

Dynam Models Bio HW 1

Due 9/6

1. In a certain species of Animals, only one-year-old, two-year-old, and three-year-old females are fertile.

The probabilities of of one-year-old, two-year-old, and three-year-old females to give birth to a new female are p_1 , p_2 , and p_3 respectively.

Assuming that there were c_0 females born at $n=0$, c_1 females born at $n=1$, and c_2 females born at $n=2$.

Set up a recurrence that will enable you to find the expected number of females born at time n .

In terms of $c_0, c_1, c_2, p_0, p_1, p_2$,

How many females were born at $n=4$?

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Problem 1 (continued)

What are our units?

- Time: $n=0, n=1, n=2, n=3, n=4, \dots$
 - Independent variable
- Probability: P_0, P_1, P_2 (only 3 instances)
 - Fixed
- # of females: $C_0, C_1, C_2, C_3, C_4, \dots$
 - Dependent variable.
 - Also used as a parameter.

What should our functions look like?

- Our functions used to model the population of females over time consist of:
 - Initial Conditions (start at $n=2$)
 - The recursive function

Function Recurse($n, P_0, P_1, P_2, C_n, C_{n-1}, C_{n-2}$)

↑
which step we are on

Pair	P_0	with	C_{n-0}	probability of young times youngest
Patr	P_1	with	C_{n-1}	probability of 2nd year times second year
Patr	P_2	with	C_{n-2}	probability of old times oldest population

Then add all the products $(P_0 C_n + P_1 C_{n-1} + P_2 C_{n-2})$ and delete the oldest fertile females (C_{n-2}) but keep two year old and one year old females.

Wrong implementation but idea is mostly there

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Problem 2: Write the maple code for problem 1

that inputs the discrete time n and outputs the number of females born at time n .

Problem 3: Taking $c_0 = c_1 = c_2 = 1$, experiment with the values of p_1, p_2, p_3 that would lead, at time $n = 1000$,

- to
- (i) Extinction
 - (ii) Stable Population
 - (iii) Population explosion

1:20-1:50

Finish Maple HW

★ TIPS for Maple

(TIP 1) SHIFT + ENTER shortcut begins a new line in the same cell

(TIP 2) Replace purple parts with stuff you like?

The pseudocode for Problem 2

Rabbit := proc($n, p_0, p_1, p_2, c_0, c_1, c_2$) option remember;

Be more organized than this!

★ We will have seq(function(n); 0...4)

and we will have the probabilities separate, so it would be good to visually isolate p_0, p_1, p_2 and not have it clutter the code that does the heavy lifting

What is the "too many levels of recursion" error in maple

- It calls itself too many

One possible solution of "too many levels" is to set a base case (like set $f(0) = 1$)

Other syntax stuff

Unlike python, Maple has single = sign in if statements

Dynamic Models Bio problem 2.

★ In maple, parentheses are super important!

```
X := proc(n) option remember ;  
  n + n + 1 ;  
end
```

yields the odd numbers

3 5 7 9 ...

But

```
X := proc(n) option remember ;  
  n + (n + 1) ;  
end
```

yields the Fibonacci Sequence.

What does the "expand" command do.

Expand unfactors all expressions, therefore this is a quick strategy to get maple to read an expression correctly.

Dynam M

Maple Tips:

The remember option for procedures allows code to execute much faster than if we did not add that option.

How to indent in Maple:

- Ensure tab Navigation is not selected

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Problem 1 (continued)

Now, we need to show how many females were born at $n=4$

given $\begin{cases} c_0 \text{ females born at } n=0 \\ c_1 \text{ females born at } n=1 \\ c_2 \text{ females born at } n=2 \end{cases}$

★ We know that c_1 and c_2 have zero dependence on the probability of females born because they were already born.

