

What is the best way to forage in patches?

Readings for today

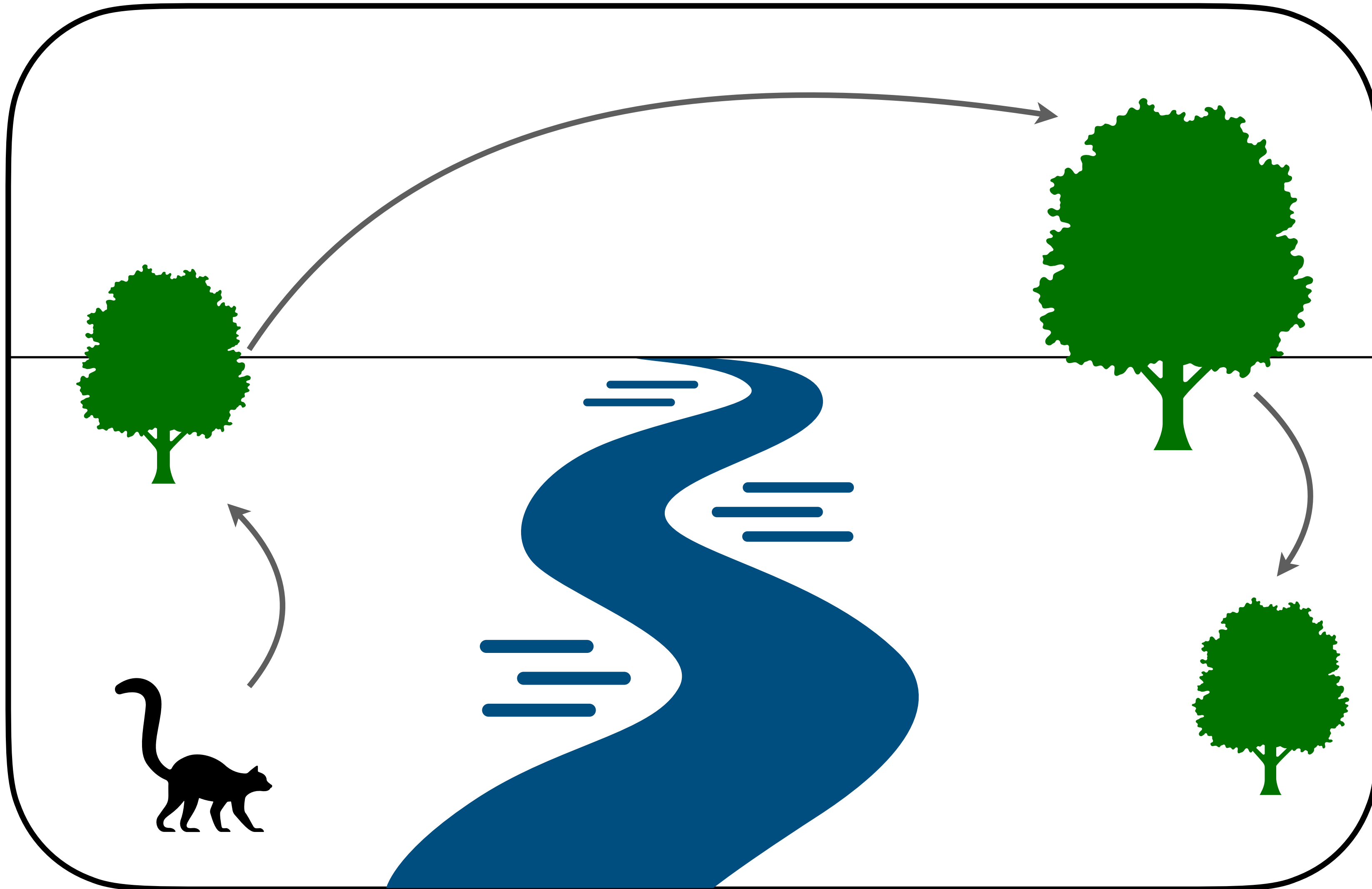
- Charnov, E. L. (1976). Optimal foraging, the marginal value theorem. *Theoretical population biology*, 9(2), 129-136.

