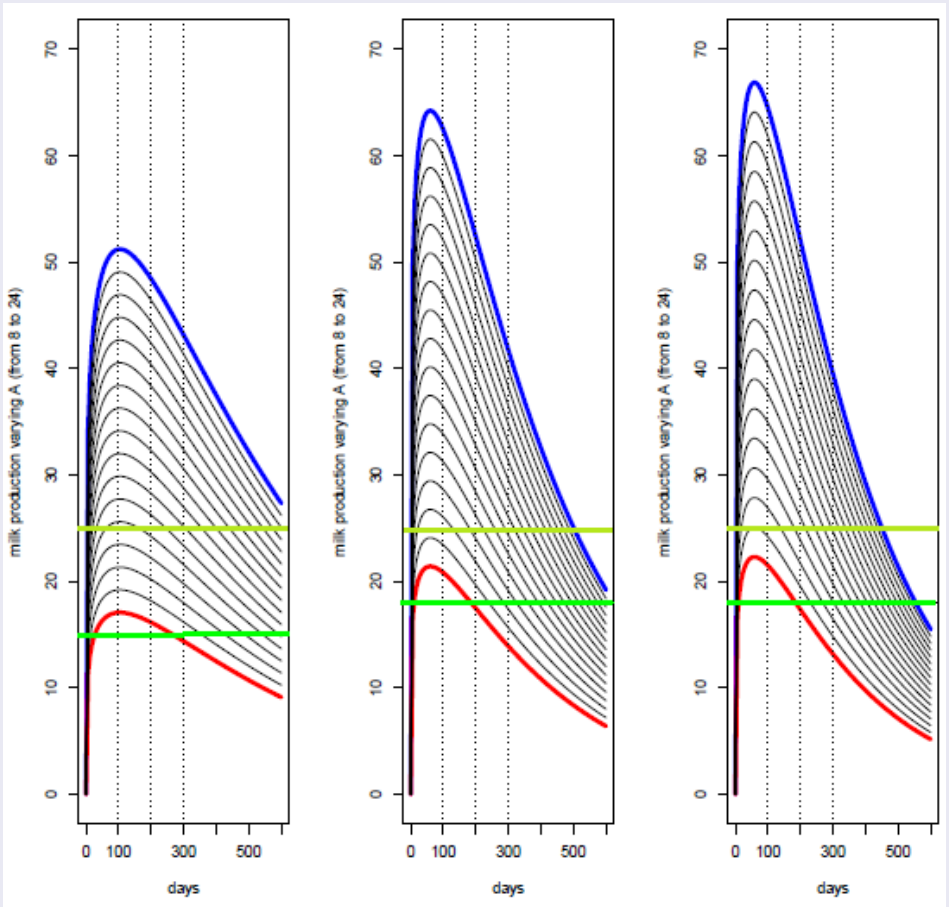
  next

OUTPUT

- Benefit of a cow

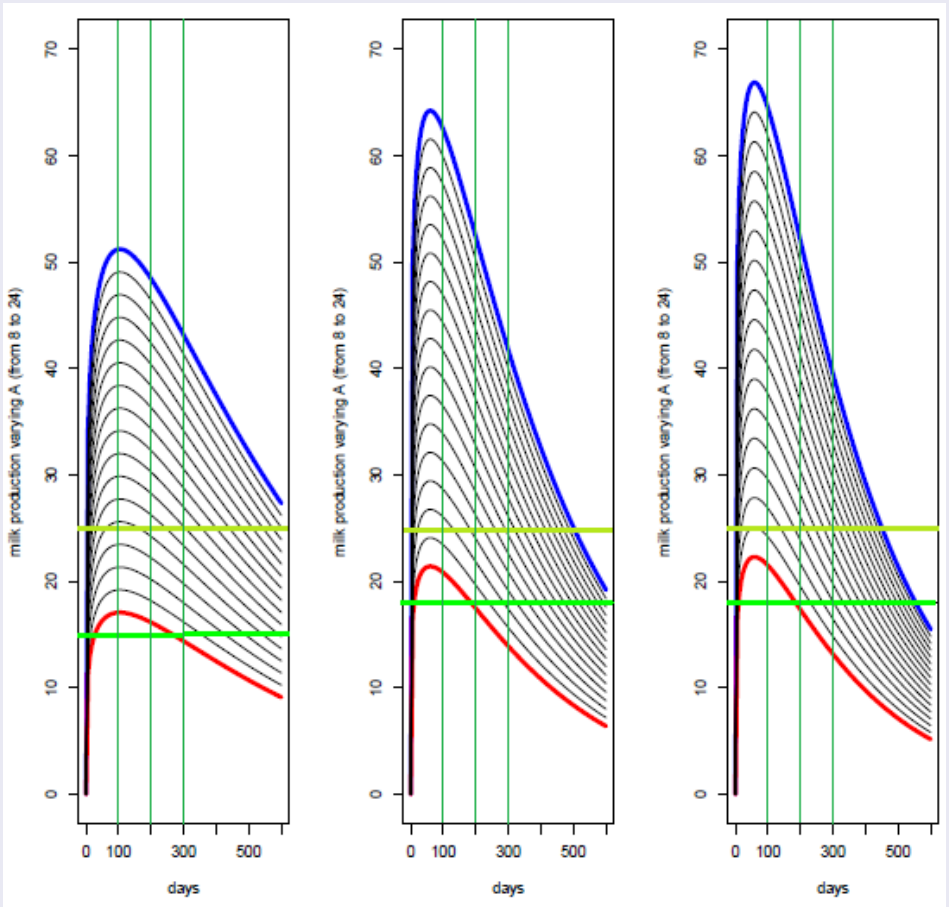
Profit of 1 cow

Thresholds for each period



Profit of 1 cow

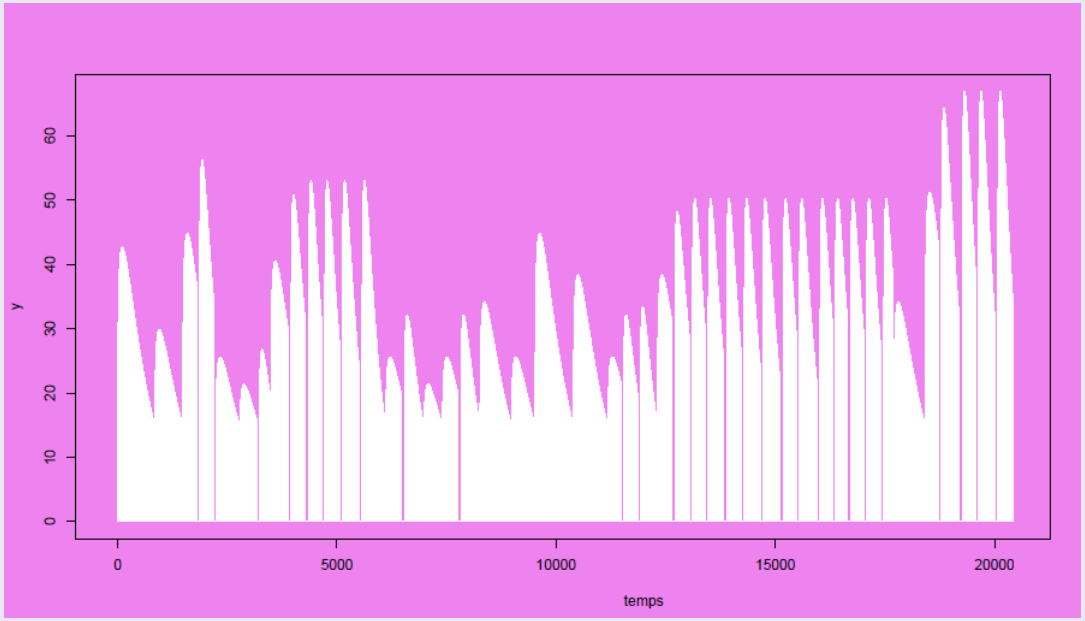
Thresholds for each period



Replication to estimate the profit

Replicating many cows $\Longrightarrow$ Average Profit, st. deviation, etc.

Consecutive simulations



Analysis of the dependence on certain parameters

How to do it?

