Lecture outline

- Feedback loops in behavioral dynamics

Behavioral dynamics

- How did you make decisions?
  - What was your thought process?
  - How would you classify your decision-making progress in terms of the four types of policies introduced earlier?
    - Myopic policy
    - Lookahead
    - Policy function approximation (which kind?)
    - Policy based on value function approximation

Behavioral dynamics

- A common policy structure is called **anchor** and **adjustment**:
  - **Anchor**: A fixed action, possibly based on a ***plan*** (a set of actions based on a particular set of future events or an expected system state).
  - **Adjustment**: Changes made to the "anchor" based on deviations from planned future events or deviation from an expected system state.

Behavioral dynamics

- What information did we have?

Physical state:

$R(t)$ = Current inventory (or backorder if $R_t < 0$) at time t

Activity variables:

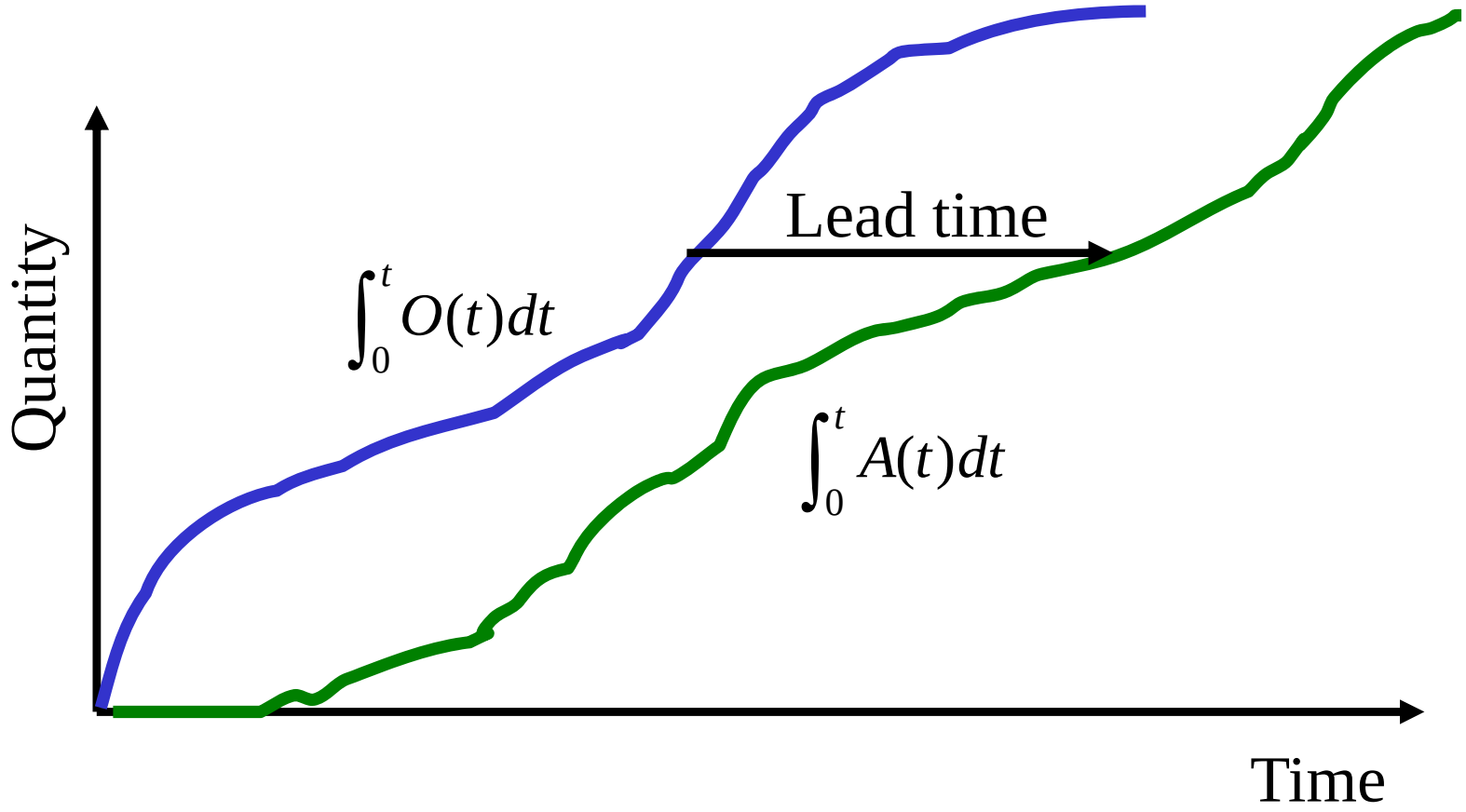
$A(t)$ = Arrival rate

$L(t)$ = Loss rate

$O(t)$ = Order rate

$R^{transit}(t)$ = In-transit inventory (inbound)

Behavioral dynamics



$$R(t) = \int_0^t \big(A(t) - L(t)\big)dt + R(0) = \text{ Current inventory}$$

$$R^{transit}(t) = \int_0^t \big(O(t) - A(t)\big)dt + R^{transit}(0) = \text{ Supply line}$$

Behavioral dynamics

- Observation:
  - » If there was no lead time (and no fixed order cost), what would you do?

$$\tilde{O}(t) = \text{"Indicated order rate" (how much you should order)}$$
$$= L(t-1) \quad \text{(i.e. order what you lost in the previous time period)}$$

  - » Why would you do otherwise?
    - Uncertainties in order lead times?
    - Need to build up larger buffer inventory?
    - Anticipation of higher demand?
    - Current stock under/over what you think you need?

We need to make "adjustments" to our basic model.

Behavioral dynamics

- Refining our model:
  - » Behavioral strategy - anchor and adjustment (Tversky)
    - Anchor - Create a known reference point
    - Adjustment - Change based on position relative to the anchor.