Topics

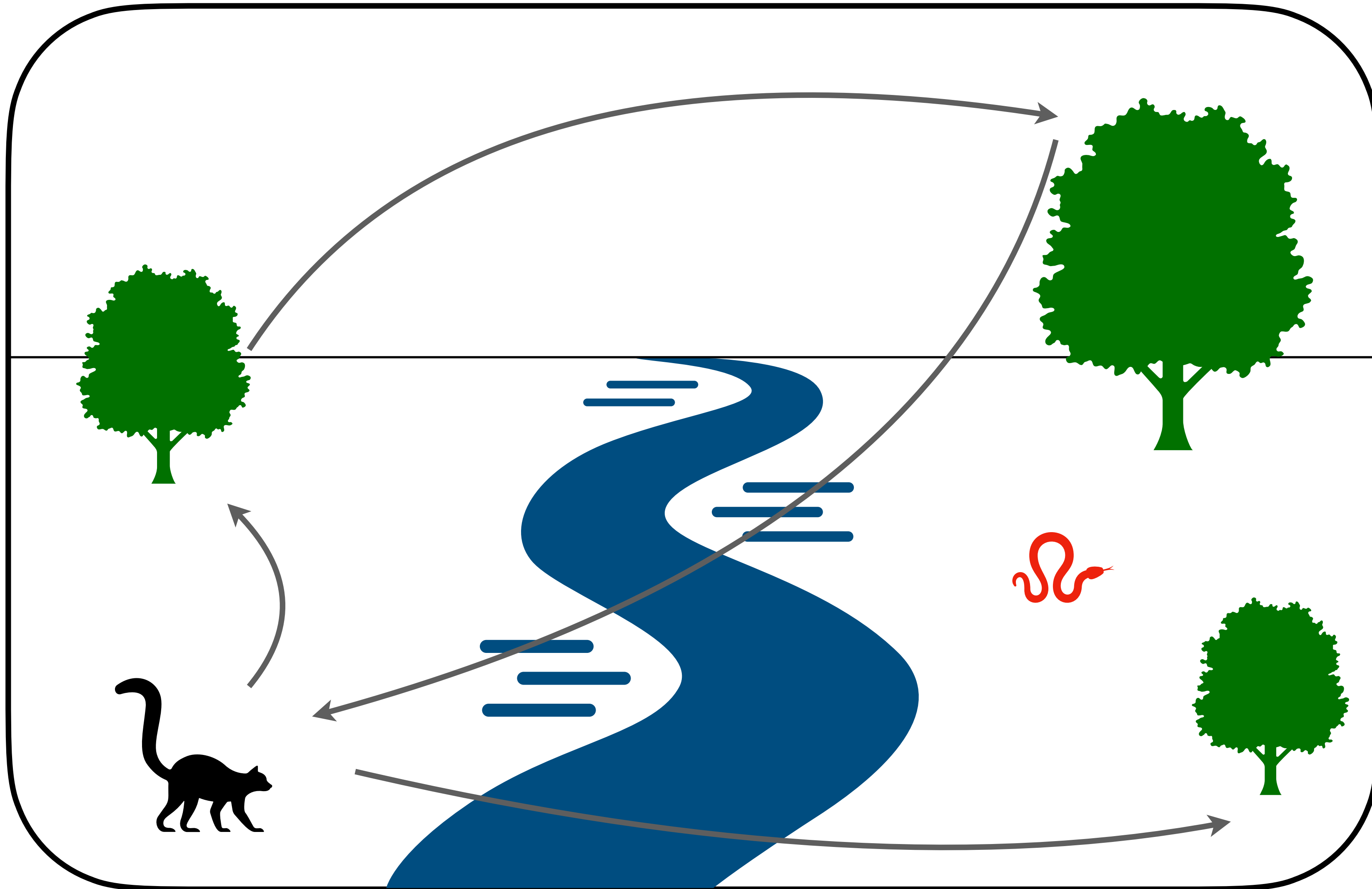
- Marginal value theorem

