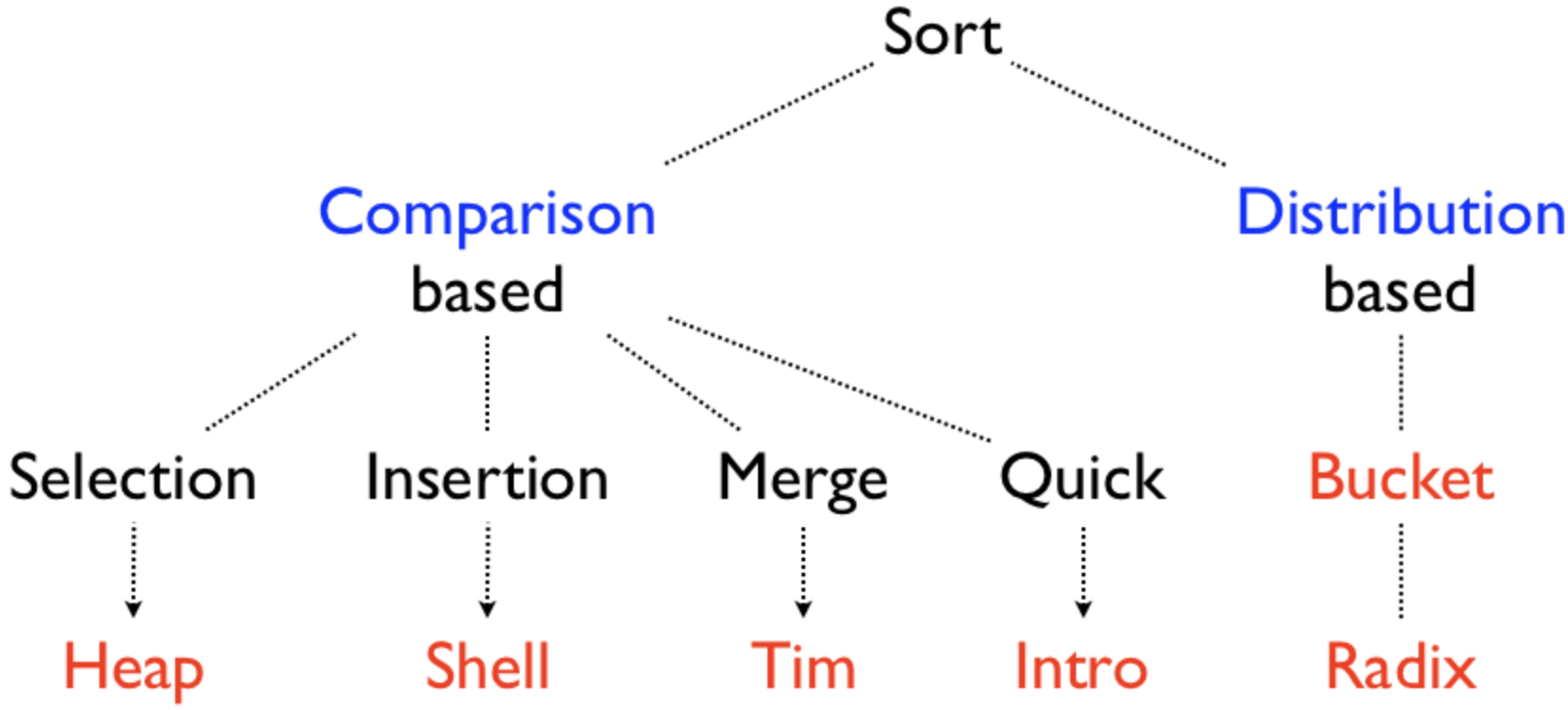
Sort: Distribution-based

Contents

Sorting Algorithms

- What is the best soring algorithm?



Bucket Sort

Source: `BucketSort.java`

```java
public abstract class BucketSort<T extends Comparable<T>> extends AbstractSort<T> {
    protected List<Deque<T>> buckets;

    /** @param numBuckets the total number of buckets.  */
    public BucketSort(int numBuckets) {
        super(null);

        buckets = Stream.generate(ArrayDeque<T>::new)
                        .limit(numBuckets)
                        .collect(Collectors.toList());
    }
```

- Comparator?
- How many buckets need to be intialized?
- Base API: `ArrayDeque`.

```
protected void sort(T[] array, int beginIndex, int endIndex, Function<T, T> f) {
    // add each element in the input array to the corresponding bucket
    for (int i = beginIndex; i < endIndex; i++)
        buckets.get(getBucketIndex(array[i], f)).add(array[i]);

    // merge elements in all buckets to the input array
    for (Deque<T> bucket : buckets) {
        while (!bucket.isEmpty())
            array[beginIndex++] = bucket.remove();
    }
}

/**
 * @param key a comparable key.
 * @param f takes one argument of type T, and return a value of type T (optional).
 * @return the index of the bucket that the key should be inserted.
 */
abstract protected int getBucketIndex(T key, Function<T, T> f);
```

- Method: `getBucketIndex()`, `bucket.removeLast()`.

Integer Bucket Sort

Source: `IntegerBucketSort.java`

```
public class IntegerBucketSort extends BucketSort<Integer> {
    private final int GAP;

    /**
     * @param min the minimum integer (inclusive).
     * @param max the maximum integer (exclusive).
     */
    public IntegerBucketSort(int min, int max) {
        super(max - min);
        GAP = -min;
    }

    @Override
    public void sort(Integer[] array, int beginIndex, int endIndex) {
        sort(array, beginIndex, endIndex, null);
    }

    @Override
    protected int getBucketIndex(Integer key, Function<Integer, Integer> f) {
        return key + GAP;
    }
}
```

- The purpose of `GAP`?

