# Sorting ~~Array~~ Linked List

- So far, our sorting algorithms work on arrays
- However, which sorting algorithm can work on **Linked List**?
  - Bubble Sort
  - Selection Sort
  - Insertion Sort
  - Merge Sort
  - Quick Sort

# Sorting ~~Array~~ Linked List

- Discussion with your neighbors
- However, which sorting algorithm can work on **Linked List**?
  - Bubble Sort
  - Selection Sort
  - Insertion Sort
  - Merge Sort
  - Quick Sort

# Discussion

| Algorithm | Can work on LL? | Time Complexity | Extra Space | Comments |
|---|---|---|---|---|
| **Bubble Sort** | | | | |
| **Insertion Sort** | | | | |
| **Selection Sort** | | | | |
| **Mergesort** | | | | |
| **Quicksort** | | | | |

# Compare to Array Version

best gen worst

| Algorithm | Can work on LL? | Time Complexity | Extra Space | Comments |
|---|---|---|---|---|
| **Bubble Sort** | Yes n | Same $n^2$ | Same $n^2$ | |
| **Insertion Sort** | Yes n | Same $n^2$ | Same $n^2$ | |
| **Selection Sort** | Yes $n^2$ | Same — | Same — | |
| **Mergesort** | Yes n log n | Same — | O(1), ( O (log n) for function stack) | |
| **Quicksort** | Yes n log n | Same n log n | Same $n^2$ | |

# The ADT Sets

- In Mathematics, a set is a group of distinct items.
- E.g. the set of all positive integers

$$A = \{x \in N | x \geq 1\}$$

- E.g. the set of all even numbers

$$B = \{x \in N | x \; mod \; 2 = 0\}$$

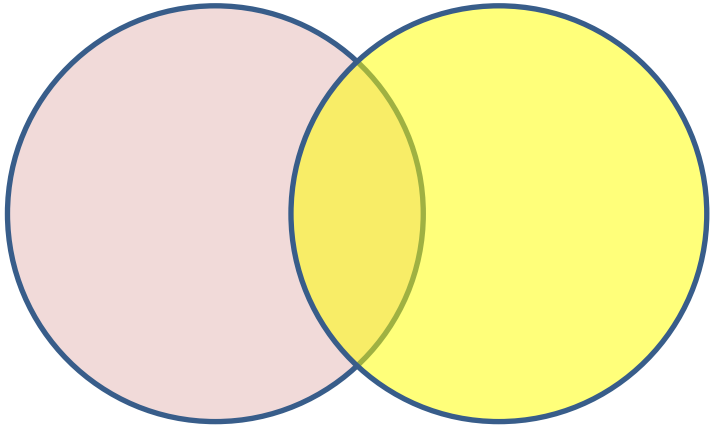
- And we can perform set operations on them, e.g. The set of all positive even numbers:

$$C = A \cap B$$

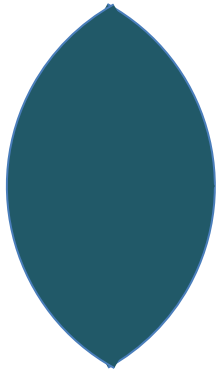
# Set Operations

- A set *X* is a subset of *Y*, namely $X \subseteq Y$, if
  - $\forall x \in X, x \in Y$
  - E.g. the set of all male is a subset of all humans
- A set *X* is equal to *Y* if $X \subseteq Y$ and $Y \subseteq X$

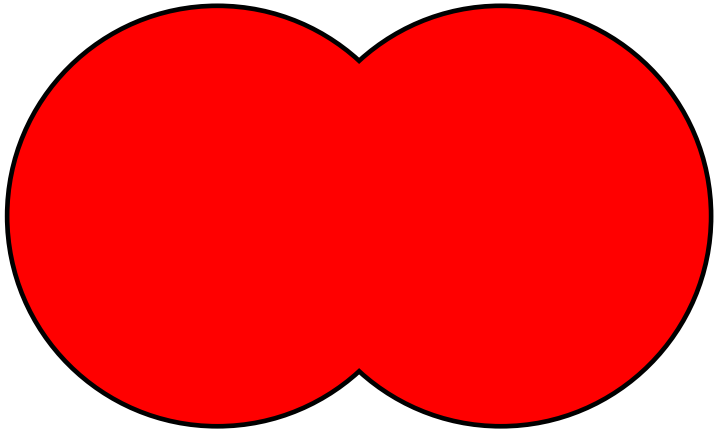
# Set Operations



Set A and Set B



Intersection



Union



A - B

# ADT Set (of Integers)

```
template <class T>
class Set {
private:
  // what data structure(s)?
public:
  void add(T);                    // add an element
  void remove(T);                 // remove an element
  bool exist(T);                  // check if x exists
  bool isSubsetOf(Set<T>& Y);     // this subsets of Y
  bool isEqualTo(Set<T>& Y);      // this == Y
  Set<T> setUnion(Set<T>& Y);     // return this U Y
  Set<T> intersect(Set<T>& Y);    // return this intersect Y
  Set<T> minus(Set<T>& Y);        // return this - Y
};
```

# Discussions

- Presentation after 10 min discussion
- What Data Structures should we used to store the elements?
- How to implement the member functions?
  - What is the time/space complexity for each of them?

# Example Operations

```
Set<int> A, B;
A.add(1);
B.add(2);
C = A.setUnion(B);
B.add(3);
```