Marginal value theorem

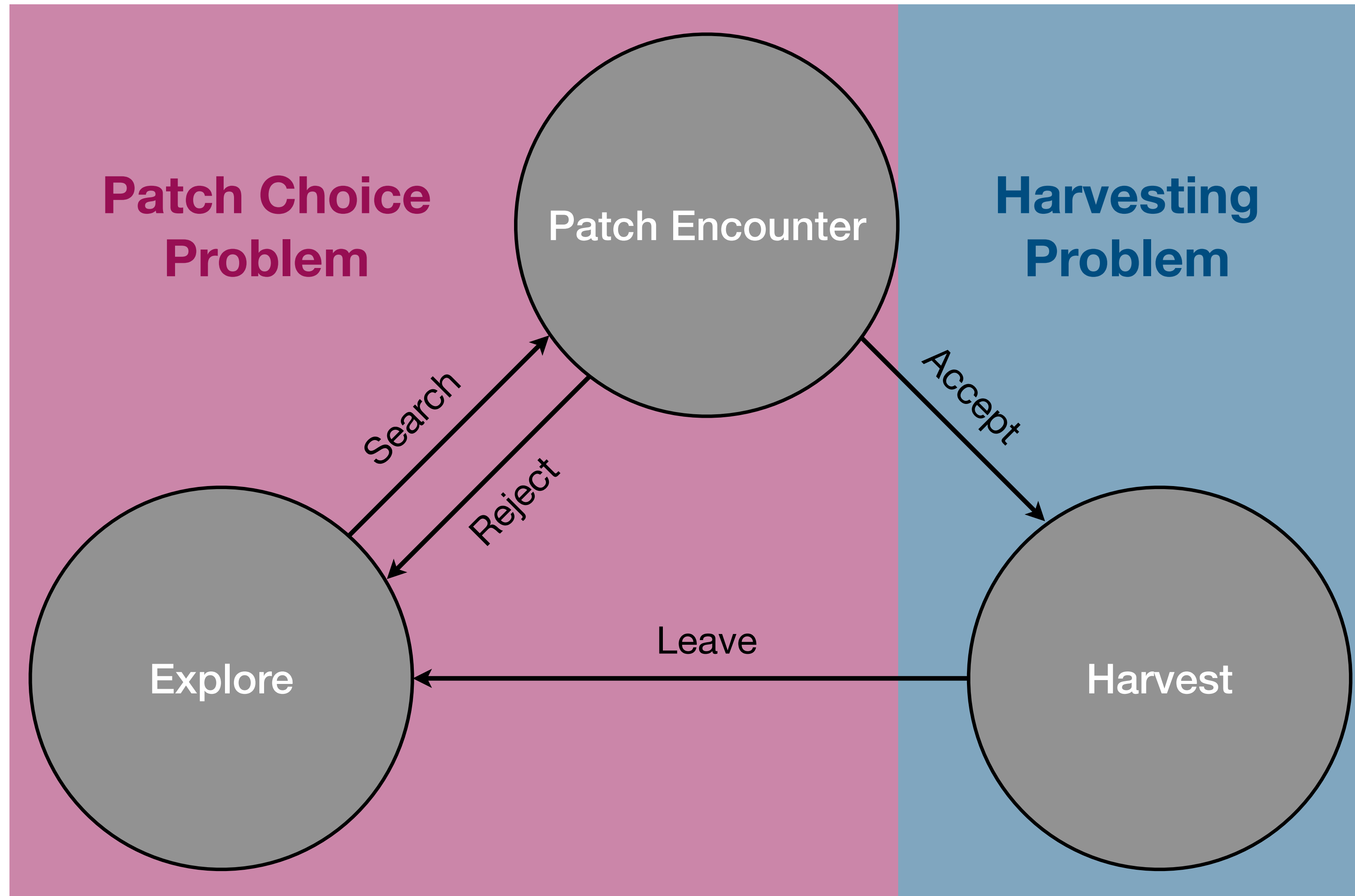
