What is the best way to forage in patches?

Readings for today

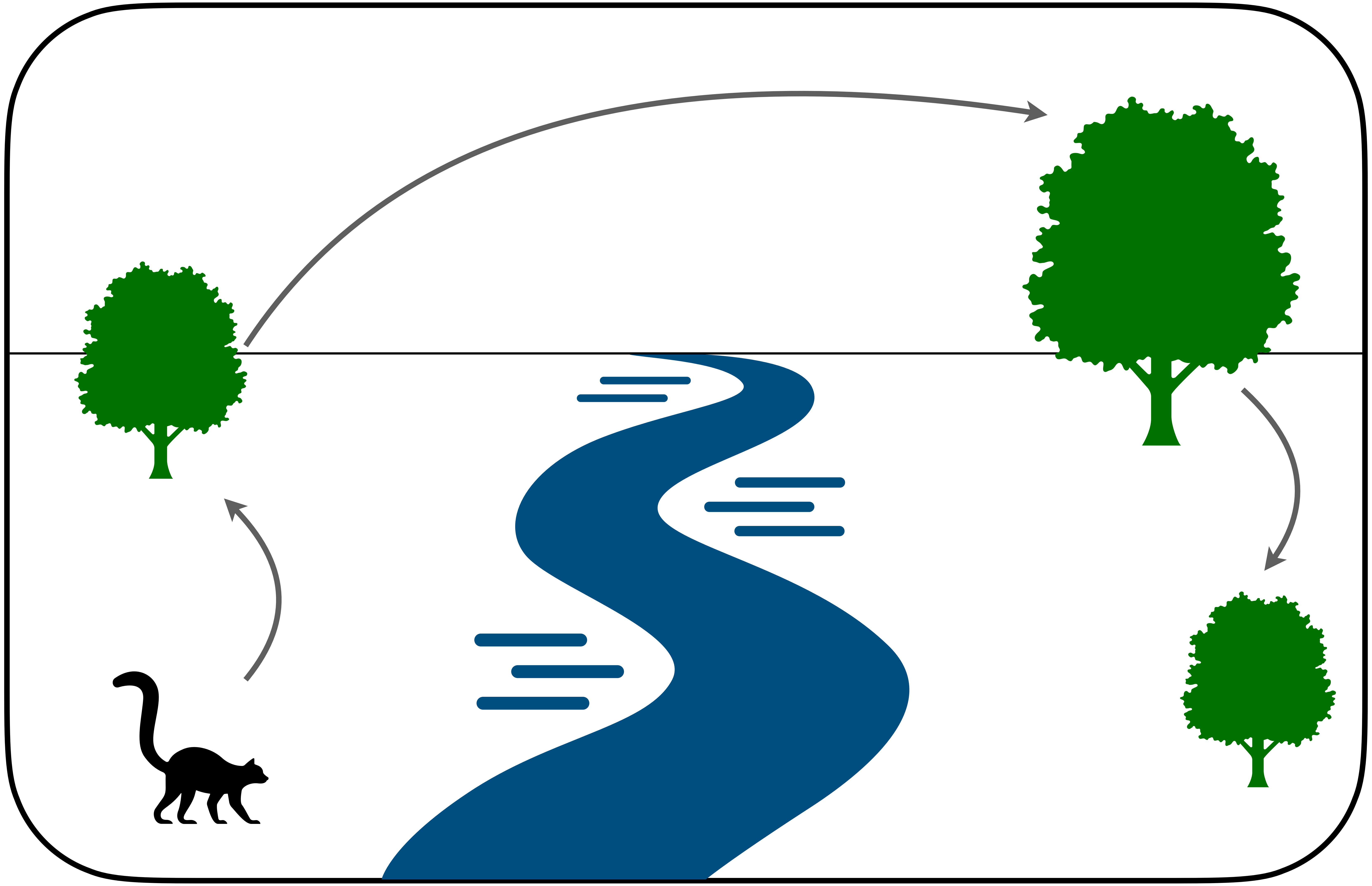
- Charnov, E. L. (1976). Optimal foraging, the marginal value theorem. Theoretical population biology, 9(2), 129-136.