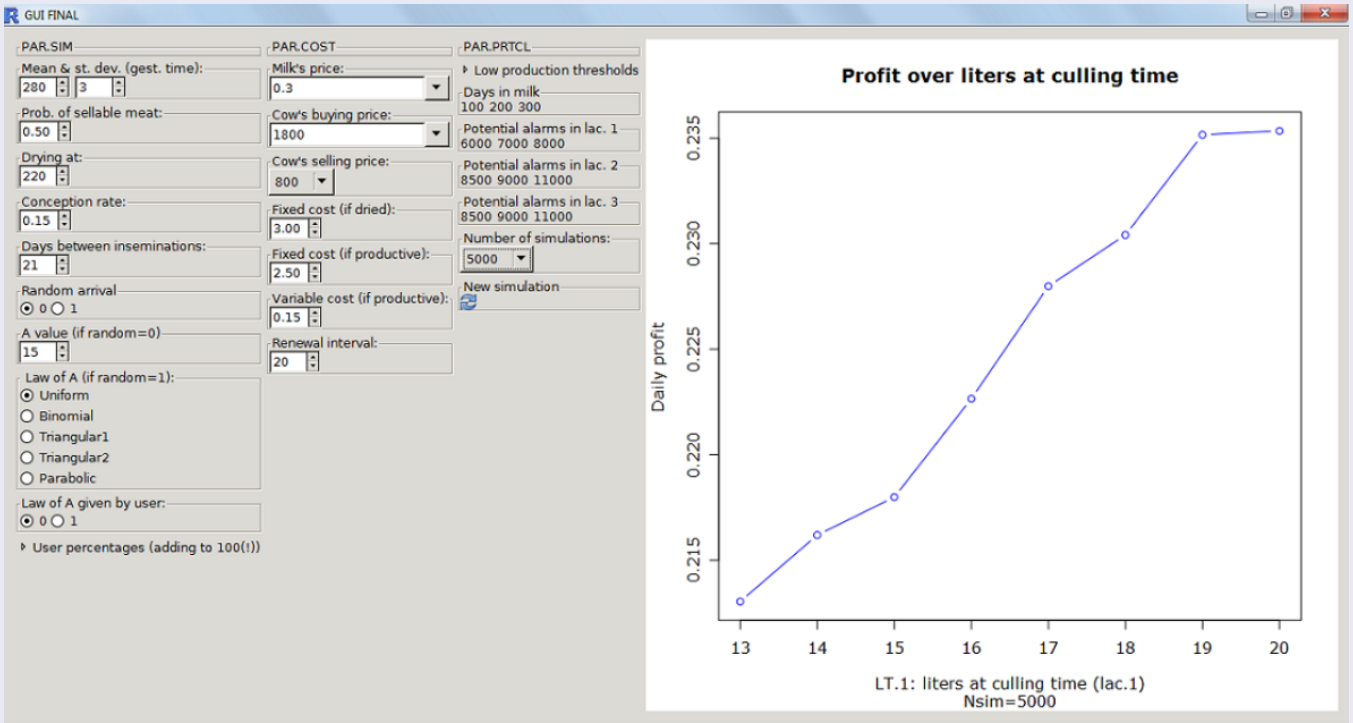
- CODE → User must know well R
  - knowing how to apply the different functions (simvaca, fbp, etc.)
  - changing the values of the parameters inside the functions

```
par.sim <- c(aleat=1,llei=d1,A0=17,a=2,p=0.15,int=20,m.gest=280,
    s.gest=3,TM0=0.5,sec=20)
rs <- simvaca(par.sim)
par.prtcl <- c(L1=c(15,25,25),L2=c(18,25,25),dates=c(100,
    200,300,100,200,300),alpot=c(6000,8500,8500,7000,9000,
    9000,8000,11000,11000))
par.preus <- c(cost1=c(2.5,0.15),cost0=3,pll=0.32,pc=1800,
    pv=800,esp=20)
li <- taula.li(vA = (8:24), L1 = par.prtcl[1:3],
    L2 = par.prtcl[4:6], dates = par.prtcl[7:15])
res <- fbp(li = li, rs, par.prtcl, par.preus)
```

Analysis of the dependence on certain parameters

How to do it?

- Graphical User Interface (GUI)



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How to create a graphical user interface for R?

