Introduction to practical disease modeling: Exercise 1

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Exercises with herd dynamics

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1. Introducing herd dynamics

We start by constructing a simple simulation model for a dairy farm, and use an age counter (days) for the cows.

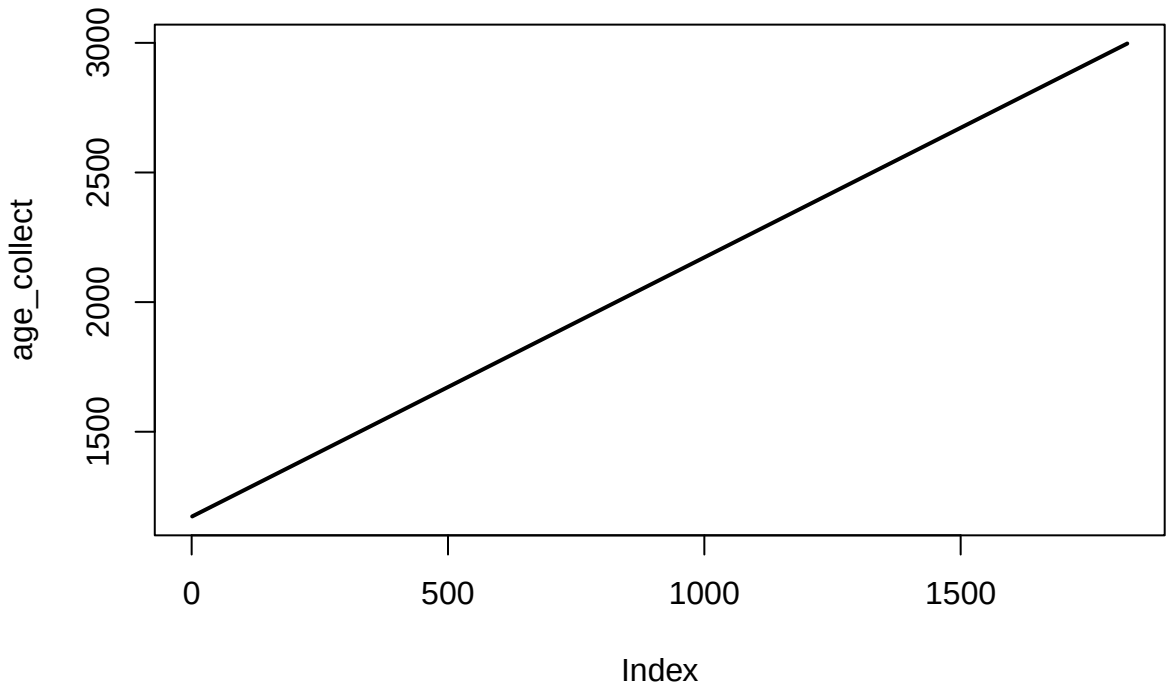
Please look at the code and make sure you understand what each line does.

First we construct a herd with cows that age over time:

```
set.seed(250)

n.cows <- 100

# Create the farm:
farm <- data.frame(id =1:n.cows,
                   age=round(runif(n.cows,730,1642)))

# We want to simulate 5 years:
end.time <- 5 * 365

# Collect the mean age of the cows in herd over time:
age_collect <- numeric(end.time)

for (k in 1:end.time)
{

   # Add one day to the age of all the animals, for each simulated:
   farm$age <- farm$age + 1

   # Save the daily mean age of all cows:
   age_collect[k] <- mean(farm$age)
}
```

We can then plot the age of the cows over time:

```r
plot(age_collect, type="l", lwd=2)
```

