Some tricks of the trade

1) Variable returns (works equally as well as variable costs)

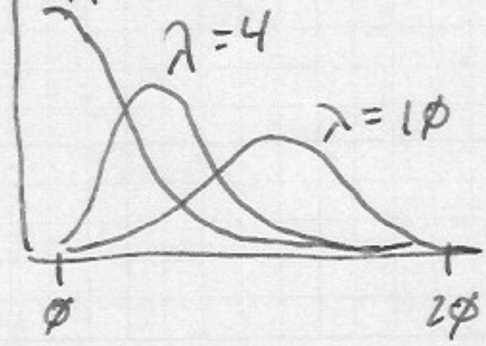
	Patch 1	2	3
Before, we had: $p=$	~~8~~ 1	3	5

let's assume that these are means of ~~probabi~~ a gain that follows so probability distribution

- We are exploring a landscape, and p scales with the number of encounters that we have with a particular food.

- The number of encounters within a particular period of time $\cancel{k}_i = \cancel{k}_i$ (M_i / m_i) follows a Poisson process where the probability is:

$$f_{M_i}(m_i \mid \lambda_i) = e^{-\lambda_i t} \frac{(\lambda_i t)^{m_i}}{m_i!}$$

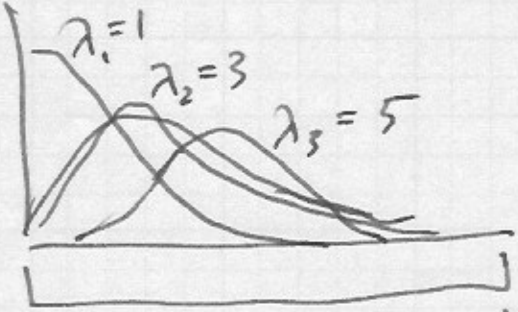


14.2

Say $p_i = (1, 3, 5)$ is the mean gain,
and each encounter results in +1 gain.

So gain ~ encounter, and $p_i \sim \lambda_i$

So:



$M_{max} = \cancel{40}\ 15$

Now we have to account for the probability of finding different gains during a foraging bout

patch 1

M_i		
0	0.36	dpois$(0, \lambda_1)$
1	0.36	dpois$(1, \lambda_1)$
2	0.18	dpois$(2, \lambda_1)$
3	0.06	
4	0.01	
5	⋮	
M_{max}		← goes to zero

Because we cut off prob$(M_i = m_i)$ @ $M_{max} = 15$, we have to ensure ~~that the~~ our revised probabilities sum to 1

$$\cancel{p_i(M_i = m_i)} \quad pr(M_i = m_i) = \frac{p_i}{\sum_{M_i=1}^{M_{max}} p_i}$$

14.3

Returning ~~to our~~ to our canonical equation, we have

$$S(x,t) = \max_i \Big\{ (1-d_i) f_i S(x - c_i + p_i, t+1) + (1-d_i)(1-f_i) S(x - c_i, t+1) \Big\}$$

