Numerical Comparative Dynamics: Ball Python Breeding

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ROADMAP OF SEMINAR

Goal

To find the effects changing parameters have on a Ball Python Breeding Program.

Truths

1. Males can inseminate 5 females apiece.
2. About 60% of pairings result in a ‘clutch’.
3. It costs about $80 to keep a snake for a year.
4. A male takes a year to grow to a breedable size.
5. A female takes two years.

Assumptions

1. Clutch size is distributed discrete triangular [3,14] max 6.
2. A breeder has a capacity that they are not willing to exceed.
3. No sickness.

Data

I went to Repticon in Tampa and recorded the price, sex, and traits of each snake. I recorded these in a csv and then filtered out genes that had fewer than 10 traits represented, and the snakes that had them.

Theory

Tweak of Becker 1973

Supposing you start with I males and J females, and $I + J$ is less than your total capacity.

$$\max_{\Pi} \left\{ \sum_{t=1}^{\infty} \sum_{i \in I_t} g\left(m_i, f_{\Pi(i)}, t\right) \delta^t \right\}$$
$$s.t. \quad I_t + J_t \leq C$$

where Π maps to possible subsets of 5 or less elements of the set of females J_t, and C is the capacity.

Problems

- Not PAM or NAM.
- g may be a profit function, but there doesn't seem to be a closed form for Π
- Brute force method is $\mathcal{O}(IJ^4)$ in each period.

Approximations

Maximize Average Profits

$$\max_{\mathbf{X},\mathbf{y},\mathbf{z}} \left\{ \sum_{i \in I} \mathbf{r}_i \mathbf{x}_i^T - 80\mathbf{y}^T \mathbf{1}_I - 80\mathbf{z}^T \mathbf{1}_J \right\}$$

$$\begin{aligned} s.t. \quad & \mathbf{X}\mathbf{1}_J \leq 5\mathbf{1}_I \\ & \mathbf{X}^T \mathbf{1}_I \leq \mathbf{1}_J \\ & \mathbf{X}\mathbf{1}_J \leq M\mathbf{y} \\ & \mathbf{X}^T \mathbf{1}_I \leq M\mathbf{z} \\ & \mathbf{y}^T \mathbf{1}_I + \mathbf{z}^T \mathbf{1}_J \leq 15 \\ & X_{ij}, y_i, z_j \in \{0, 1\} \end{aligned}$$

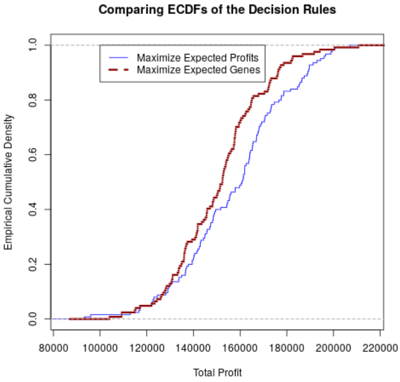
Maximize Weighted Number of Genes

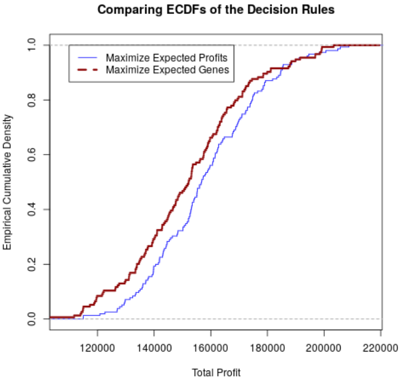
This is what snake breeders actually do, and I implemented it as follows:

$$\begin{aligned}
\max_{\mathbf{X},\mathbf{y},\mathbf{z}} & \left\{ \sum_{i \in I} \mathbf{g}_i \mathbf{x}_i^T \right\} \\
s.t. \quad & \mathbf{X}\mathbf{1}_J \leq 5\mathbf{1}_I \\
& \mathbf{X}^T\mathbf{1}_I \leq \mathbf{1}_J \\
& \mathbf{X}\mathbf{1}_J \leq M\mathbf{y} \\
& \mathbf{X}^T\mathbf{1}_I \leq M\mathbf{z} \\
& \mathbf{y}^T\mathbf{1}_I + \mathbf{z}^T\mathbf{1}_J \leq 15 \\
& X_{ij}, y_i, z_j \in \{0, 1\}
\end{aligned}$$

Results Thus Far

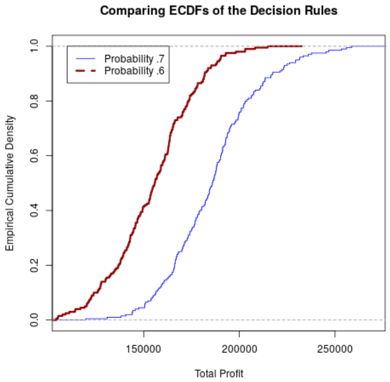
Show my decision rule is better





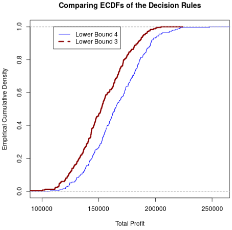
151096.2 152198.7 157535.2

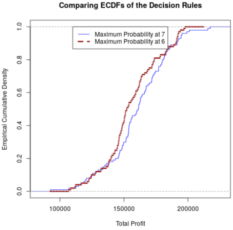
Probability of Clutch

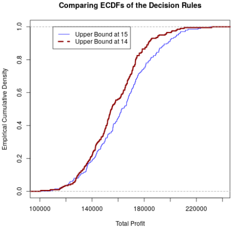


157535.2 186213

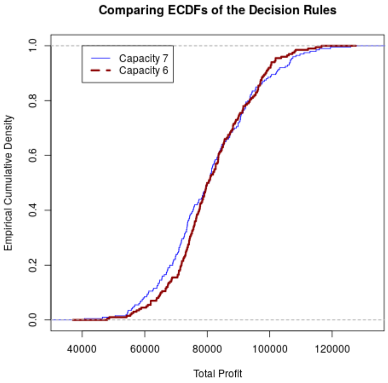
Distribution

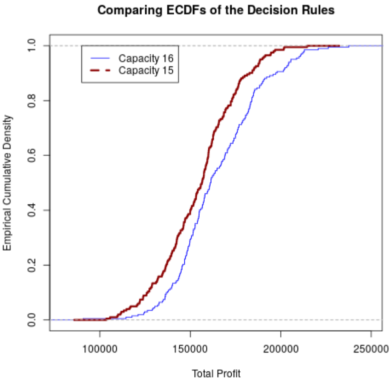






Capacity





80799.23 81569.97

154631.8 164730.1