

Computer *Science*

Empirical Analysis!



*You need a partner,
and at least half a
laptop.*

These slides are posted.

Computer Science 201



Maps redux

Maps can:

- Make an empty one (*constructor*)
- Add a key-value pair (*.put*)
- Check if a key is in the map (*.containsKey*)
- Get the value for a key (*.get*)
- Tell you its size (*.size*)



You've seen maps before!

One way to do a map

ArrayList of Pairs

m =

Key	AK	NC	CA
Value	49	12	31

```
System.out.println(m.get("CA"));
```



One way to do a map

ArrayList of Pairs

m =

Key	AK	NC	CA
Value	49	12	31

```
m.put("NM", 47);
```



One way to do a map

ArrayList of Pairs

m =

Key	AK	NC	CA	NM
Value	49	12	31	47

```
m.put("NM", 47);
```



You can probably predict why I chose three of these four...

Snarf Sep 12 InClass

`Read ArrayListMap.java`

`(and Pair.java)`



CountUniqueWords.java



CountUniqueWords.java

0. Time *War & Peace* for

- 100 words
- 500 words
- 2500 words
- 12,500 words
- 62,500 words
- 312,500 words
- 565,460 words (the total) *This one in particular is very slow.*

Once you have five datapoints:

1. Plot your five points.
2. Have a group member put a hand up.
3. Keep working on six and seven!

Ask: How does this scale?

1. Plot the timings using your favorite tool.

2. Enter them in

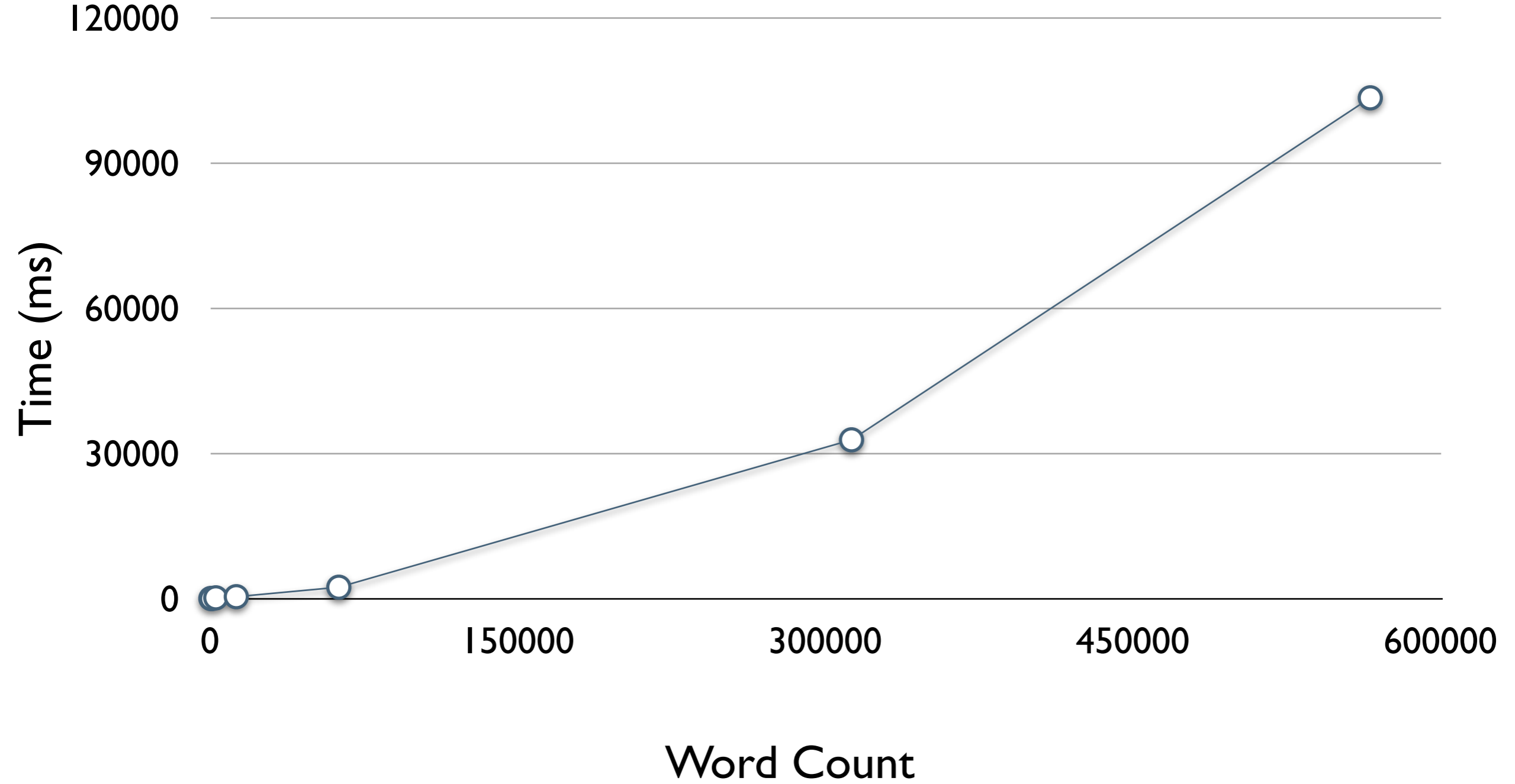
<http://www.cs.duke.edu/courses/fall12/compsci201/charts/sep12.html>