Topics

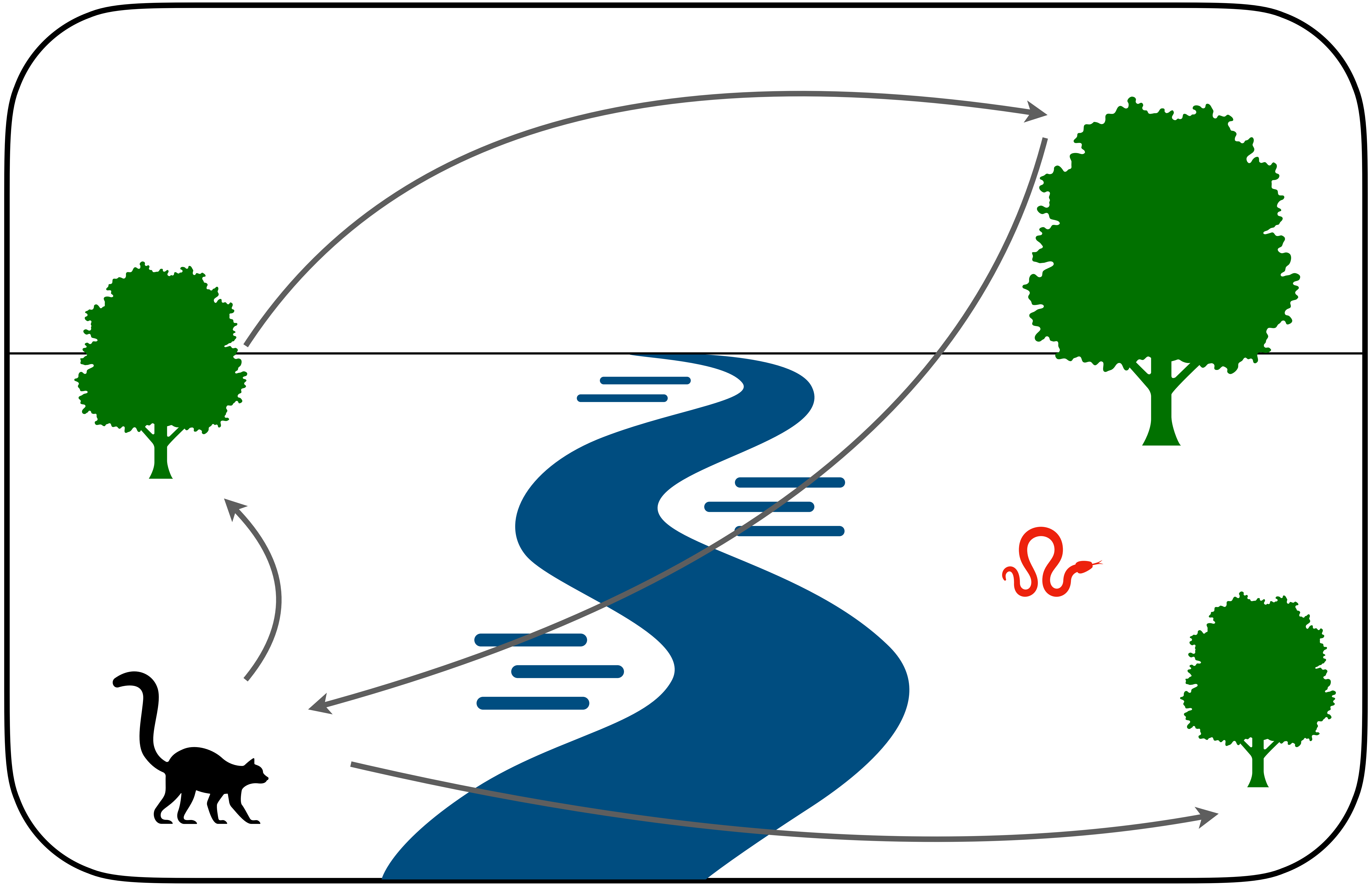
- Marginal value theorem

Marginal value theorem

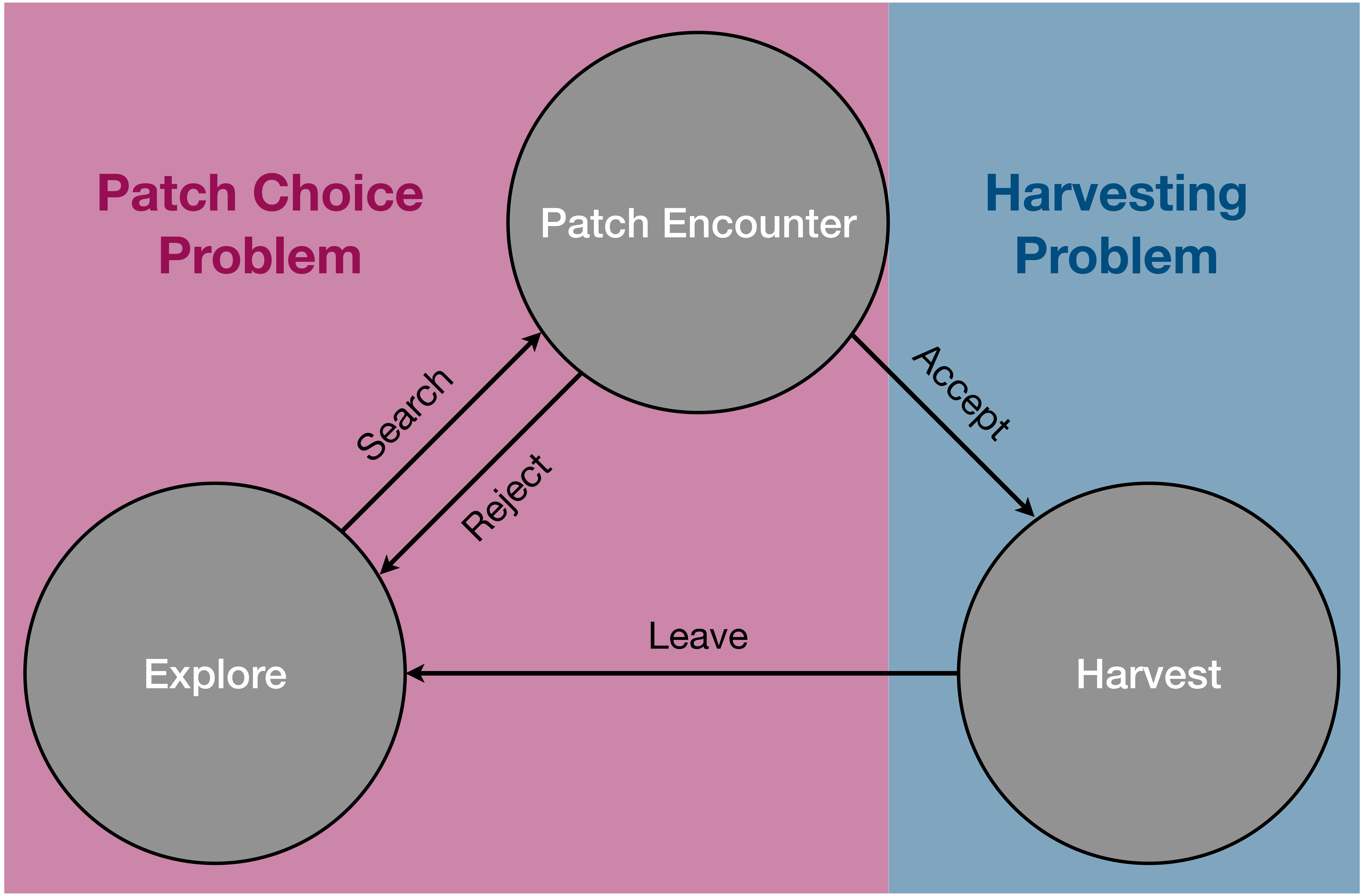
The foraging problem



The foraging problem

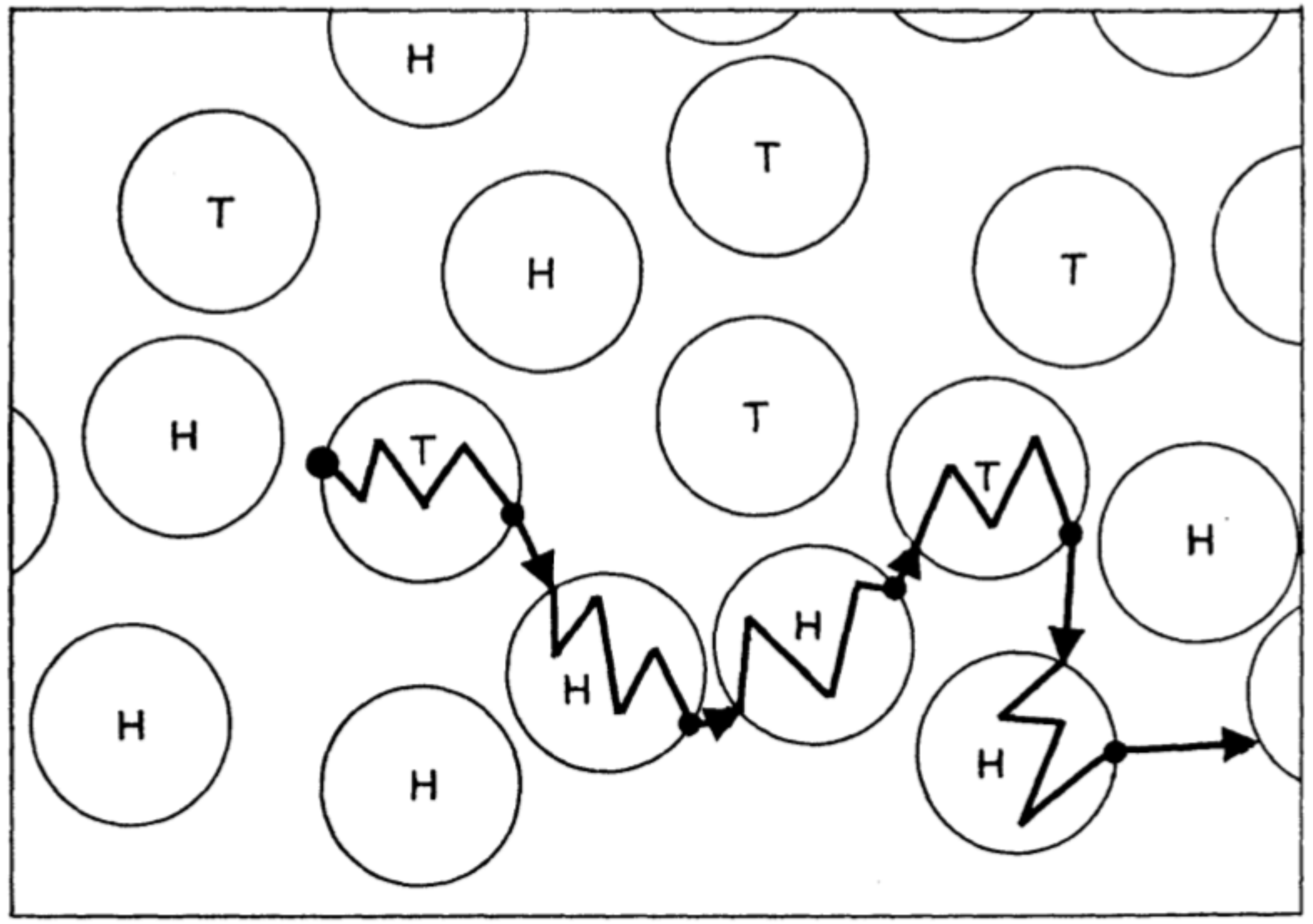


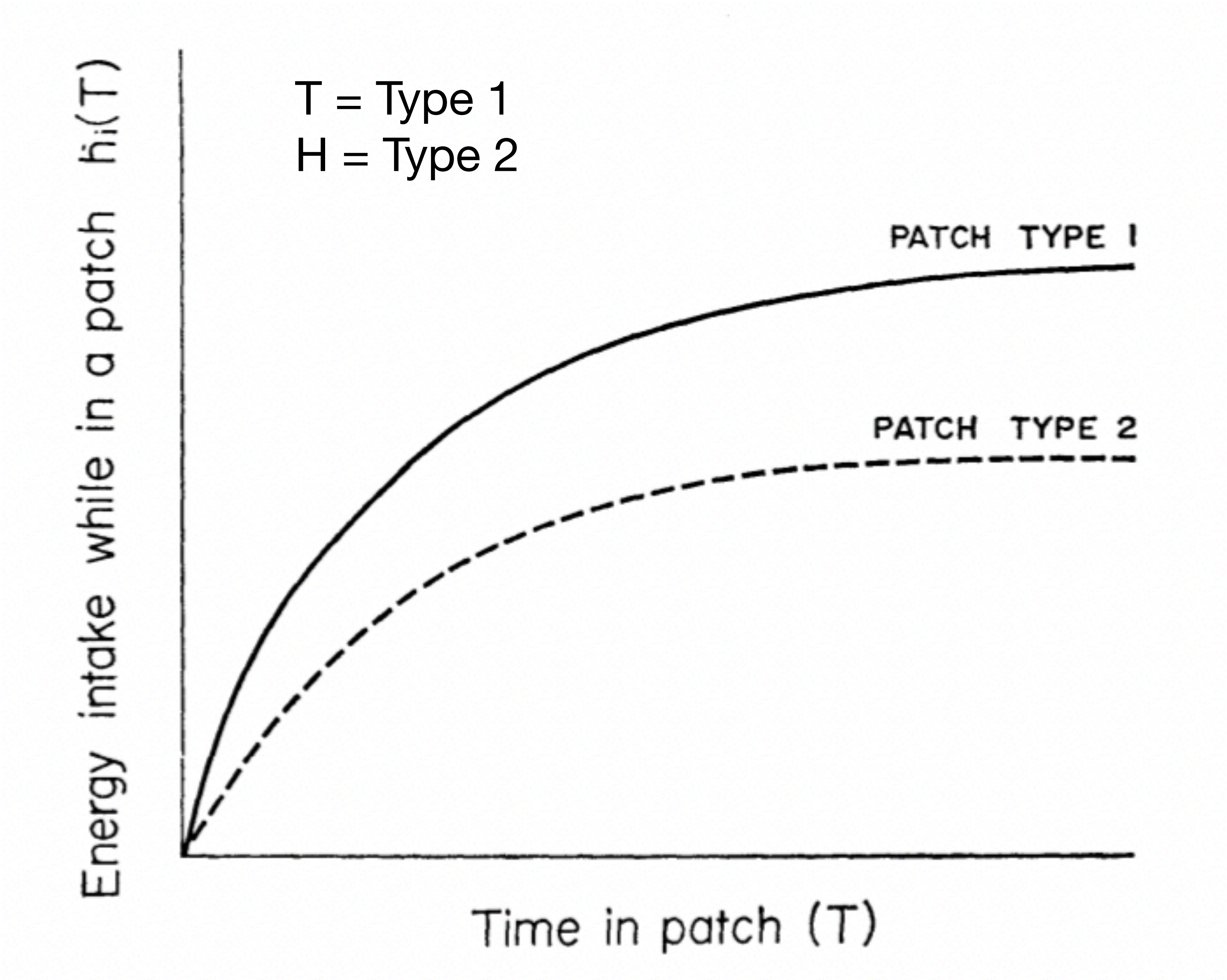
The patch foraging problem



(Barack 2024)

Foraging tasks





Since patches are limited resources within the timescale of foraging, there is an energy cost for staying on a single patch for too long (i.e., energy acquired < energy burned)

(Charnov 1976)

The foraging problem

Patch use model

- P_i = proportion of visited patches of type i
- E_T = energy cost per unit time in traveling between patches
- E_{si} = energy cost per unit time while searching in a patch of type i
- $h_i(T)$ = energy from hunting for T time in patch type i
- $g_i(T) = h_i(T) - E_{si} \cdot T$ = total energy corrected for cost of search

Average time to use one patch

- t = interpatch travel time
- $T_u = t + \sum P_i \cdot T_i$

Patch time in type i

Average energy from a patch

- $E_e = \sum P_i \cdot g_i(T_i)$

Net energy (E_n)

$$E_n = \frac{E_e - t \cdot E_T}{T_u} = \frac{\sum P_i \cdot g_i(T_i) - t \cdot E_T}{t + \sum P_i \cdot T_i}$$

