UGBA 141
Discussion 10

Agenda:
- **Amazon Experience**
- **Little's Law**
- **Poisson and Exponential**
- **Supply Chain Recap**

April 1, 2022
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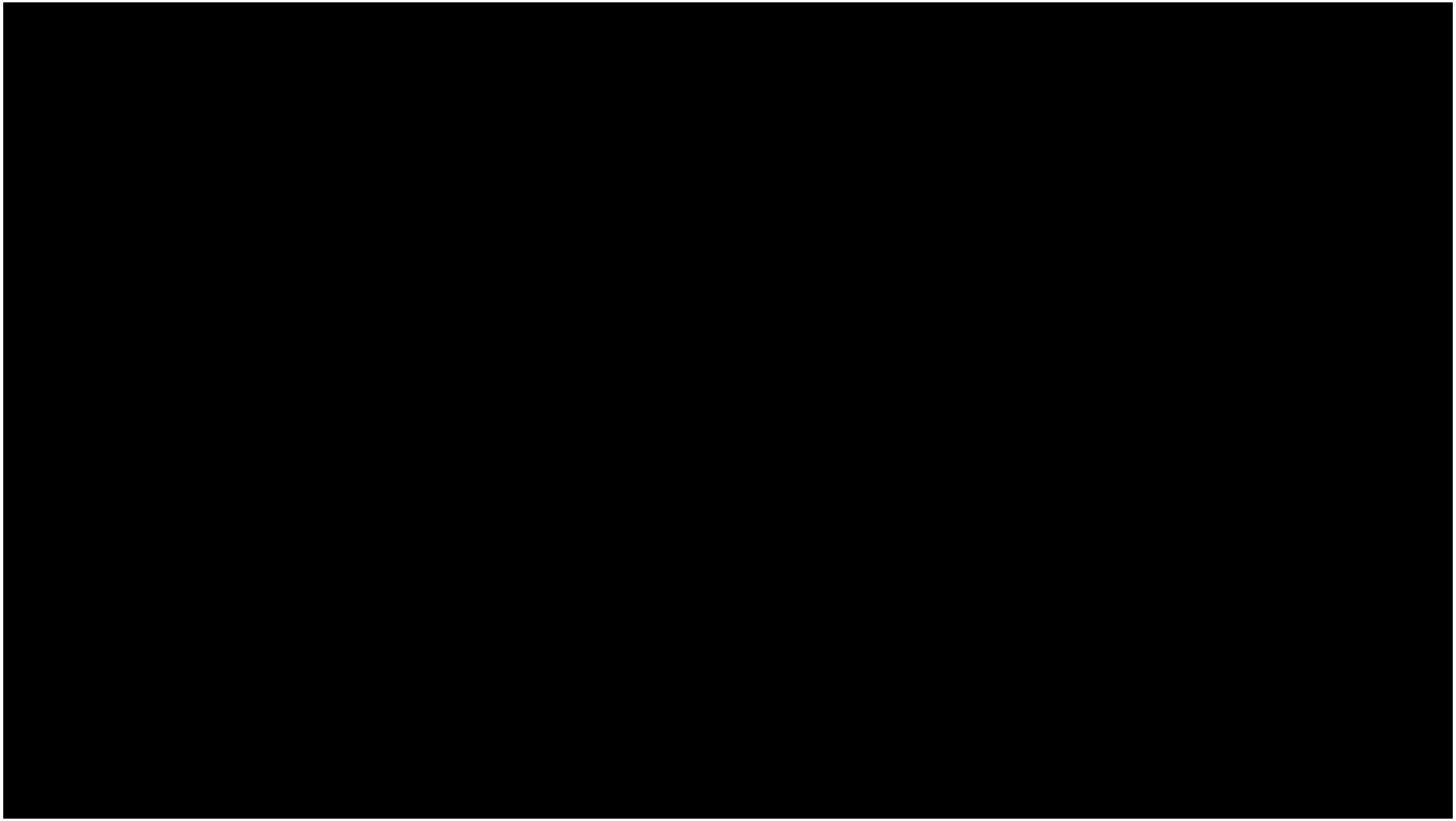
Reminder