The foraging problem



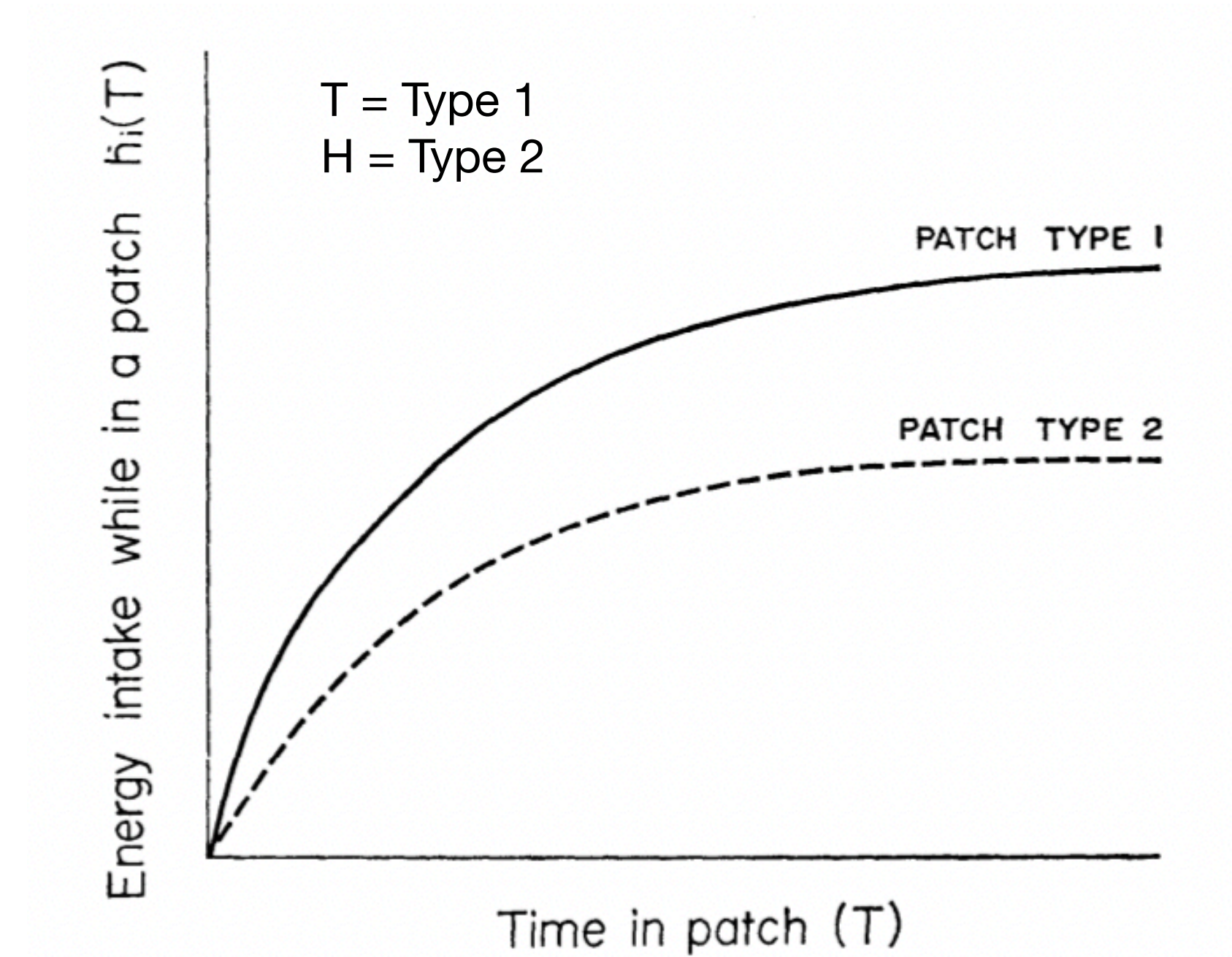
