Dyn Mod in Bio HW 10 Rachel Adelman

Problem 1:

$ExactPD\left(20, 40, \frac{19}{40}\right)$

[0.1190277811, 304.7777751]

$EstPD\left(20, 40, \frac{19}{40}, 100\right);$

292.06000000

[0.1000000000, ~~[illegible]~~]

$EstPD\left(20, 40, \frac{19}{40}, 1000\right);$

[0.1160000000, 308.3440000]

$EstPD\left(20, 40, \frac{19}{40}, 5000\right);$

307.17280000

[0.1216000000, ~~[illegible]~~]

As K increases:
The probability estimate gets closer to 0.119 almost exact at K=5000.
The expected duration converges toward ≈ 305 as well.

What this means is as the number of simulations K increases, it converges to the true expected value. When K is small (like 100), it leads to high variance. This means it fluctuates to a few “lucky” or “unlucky” runs which ever on dominates the average. When K is large, (like 5000) the large K averages over many more games reduces the effect of random fluctuation and giving a stable estimate.

The best estimate is K = 5000, because it’s closest to the theoretical (ExactPD) values. The reason is simply that larger K = more simulations = smaller sampling error.

Problem 2:

```
with(plots) :

pmin := 0.45 :
pmax := 0.5 :
n_values := [10, 20, 30, 40, 50, 60, 70, 80, 90] :
colors := [red, green, blue, cyan, magenta, orange, brown, purple, grey] :

plots_list := [ seq(plot( ForPD(n_values[i], 100, p)[1],
      p = pmin ..pmax,
      color = colors[i],
      thickness = 2 ),
    i = 1 ..nops(n_values)) ] :

display(plots_list,
    title = "P(win) = ForPD(n,100,p)[1] vs p",
    labels = ["p", "P(win)"],
    legend = [ seq( sprintf("n=%d", n_values[i]), i = 1 ..nops(n_values) ) ],
    legendstyle = [location = top, font = [Helvetica, 9]] );
```