Radix Sort

Source: `RadixSort.java`

```java
public abstract class RadixSort extends BucketSort<Integer> {
    public RadixSort() { super(10); }

    @Override
    protected int getBucketIndex(Integer key, Function<Integer, Integer> f) {
        return f.apply(key) % 10;
    }

    protected int getMaxBit(Integer[] array, int beginIndex, int endIndex) {
        Integer max = Arrays.stream(array, beginIndex, endIndex)
                            .reduce(Integer::max)
                            .orElse(null);
        return (max != null && max > 0) ? (int)Math.log10(max) + 1 : 0;
    }
```

- Exception handling: `throw new UnsupportedOperationException()`.
- `getMaxBit()`: return the order of the most significant digit in the input array.

LSD Radix Sort

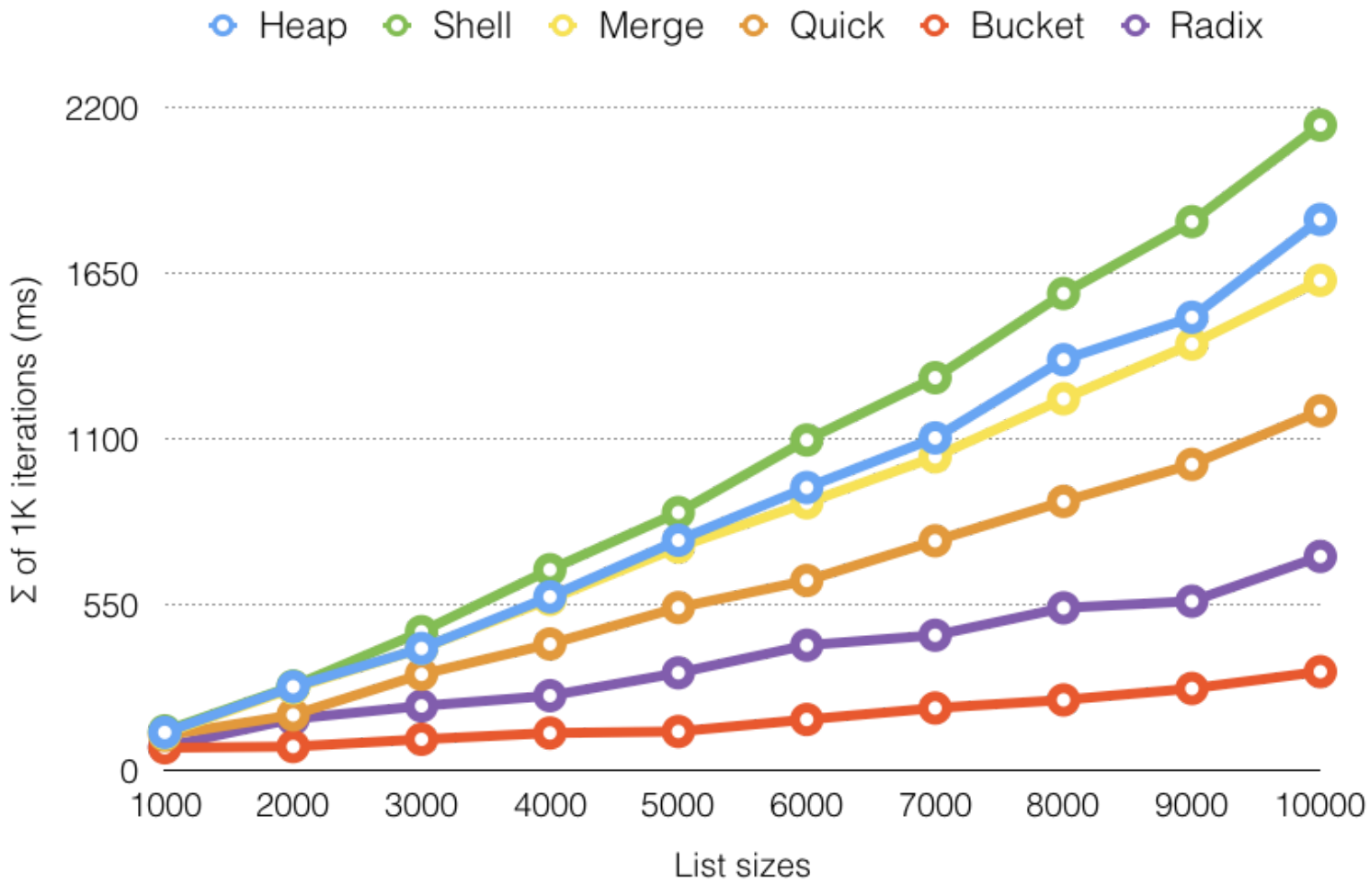
Source: `LSDRadixSort.java`

```java
public class LSDRadixSort extends RadixSort {
    @Override
    public void sort(Integer[] array, int beginIndex, int endIndex) {
        int maxBit = getMaxBit(array, beginIndex, endIndex);
        for (int bit = 0; bit < maxBit; bit++) {
            int div = (int) Math.pow(10, bit);
            sort(array, beginIndex, endIndex, k -> k / div);
        }
    }
}
```

- Lambda function: `k -> k / div`.

Benchmarks

Speed Comparison



References

- Bucket sort.
- Radix sort.