★ At step $n=3$, we know the total amount of rabbits born is:
offspring of youngest $+ p_0 c_2$ offspring of middle $+ p_1 c_1$ offspring of oldest $+ p_2 c_0$

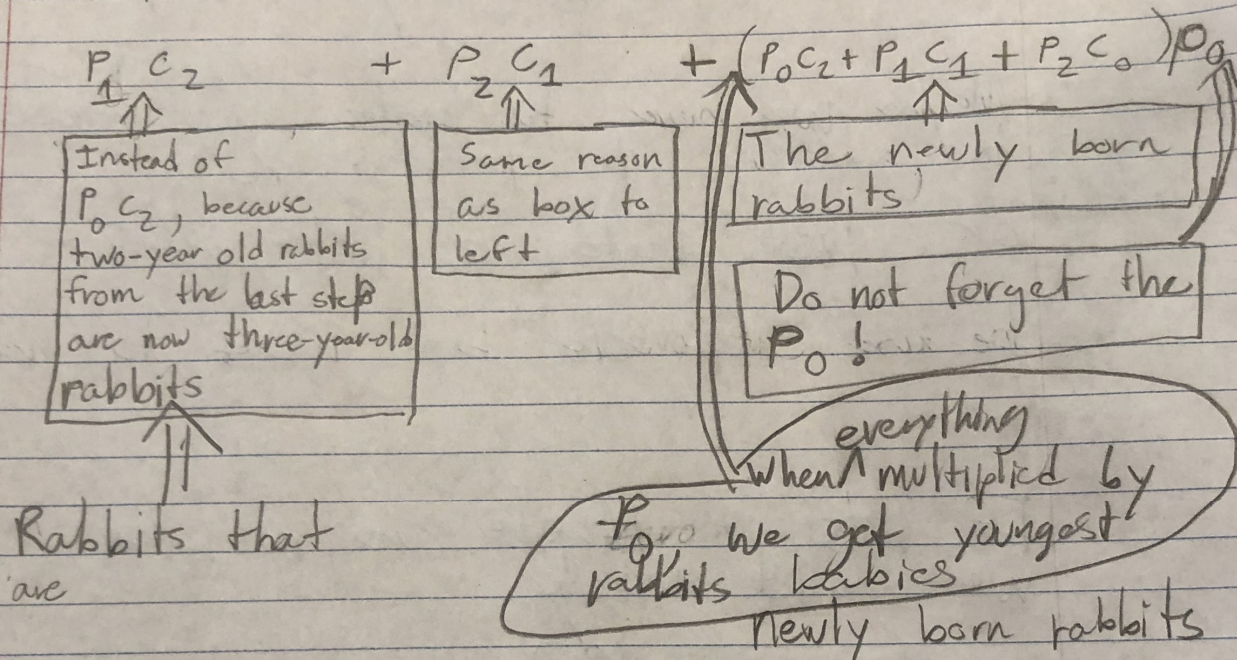
Realization 0

We might not need to index any c -values

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Problem 1 (continued)

★ Following step $n=3$, the amount of new rabbits born is:



★ Following step $n=4$, we have

$$P_2 C_2 + (P_0 C_2 + P_1 C_1 + P_2 C_0) P_1 + (P_1 C_2 + P_2 C_1 + (P_0 C_2 + P_1 C_1 + P_2 C_0) P_0) P_0$$

$* P_0$

Stare at this for a bit and see if you have any ideas on how to create a definition of this that Maple Understands

Sanity Check

◦ I have 3 mega-terms for each step, IF I am not seeing P_1 , P_2 , and P_0 fully distributed over their own mega-terms

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Do we code from step 0 to step 4
or do we just generalise it.

Na! It's all the way to step N

Maybe we have to make a process C
in addition to process N

or just create a list called c

because it would be hard to make

If lists in Maple are mutable,
we could easily

create a $c(n), c(n+1), \dots$

★ I finished the code in python,
but I am too much of a noob
in maple

Problem Experiments^o

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TRIAL 1^o $P_0 = P_1 = P_2 = \frac{1}{2}$ - Grows
out of control

TRIAL 2^o $P_0 = P_1 = P_2 = 0.34$ - Grows
out of control

Trial 3^o $P_0 = P_1 = P_2 = 0.33$ - sinks towards
0