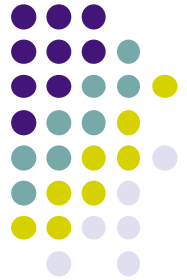
Best case, average case, and worst case



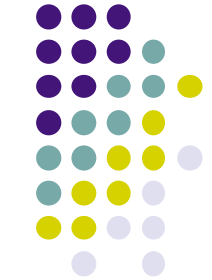
? What does it mean to say *f(n)* is a function of input size *n* if there can be *many* different inputs with same size *n* (e.g., if the input is a list)?

! *f(n)* might be different for different input lists!

- So we need to take some kind of *average*

- There are three standard ways to do this: best case, average case, and worst case
  - Best case: take only inputs of size *n* with smallest time
  - Worst case: take only inputs of size *n* with largest time
  - Average case: take inputs of size *n* according to some probability distribution (which must be given)

Example of best, average, and worst



- Let's use the function {FirstNegative L} that takes a list of integers and returns the position of the first negative:
  - For example, {FirstNegative [5 ~8 6 7]} returns 2

- Best case: We only give lists whose first element is negative. Then $f_{best}(n) \in O(1)$
- Worst case: We only give lists with all elements positive except the last. Then $f_{worst}(n) \in O(n)$
- Average case:
  - If each element has independent probability 0.5 to be negative, then $f_{average}(n) \in O(1)$
  - If the *position* of the first negative element in the list is uniformly distributed from 1 to n, then $f_{average}(n) \in O(n)$