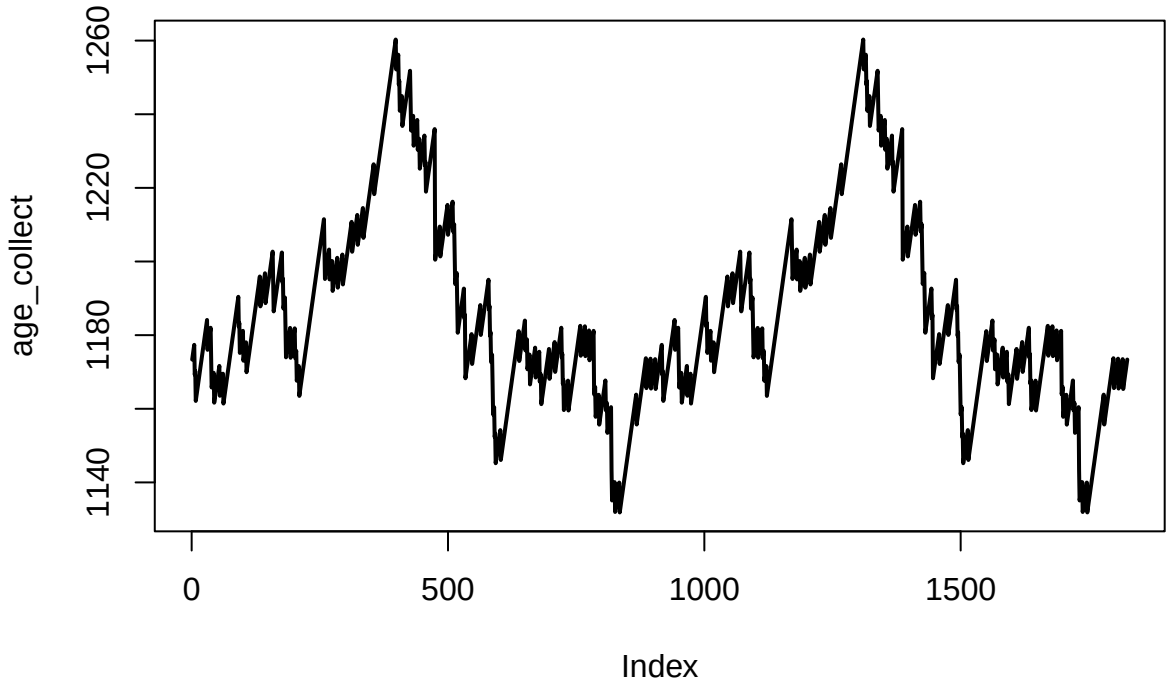


We see that the cows age over time as the mean age in the herd increases. However, this does not reflect a real herd. We want to model a cattle farm where the old cows are replaced with new cows over time. When the cows reach 1642 days, they will be replaced with a new cow that is two years old:

```r
set.seed(250)

n.cows <- 100

# Create the farm:
farm <- data.frame(id =1:n.cows,
                   age=round(runif(n.cows,730,1642)))

# We want to simulate 5 years:
end.time <- 5 * 365

# Collect the mean age of the cows in herd over time:
age_collect <- numeric(end.time)

for (k in 1:end.time)
{
   # If cows reach the age of 1642, they are replaced with a new cow that is 2 years old in DIM = 1:
   farm$age[farm$age>=1642] <- 730

   # Add one day to the age of all the animals, for each simulated:
   farm$age <- farm$age + 1

   # Save the daily mean age of all cows:
   age_collect[k] <- mean(farm$age)
}
```

We can then plot the age of the cows over time:

```
plot(age_collect, type="l", lwd=2)
```



The mean age in the herd oscillates over time, as a natural cause of the dynamics in the herd when cows age and are replaced with new cows.

We can look at the variation in the age over time:

```
quantile(age_collect)
```

```
##       0%      25%      50%      75%     100%
## 1131.85 1169.13 1179.41 1201.37 1260.29
```

2. Exercises

Hint: Modify the above code to solve the exercises.

A.

What happens with the variation if you increase the number of cows to 500? And 5000?

B.

Try to change the age before replacement up and down. What happens with the variation in the results? Look at the mean age of the cows over time. Can you identify a repeating pattern (periodicity) in the results? Where does that come from?

C.

Now introduce dynamics in the replacement age: Make a new column with an individual replacement age for each cow (normal distribution with mean = 1642 and sd=50). When the cows reach their own predefined replacement age, then replace them. Remember that the new cows should have their own replacement age. What happens? Look at the periodicity now. What happened?

D.

What modification would you like to introduce to this model, to explore the dynamics in the herd?

E.

Try to run the initial model twice with the same seed and compare results. Then change the seed and compare again. What happens?