Library `gWidgets`

- It tries to be a link between R and other libraries
- It's a well documented package with examples
- It quickly creates GUIs
- It follows a logical hierarchy
- It has different types of `widgets`

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gbutton("Hello world", cont=TRUE)
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items = c("Coke","Pepsi","None of the above")
gradio(items, cont=TRUE)
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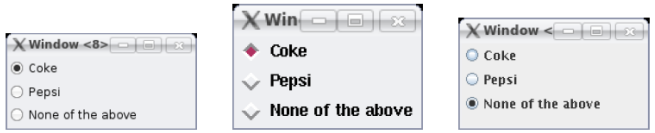

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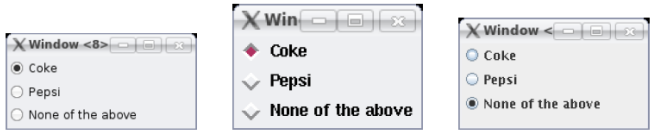

gslider

```
gslider(from=0, to = 100, by = 1, cont=TRUE)
```

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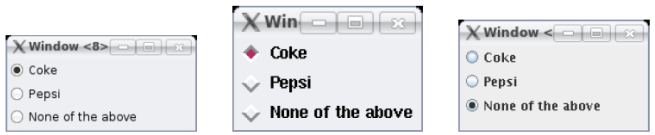
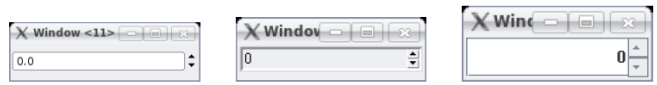


gslider

```
gslider(from=0, to = 100, by = 1, cont=TRUE)
```

gspinbutton

```
gspinbutton(from=0, to = 1, by = 0.1, cont=TRUE)
```



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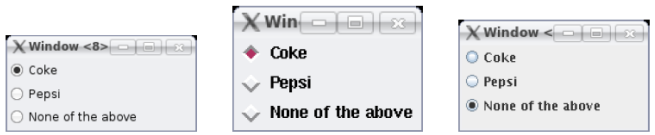

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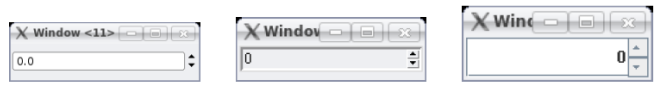

gcheckbox

```
gcheckbox("Do you like coke", cont=TRUE)
```

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Examples of gWidgets library

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gslider

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gcheckbox

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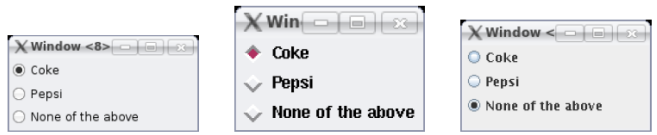

gspinbutton

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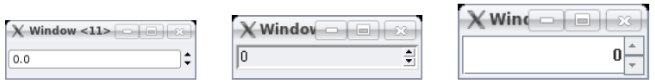
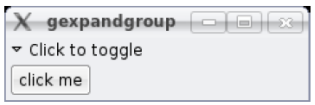
```



gexpandgroup