- HW5 is out (only need to one of HW4 and HW5, can also do both: see grading policy on bCourses)
- Schedule the second team meeting with sponsors
- Project Brief Update due Sun 4/3
- Read Case “Rent the Runway” for Monday’s class
- Read about Littlefield simulation in bCourses/Files
- Sheet04_SupplyChain is available on bcourses
  - https://bcourses.berkeley.edu/courses/1510160/files/folder/Discussion%20Materials/Cheatsheets?preview=83022468

Amazon Supply Chain Optimization Technologies



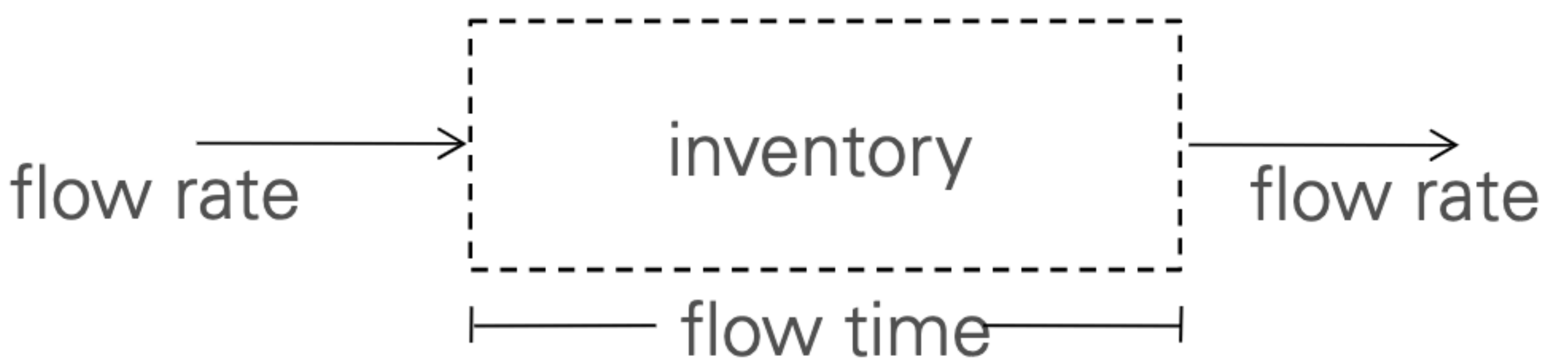
Video source: YouTube

Tech in Amazon

- Most customers think of Amazon as a retailing/logistics company
- What is the **Tech** behind the current practice of retailing/logistics that help Amazon generate more revenue while providing better service to customers?
- An important theme: **Data** -> **Decisions**
- Some examples
  - Personalized recommendations
  - Demand forecasting
  - Optimizing costs in logistics
- Check out https://www.amazon.science/ for more cool projects

Little's Law

average **Inventory (I)** (number of units in system) **=** average **flow rate (R)** (rate at which units enter and leave system) **x** average **flow time (T)** (time unit spends in system)



Little's Law Practice Problem I

Caller	Time in	Time Out	Time in process (min)
1	10:00	10:02	2
2	10:01	10:06	5
3	10:04	10:08	4
4	10:05	10:06	1
5	10:10	10:12	2