Survival probability @ x from $t = t \to T$ if 1) Don't die, AND find food

OR 2) Don't die, AND find $\emptyset$ food

we want: 1) Don't die, AND find food w/ m_1 value

OR 2) Don't die, AND find food w/ m_2 value

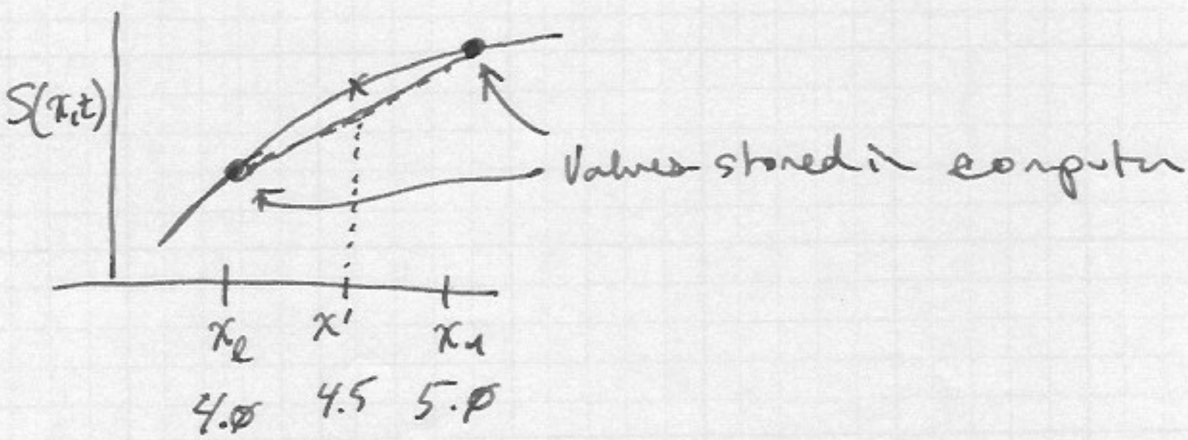
⋮

etc.

$$S(x,t) = \max_i \left\{ (1-d_i) \sum_{m=\emptyset}^{M_{max}} pr(M_i = m_i)\, S(x - c_i + m_i, t+1) \right\}$$

14.4 Now consider Noninteger states

- p_i is not an integer...!



x_e = integer part of x' $\quad$ floor(x')

- Make sure $x_e > x_c$

$x_u = x_e + 1$ $\quad$ floor(x') + 1

If diff(x_u, x_e) is small, we can assume x' falls on the line in between

$(x_u - x_e)^2$

= Linear interpolation

$q_x = x' - x_e$ $\quad$ weight x_u, x_e based on q_x

$$S(x', t) = q_x S(x_u, t) + (1 - q_x) S(x_e, t)$$

A new interpretation: Per-period fitness

- When patch i is visited, state changes as before, but in addition, there is a contribution to total ~~prey~~ reproduction $\psi_i(x)$

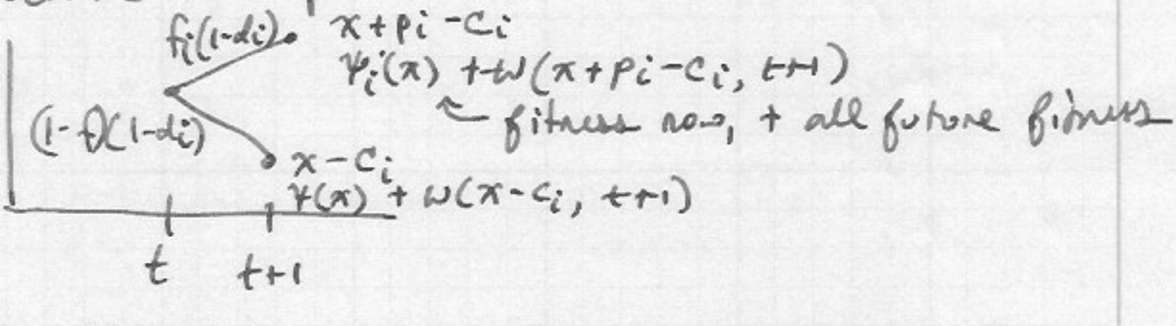
$W(x,t)$ = maximum expected (own patches; stochastic events of survival, finding food) accumulated fitness btw t and T given that $X(t) = x$

Sum of fitness gains by visiting patches

if T = last chance to accumulate fitness then $W(x,T) = \max_i \psi(x)$

if $T-1$ = last chance, then $W(x,T) = \phi$

Patch structure + reproduction



$$W(x,T) = \max_i \psi_i(x)$$

$$W(x,T) = \phi \text{ if } x \le x_c \text{ for all } t$$

$$W(x,t) = \max_i \Big[d_i \psi_i(x) + (1-d_i) f_i \{\psi(x) + W(x+p_i-c_i, t+1)\} + (1-d_i)(1-f_i)\{\psi(x) + W(x-c_i, t+1)\}\Big]$$

14.6

After Algebra:

$$= \max_i \Big[\psi(x) + (1-d_i) f_i \{ W(x + \rho_i - c_i, t+1) \} + (1-d_i)(1-f_i) W(x - c_i, t+1) \Big]$$

