Today

- Optimal foraging
- Intro to least squares
Foraging time includes
- a commute \((t_0 \rightarrow \text{constant})\),
- a visit to each patch \((t_p)\)
Foraging success is characterized by $f(t_p) = \text{resource collected from a single patch after a time } t_p \text{ spent in the patch.}$

Remember the definition of $f(t_p)$ for an upcoming clicker Q.
Which of the following graphs matches the given description of $f(t)$?

Collection goes well at first but gradually slows down as the resource is depleted.
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It is initially hard to find nuts but gets easier with time. Eventually, there are none left to collect.

(A)  
(B)  
(C)  
(D)  
(E)
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Foraging

What to maximize?

- Total amount collected?
  - Stay in a patch forever.
- If you can move to a new patch, move when the returns diminish enough to make the new patch look better.
  - Leave right away!
- Maximize average rate of collection.

Don’t forget travel time!
Foraging

I waited

(A) not long enough.
(B) just the right amount of time.
(C) too long.

\[
R(t) = \frac{\text{food}(t) - \text{food}(0)}{t - 0}
\]

Choose \( t \) to maximize \( R(t) \).
Foraging
Foraging

food

$t$
Foraging
Foraging
Foraging

Max average rate occurs when orange line is tangent to yellow.
Foraging

\[
\text{food}(t) = \begin{cases} 
0 & \text{for } 0 \leq t \leq t_0 \\
\text{f}(t-t_0) & \text{for } t > t_0
\end{cases}
\]

Average Rate of Collection

\[
R(t) = \frac{\text{food}(t) - \text{food}(0)}{t - 0}
\]

\(R(t)\) maximal at \(t_{\text{max}}\).

Optimal \(t_p = t_{\text{max}} - t_0\).

Could have maximized \(R(t_p+t_0) = \text{f}(t_p) / (t_p+t_0)\) to get best \(t_p\).
Least squares model fitting

How do we find the best line to fit through the data?
Least squares model fitting

Each red bar is called a residual. We want all the residuals to be as small as possible.

\[ y = ax \]
The residuals are...

(A) \( r_i = y_i^2 + x_i^2 \)
(B) \( r_i = a^2 (y_i^2 + x_i^2) \)
(C) \( r_i = y_i - ax_i \)
(D) \( r_i = y_i - x_i \)
(E) \( r_i = x_i - y_i \)
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