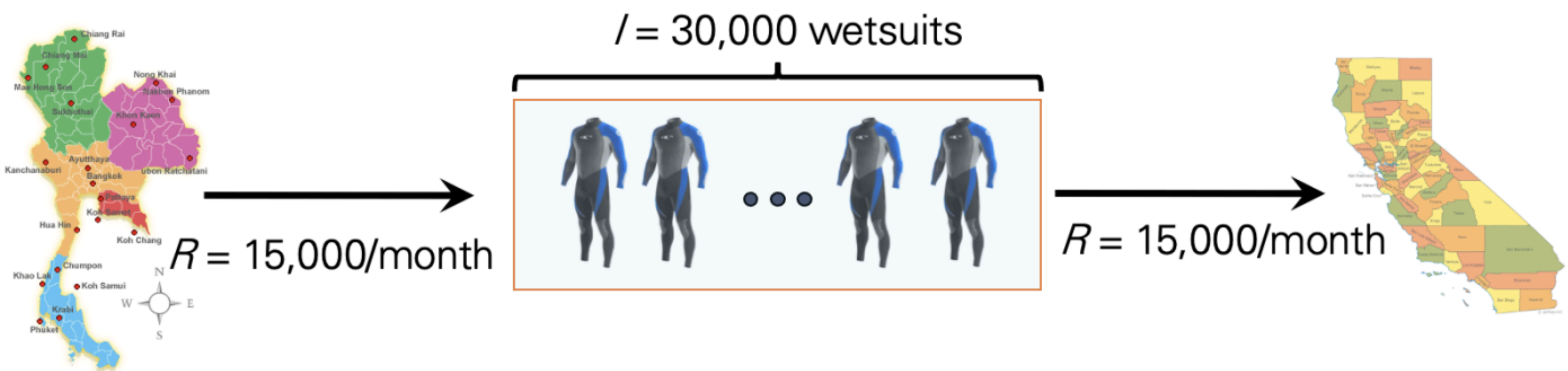
5 callers in 12 min

- Average flow rate R = 5/12 callers/min
- Average flow time T = (2+5+4+1+2)/5 = 14/5 min
- Average inventory I = R * T = 5/12 * 2.8 = 7/6 callers

Little’s Law Practice Problem II

SF-based O’Neill buys wetsuits from a supplier in Thailand:

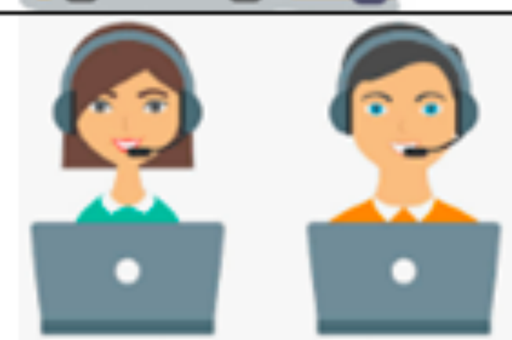
- Each month they order 15,000 wetsuits on average, $R = 15{,}000$
- On average, there are $I = 30{,}000$ wetsuits in transit from Thailand to SF



- Question: What is the annual inventory turns of wetsuits?
  - Hint: connect inventory turn with flow time
  - R = 15000 * 12 month/year = 180,000
  - T = I/R = 30,000/180,000 = 1/6 year = 2 month