```
win = gwindow("gexpandgroup")
g = gexpandgroup("Click to toggle", cont=win)
gbutton("click me", cont=g)
visible(g) <- TRUE  ## open up
```



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4 random variables

4 random variables to simulate the physiologic functions of the life cycle of a dairy cow.

4 random variables

4 random variables to simulate the physiologic functions of the life cycle of a dairy cow.

- Time of natural death (assumed to be Weibull)
- Start of the reproductive cycle (Weibull)
- Number of unsuccessful inseminations (Geometric)
- Gestation time (Gaussian)

Parameter values allow the user to adapt to several scenarios.

4 random variables

Time of non-forced death

Weibull distribution with $a = 2$, $b = 1000(log2)^{-\frac{1}{a}}$ by default,

$$f(x; a, b) = \frac{a}{b}\left(\frac{x}{b}\right)^{a-1} e^{-(\frac{x}{b})^a} \mathbf{1}_{[0,\infty]}(x), \text{ with } a, b > 0 \quad (1)$$

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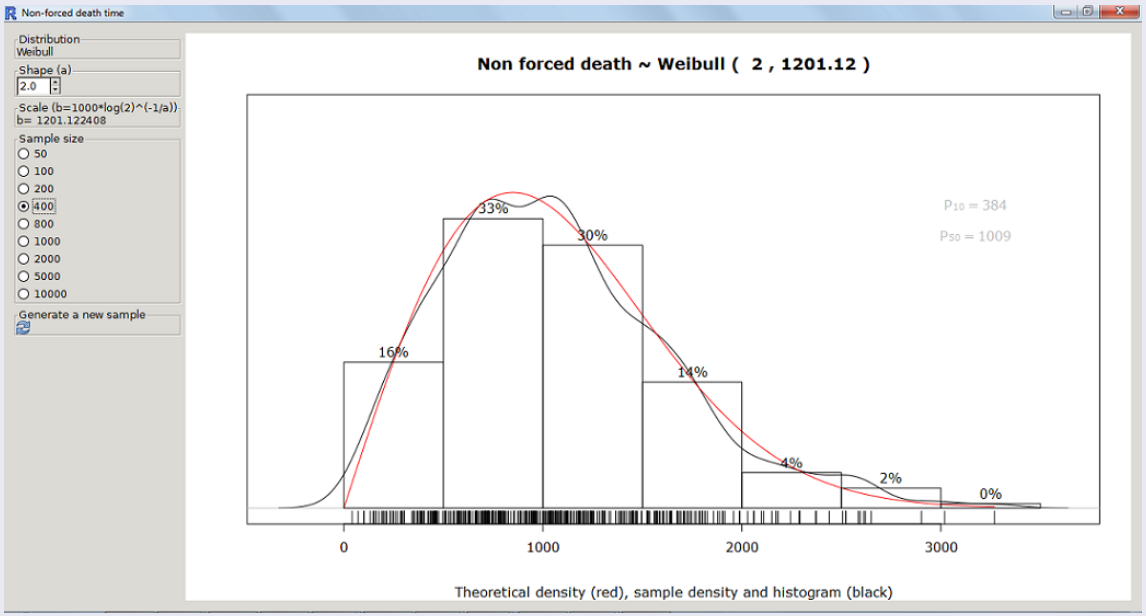

4 random variables

Number of unsuccessful inseminations

Geometric distribution where $p \in (0, 1)$, $q = 1 - p$, with $p = 0.15$ by default:

$$P(X = n) = q^n p, \forall n \geq 0 \tag{2}$$

4 random variables

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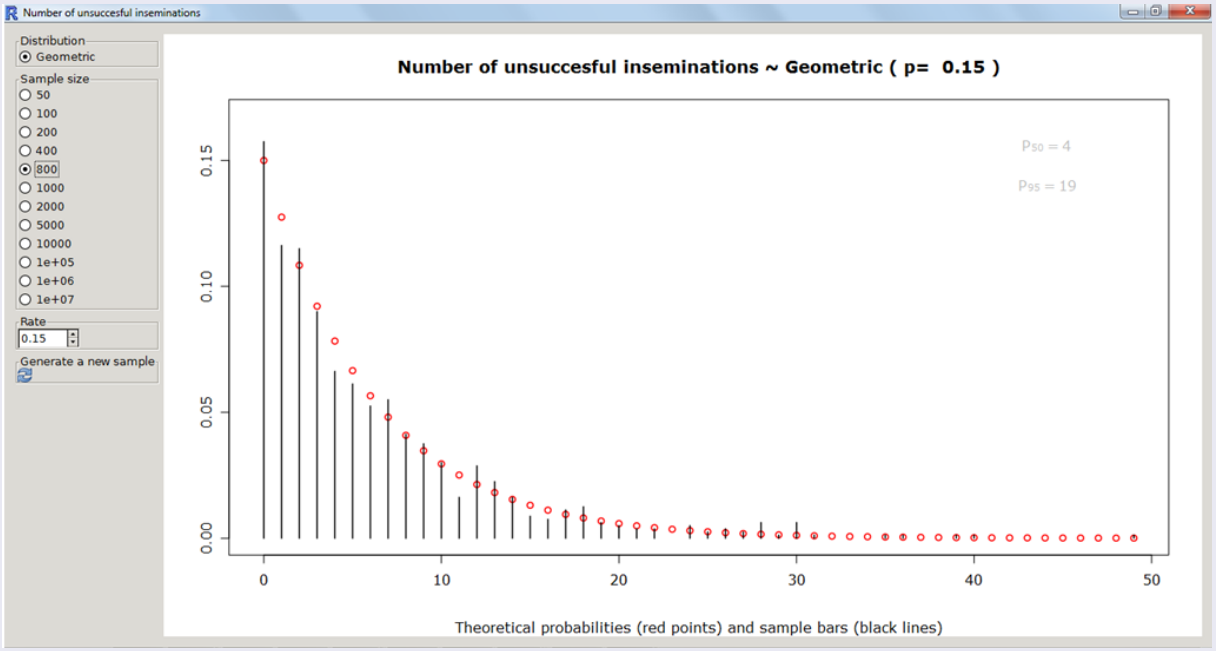


4 random variables

Number of unsuccessful inseminations