$\frac{\text{[illegible]}}{15.1}$

$$W(x,T) = \max_i \psi_i(x)$$

$\hookrightarrow i^*(x,T)$

$Q(x,t)$ = expected accumulated ~~p~~ reproduction between t & T for an organism always going to patch $\underline{i^*(x,T)}$ ~ denote i^*

What is $Q(x,T)$?

$$Q(x,T) = \psi_{i^*}(x)$$

$$Q(x,t) = \psi_{i^*(x,T)} + d_{i^*(x,T)} \cdot \emptyset + (1-d_{i^*(x,T)}) f_{i^*(x,T)}$$
$$\times Q(x + p_{i^*(x,T)} - c_{i^*(x,T)}, t+1)$$
$$+ (1-d_{i^*(x,T)})(1-f_{i^*(x,T)}) Q(x - c_{i^*(x,T)}, t+1)$$

$\frac{W(x,1)}{Q(x,1)} \geq 1$ if close to 1, not much selection pressure for optimal decision-making

Maybe we should consider some cost of cognitive load.

Compare $Q(x,1)$ with $W_\delta(x,t)$

$$W_\delta(x,t) = \max_i \Big[\psi_i(x) + (1-d_i)(1-f_i) W_\delta(x - c_i - \delta + p_i, t+1)$$
$$+ (1-d_i)(1-f_i) W_\delta(x - c_i - \delta, t+1) \Big]$$

where $W_\delta(x,1) \gtrless Q(x,1)$

depending on δ

where $\min(\delta)$ where $W_\delta(x,1) > Q(x,1)$ is the max. cognitive load that would support evolution of optimal decision making

15.2 Random patch Selection

$R(x,t)$ = accumulated reproduction from $t \to T$
given $X(t) = x$ and <u>Random</u> patch choice

~ equal prob of choosing any patch

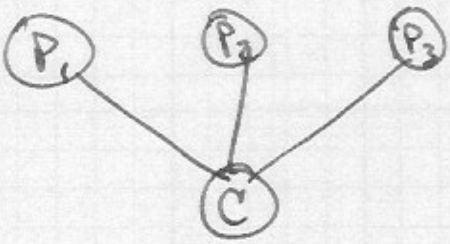
$$R(x,T) = \frac{1}{3} \sum_i \psi(x) + \text{B.C.}$$

$$R(x,t) = \frac{1}{3} \Big\{ \sum_i \Big[\psi(x) + (1-d_i) f_i R(x+p_i-c_i, t+1) + (1-d_i)(1-f_i) R(x-c_i, t+1) \Big] \Big\}$$

Now compare $W(x,1)$ $Q(x,1)$ $W_S(x,1)$, $R(x,1)$

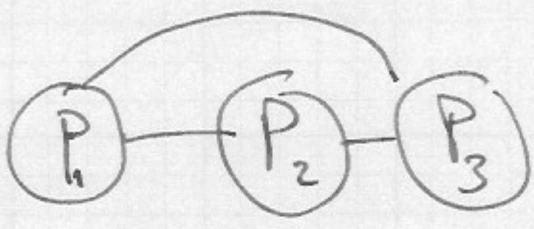
Now suppose we want to model movement rules into patches

Before



state: energy
x

Now



state: energy
x
where you are
+ where you are going S

(x, S)

d_{ij} = cost of mortality while travelling from patch i to j

c_{ij} = cost of moving from patch i to patch j

15.3

$$W(x, i, T) = \max_j \; \psi_j (x - c_{ij})(1 - d_{ij})$$

$$W(x, i, T) = \max_j \Big[\psi(x - c_{ij}) \cancel{+ (1-d_{ij})(1-d_j) f_j}$$

$$+ (1-d_{ij})(1-d_j) f_j W(x - c_{ij} - c_j + p_j, j, t+1)$$

$$+ (1-d_{ij})(1-d_j)(1-f_j) W(x - c_{ij} - c_j, j, t+1) \Big]$$

Nowe we will have a $(x_{max} - x_c) \times (\# \text{patch}) \times T$ array

for W

& D