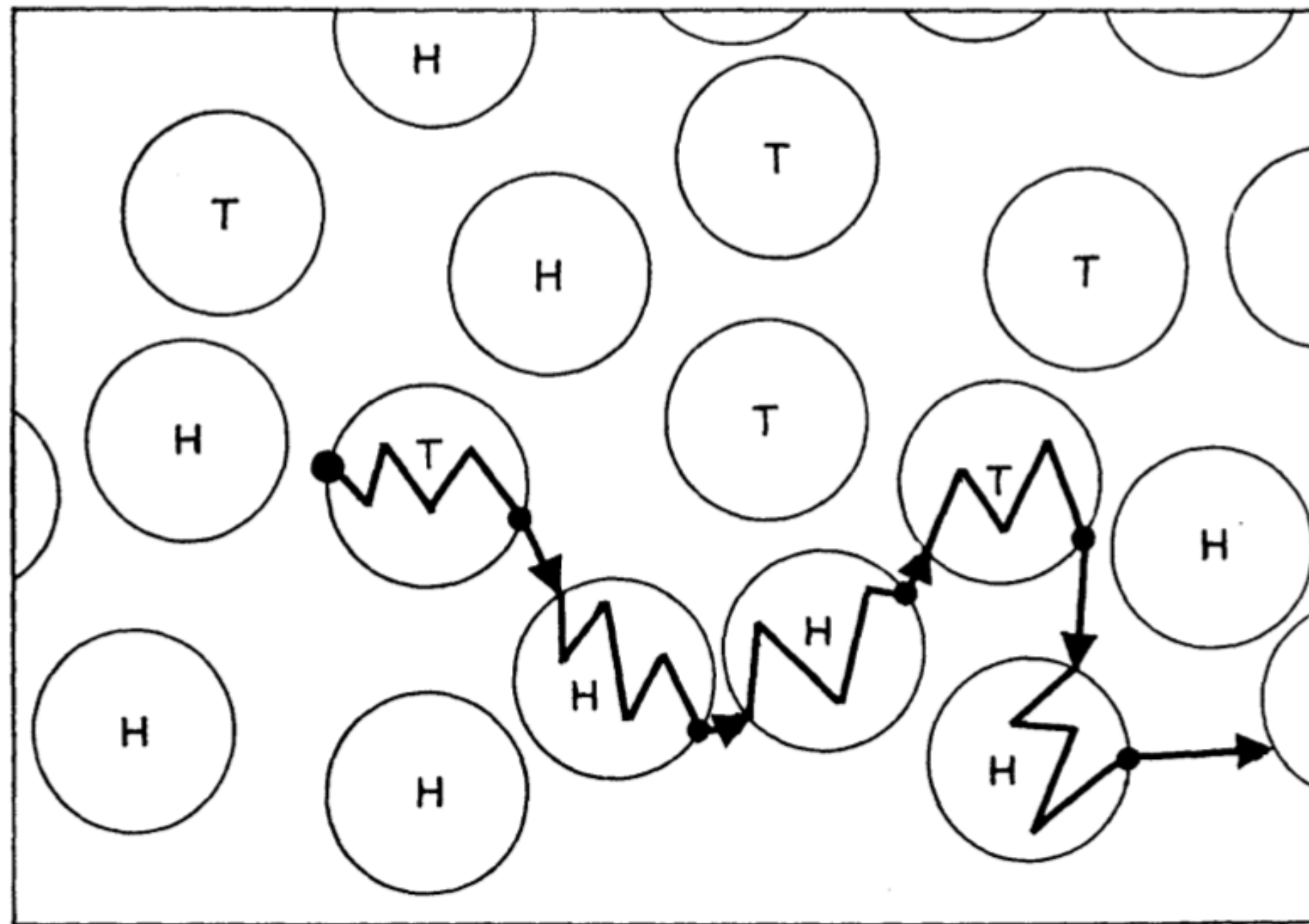
The foraging problem