  - » Let:

$$\tilde{L}(t) = \text{Perceived loss rate}$$

$$\delta R(t) = \text{Adjustment to order based on current stock.}$$

$$\delta R^{transit}(t) = \text{Adjustment to order based on current supply line.}$$

  - » New behavioral model:

$$\tilde{O}(t) = \tilde{L}(t) + \delta R(t) + \delta R^{transit}(t)$$

  - » Since this may be negative, our new ordering model is:

$$O(t) = \left[\tilde{O}(t)\right]^{+}$$

Behavioral dynamics

- Calculating the perceived loss rate:
  - » Possible models:

Reactive:

$$\tilde{L}(t) = L(t-1)$$ Perceived loss equal to last period's actual loss.

Stable:

$$\tilde{L}(t) = L^*$$ Equal to a constant

Regressive expectations

$$\tilde{L}(t) = \gamma L(t-1) + (1-\gamma)L^*$$

Adaptive:

$$\tilde{L}(t) = (1-\gamma)\tilde{L}(t-1) + \gamma L(t-1)$$

Behavioral dynamics

- Adjustments:
  - » For current stock:

$$\delta R(t) = \alpha \left(R^* - R(t) \right)$$

where:

α = damping factor.

R^* = desired stock level (in itself a function)

$R(t)$ = current stock

  - » What is R^* a function of?

Behavioral dynamics

- Adjustments:
  - » For supply line:

$$\delta R^{transit}(t) = \alpha_{SL}\left(R^{transit*}(t) - R^{transit}(t)\right)$$

where:

α_{SL} = damping factor for the supply line.

$R^{transit*}(t)$ = desired supply line level (in itself a function).

$R^{transit}(t)$ = current supply line.

The target supply line might be:

$$R^{transit*}(t) = T^{lag}(t)P^{*}(t)$$

where:

$T^{lag}(t)$ = estimated time lag between order and arrival.

$P^{*}(t)$ = desired product throughput.

Behavioral dynamics

- Observation:
  - » Anchoring and adjustment is an exceptionally powerful model.
  - » General method:
    - Find an anchor by solving a simple version of the problem
    - Develop adjustment mechanisms based on available information.
  - » Examples:
    - What quantity to order (product, investment, energy storage)?
      - – Anchor – based on expectation
      - – Adjustment – over time, build up an idea of safety stock