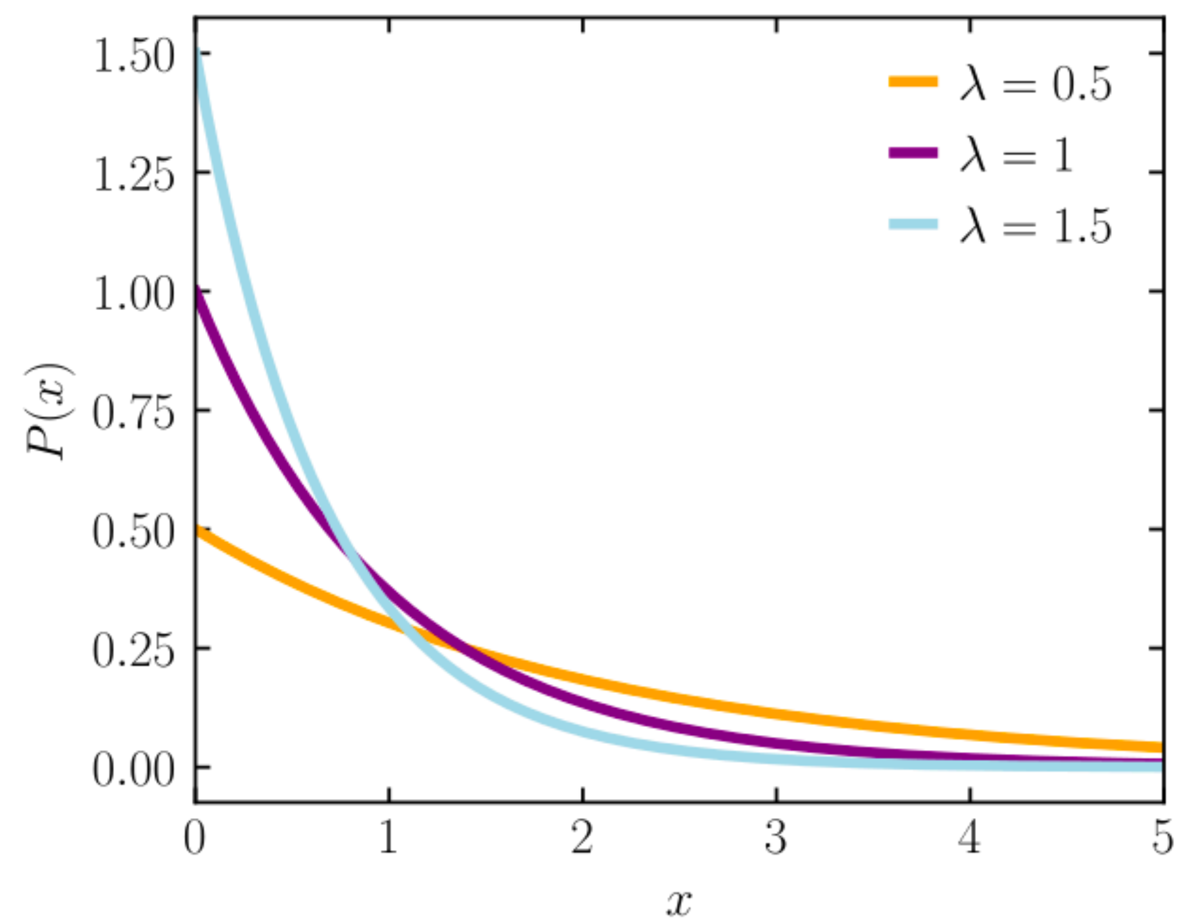
Preview: Poisson Distribution and Exponential Distribution

- Two useful random distributions that can model a number of objects in practice

Poisson Distribution		Exponential Distribution
Number of cars passing in a drive-thru in a hour		Number of minutes between car arrivals in drive-thru
Number of phone calls received in a call center in an hour		The time it takes for a call center executive respond to a caller
Number of machines breakdown in a month		Time between machine breakdown