The patch foraging problem



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)

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)

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

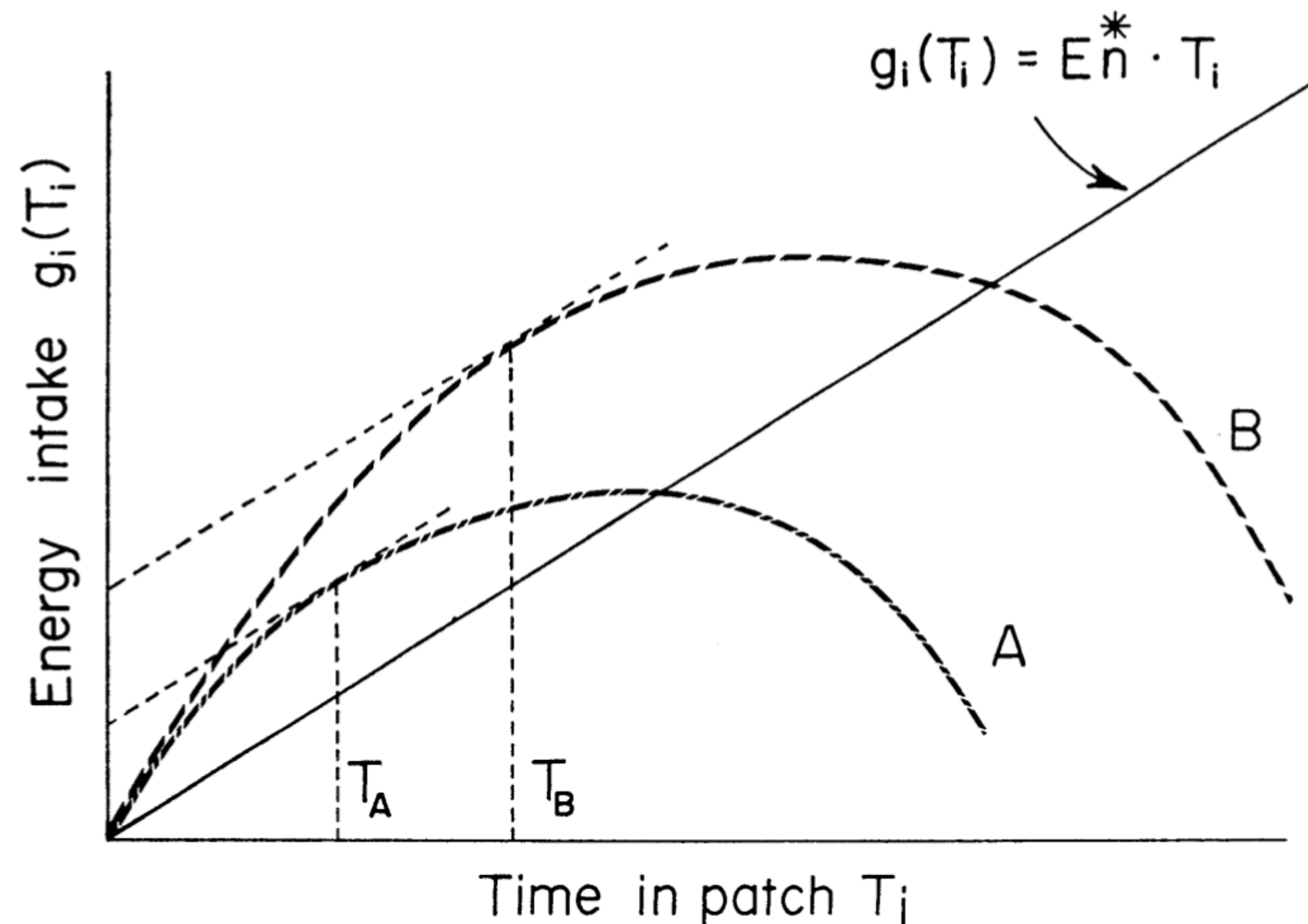
Optimal energy use

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

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
 $\delta E_n / \delta T_j = 0$