```
availDists<-c(Geometric='rgeom')
updatePlot<-function(h,...){
    x ¡-do.call(availDists[svalue(distribution)],list(svalue(sampleSize),svalue(p)))
    t<-0:max(x)
    tab<-prop.table(prop.table(table(x)))
    dfx<-as.data.frame(tab)
    valors<-as.numeric(levels(dfx$x))
    f.rel<-dfx$Freq
    ymax<-max(f.rel,dgeom(t,svalue(p)))
    plot(t,dgeom(t,svalue(p)),type='p',col='red',lwd=1.5,ylim=c(0,ymax+.01),xlab='',ylab='')
    points(valors,f.rel,type='h',lwd=1.5)
    title(main=paste('Number of unsuccesful inseminations Geometric (p=',svalue(p),')'),
    sub='Theoretical probabilities (red points) and sample bars (black lines)')
    text(0.9*max(x),0.99*ymax,bquote(paste(P,scriptstyle(50)==.(round(median(x))))),col='gray')
    distribution<-gradio(names(availDists),horizontal=FALSE)
}
```

4 random variables

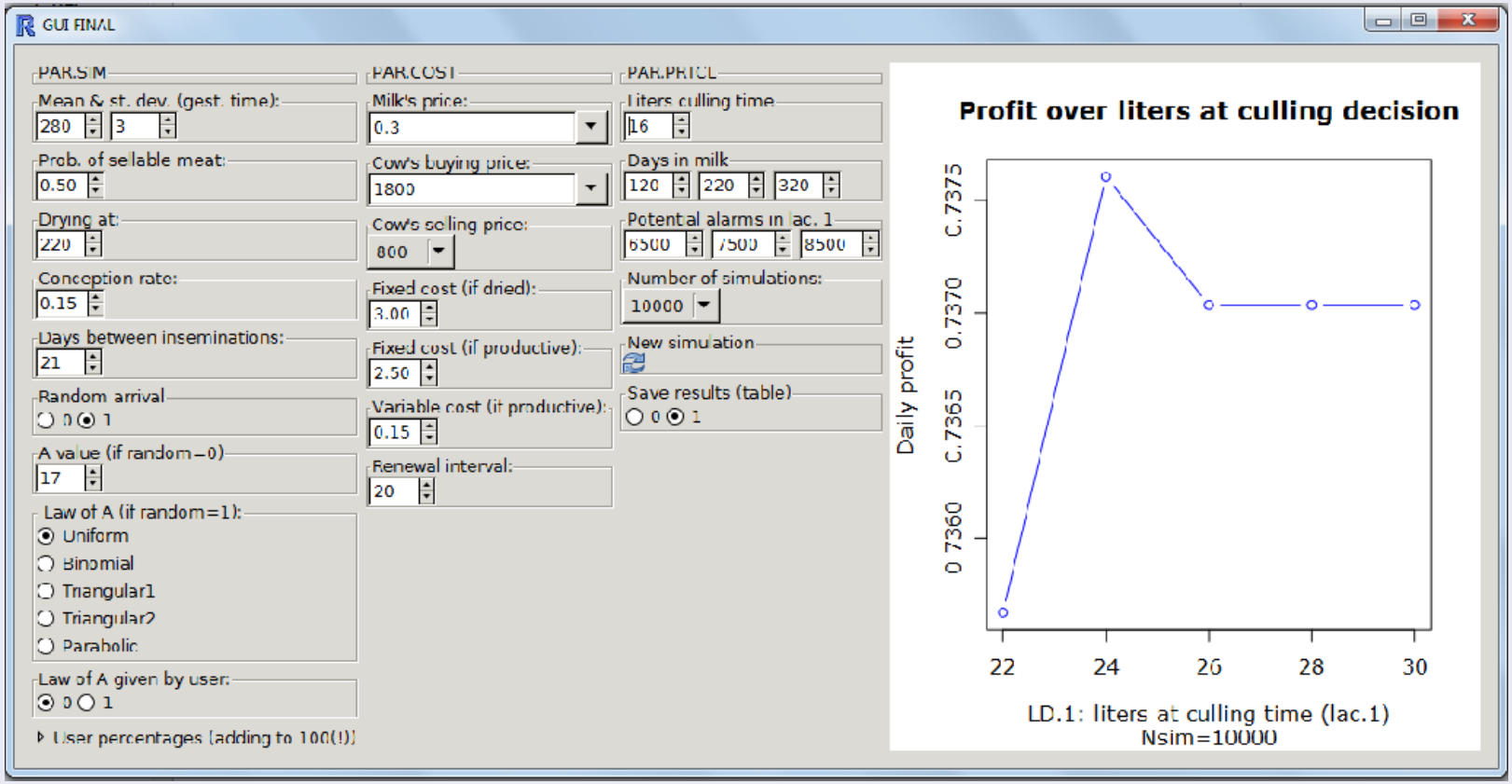
Number of unsuccessful inseminations