Exponential Distribution

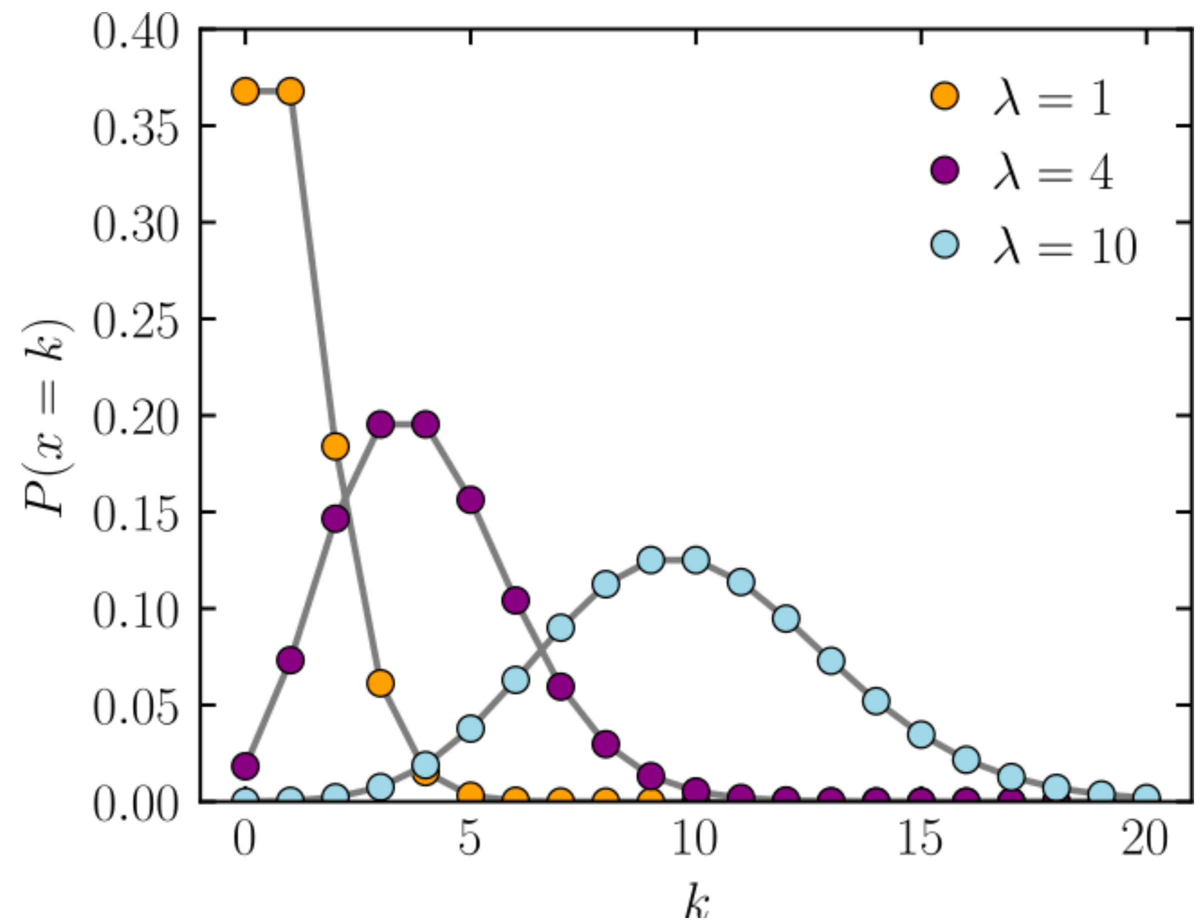
- A random distribution with parameter λ
  - Model the random time between two consecutive arrival of customers
  - Model the random service time
- Key properties
  - Mean = Std = $\frac{1}{\lambda}$ = **expected time**
  - Valued as nonnegative number
- Example in practice:
  - The time between two arrivals of passengers at the bus stop
  - The time between two phone calls to service center



Poisson Distribution

- A random distribution with parameter λ
  - Model the number of occurrences per unit of time or space

- Key properties
  - Mean = λ = **expected number**
  - Std = $\sqrt{\lambda}$
  - Valued as non-negative **integer**
- Example in practice
  - How many passengers arrive at a but stop during 20min
  - How many phone calls does the service center receive in one hour



Relation of Poisson and Exponential

If the Poisson Distribution captures a random number of occurrences per **<u>unit of time</u>**	⟺	Then, the related Exponential Distribution captures the random **<u>time duration BETWEEN</u>** each occurrence.

This relationship is not so easy to show when the Poisson Distribution is used per unit of space, since space is 2-D.
In this course, we will only focus on applying these distributions to time (i.e. customer arrival times, service processing times, etc.).

For Example:	
"The number of customers arriving at the post-office each lunch-hour on weekdays is Poisson distributed with rate 20 per hour."	"The interarrival time (time elapsed between subsequent customer arrivals) during weekday lunch-hours at the post-office is exponentially distributed with a mean of 3 minutes."

Poisson = $\frac{\text{20 customers}}{\text{1 hour}}$ *Flip it to get →* **Exponential** = $\frac{\text{1 hour}}{\text{20 customers}} * \frac{\text{60 minutes}}{\text{1 hour}} = \frac{\text{3 minutes}}{\text{1 customer}}$