Marginal value theorem



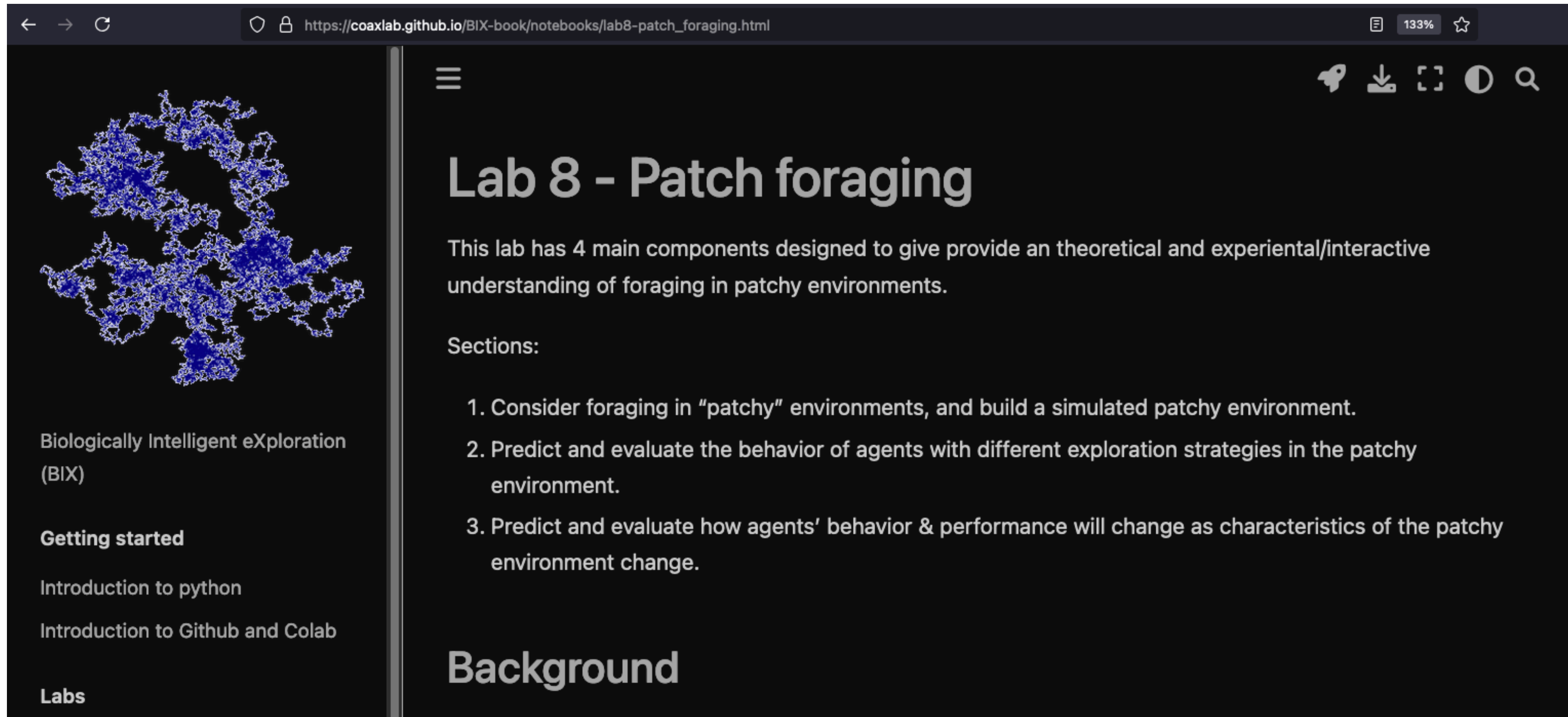
The optimal strategy for foraging is one that maximizes gain per unit time when resources, as well as rate of returns, decrease with time.

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



The screenshot shows a web browser displaying the 'Lab 8 - Patch foraging' page from the BIX book. The browser's address bar shows the URL https://coaxlab.github.io/BIX-book/notebooks/lab8-patch_foraging.html. The page has a dark theme. On the left is a sidebar with a blue fractal image and a list of links: 'Biologically Intelligent eXploration (BIX)', 'Getting started', 'Introduction to python', 'Introduction to Github and Colab', and 'Labs'. The main content area has a title 'Lab 8 - Patch foraging', a paragraph stating 'This lab has 4 main components designed to give provide an theoretical and experiential/interactive understanding of foraging in patchy environments.', a 'Sections:' heading, and a list of three numbered items. At the bottom of the main area is the heading 'Background'.

← → ↻ https://coaxlab.github.io/BIX-book/notebooks/lab8-patch_foraging.html 133% ☆

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Lab 8 - Patch foraging

This lab has 4 main components designed to give provide an theoretical and experiential/interactive understanding of foraging in patchy environments.

Sections:

1. Consider foraging in “patchy” environments, and build a simulated patchy environment.
2. Predict and evaluate the behavior of agents with different exploration strategies in the patchy environment.
3. Predict and evaluate how agents’ behavior & performance will change as characteristics of the patchy environment change.

Background

Biologically Intelligent eXploration (BIX)

Getting started

Introduction to python

Introduction to Github and Colab

Labs