Optimal energy use

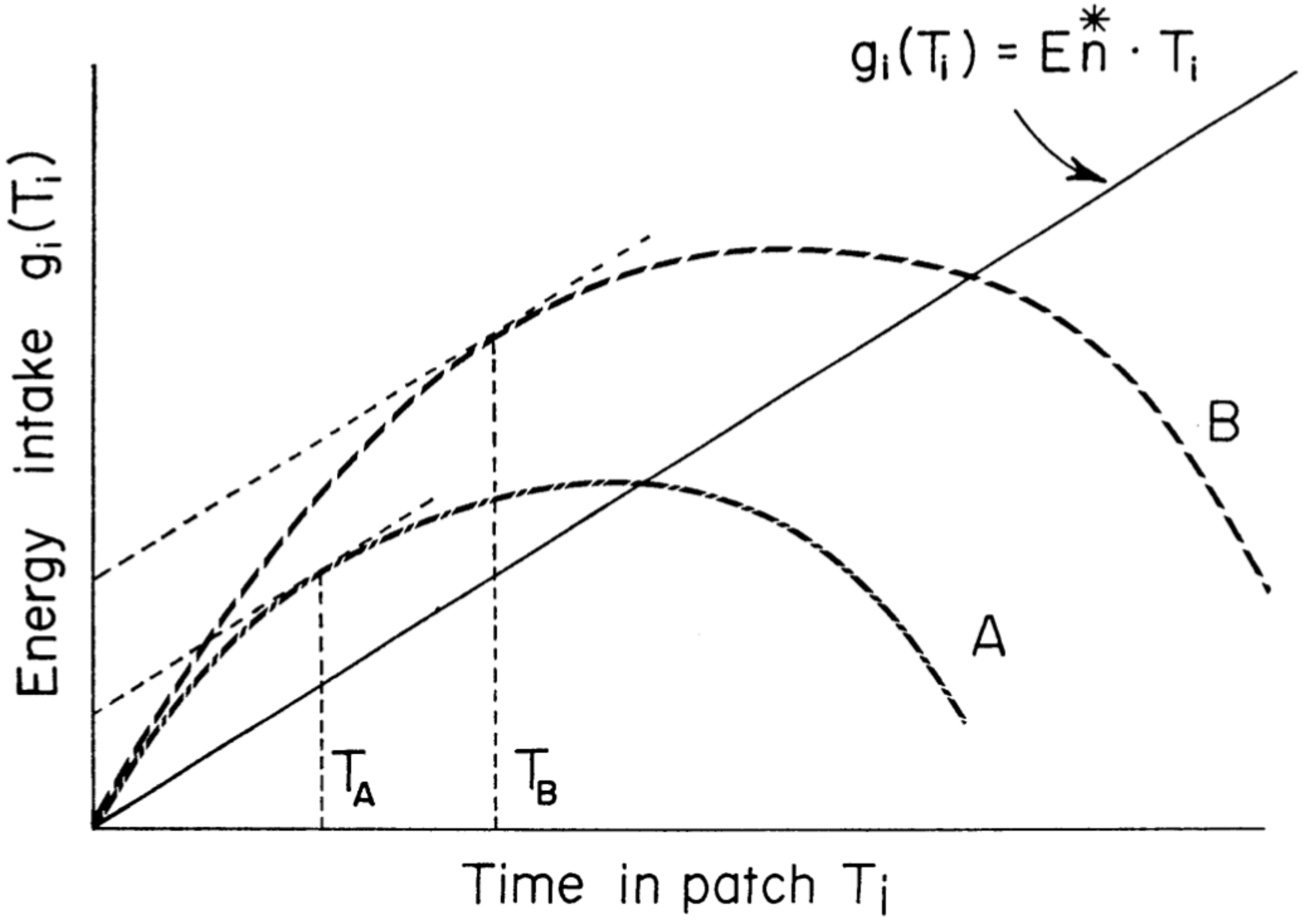
$$\frac{\delta g_j(T_j)}{\delta T_j} = E_n^*$$

Leave patch j when the marginal capture rate in the patch ($\delta g_j(T_j)/\delta T_j$) drops to the average capture rate for the habitat.

Solve for
$\delta E_n/\delta T_j = 0$

(Charnov 1976)

Marginal value theorem



The optimal strategy for foraging is one that maximizes gain per unit time when resources, as well as rate of returns, decrease with time.

(Charnov 1976)

Take home message

- The Marginal Value Theorem provides an optimal solution to the foraging problem when energy costs and energy capture rates are known.

Lab time!

https://coaxlab.github.io/BIX-book/notebooks/lab8-patch_foraging.html