```
sampleSize<-gradio(c(50,100,200,400,800))
p<-gspinbutton(from=0,to=100,by=0.05,value=0.15
refresh<-gimage('refresh',dirname='stock',handler=updatePlot)
window<-gwindow('Number of unsuccessful inseminations')

BigGroup<-ggroup(cont=window)

group<-ggroup(horizontal=FALSE,container=BigGroup)
  tmp<-gframe('Distribution',container=group)
  add(tmp,distribution)
  tmp<-gframe('Sample size',container=group)
  add(tmp,sampleSize)
  tmp<-gframe('Rate',container=group)
  add(tmp,p)
  tmp<-gframe('Generate a new sample',container=group)
  add(tmp,refresh)
add(BigGroup, ggraphics())
```

Final GUI


GUI FINAL
PAR.SIM
Mean & st. dev. (gest. time):
280
3
Prob. of sellable meat:
0.50
Drying at:
220
Conception rate:
0.15
Days between inseminations:
21
Random arrival
0 1
A value (if random=0)
17
Law of A (if random=1):
Uniform
Binomial
Triangular1
Triangular2
Parabolic
Law of A given by user:
0 1
User percentages (adding to 100(!))
PAR.COST
Milk's price:
0.3
Cow's buying price:
1800
Cow's selling price:
800
Fixed cost (if dried):
3.00
Fixed cost (if productive):
2.50
Variable cost (if productive):
0.15
Renewal interval:
20
PAR.PRTCL
Liters culling time
16
Days in milk
120
220
320
Potential alarms in lac. 1
6500
7500
8500
Number of simulations:
10000
New simulation
Save results (table)
0 1
Profit over liters at culling decision
Daily profit
0.7360
0.7365
0.7370
0.7375
22
24
26
28
30
LD.1: liters at culling time (lac.1)
Nsim=10000

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Conclusions

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- We have created a principal GUI containing all the methods, parameters, functions, replicates, etc., and showing the mean profit plot with respect to some threshold.

Conclusions

- We have created 4 auxiliary GUIs that can help in the modelization process.
- Varying the values of the parameters allows the adaptation to different farms.
- We have created a principal GUI containing all the methods, parameters, functions, replicates, etc., and showing the mean profit plot with respect to some threshold.
- In the example the maximum profit is achieved by taking the culling decision threshold at 24 liters.

Future work

- We now have the tools to interact with the model.

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Then,

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Then,
Test phase (1): testing the reliability of the models with actual cases.
Profit analysis (2): searching for those protocols that maximize the (mean) profit.

THANK YOU FOR YOUR ATTENTION