(*War & Peace*) (leave this browser window open for later)



My timings

Two minutes!



Ask: Why?

So, what's going on?

Map Value

Key
Value

Comparisons: 0
Operations: 0

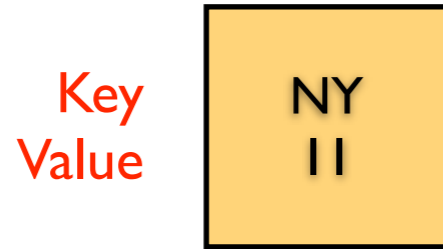
Code to run next

```
m.put("NY", 11);
```



So, what's going on?

Map Value



Comparisons: 0
Operations: 1

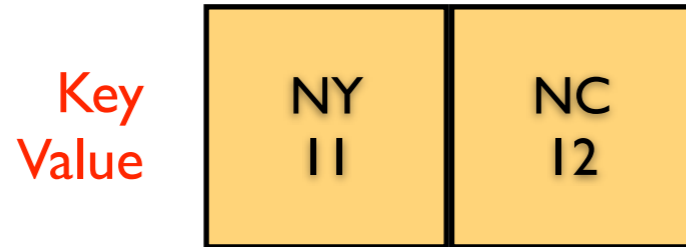
Code to run next

```
m.put("NC", 12);
```



So, what's going on?

Map Value



Comparisons: 1
Operations: 2

Code to run next

```
m.put("AK", 49);
```



So, what's going on?

Map Value

Key
Value

NY 11	NC 12	AK 49
----------	----------	----------

Comparisons: 3

Operations: 3

Code to run next

```
m.put("CA", 31);
```



So, what's going on?

Map Value

Key
Value

NY 11	NC 12	AK 49	CA 31
----------	----------	----------	----------

Comparisons: 6

Operations: 4

Code to run next

```
m.put("NM", 47);
```



So, what's going on?

Map Value

Key
Value

NY 11	NC 12	AK 49	CA 31	NM 47
----------	----------	----------	----------	----------

Comparisons: 10
Operations: 5

Code to run next

```
m.put("WA", 42);
```



So, what's going on?

Map Value

Key
Value

NY 11	NC 12	AK 49	CA 31	NM 47	WA 42
----------	----------	----------	----------	----------	----------

Comparisons: 15
Operations: 6

Code to run next

```
m.put("DC", 51);
```



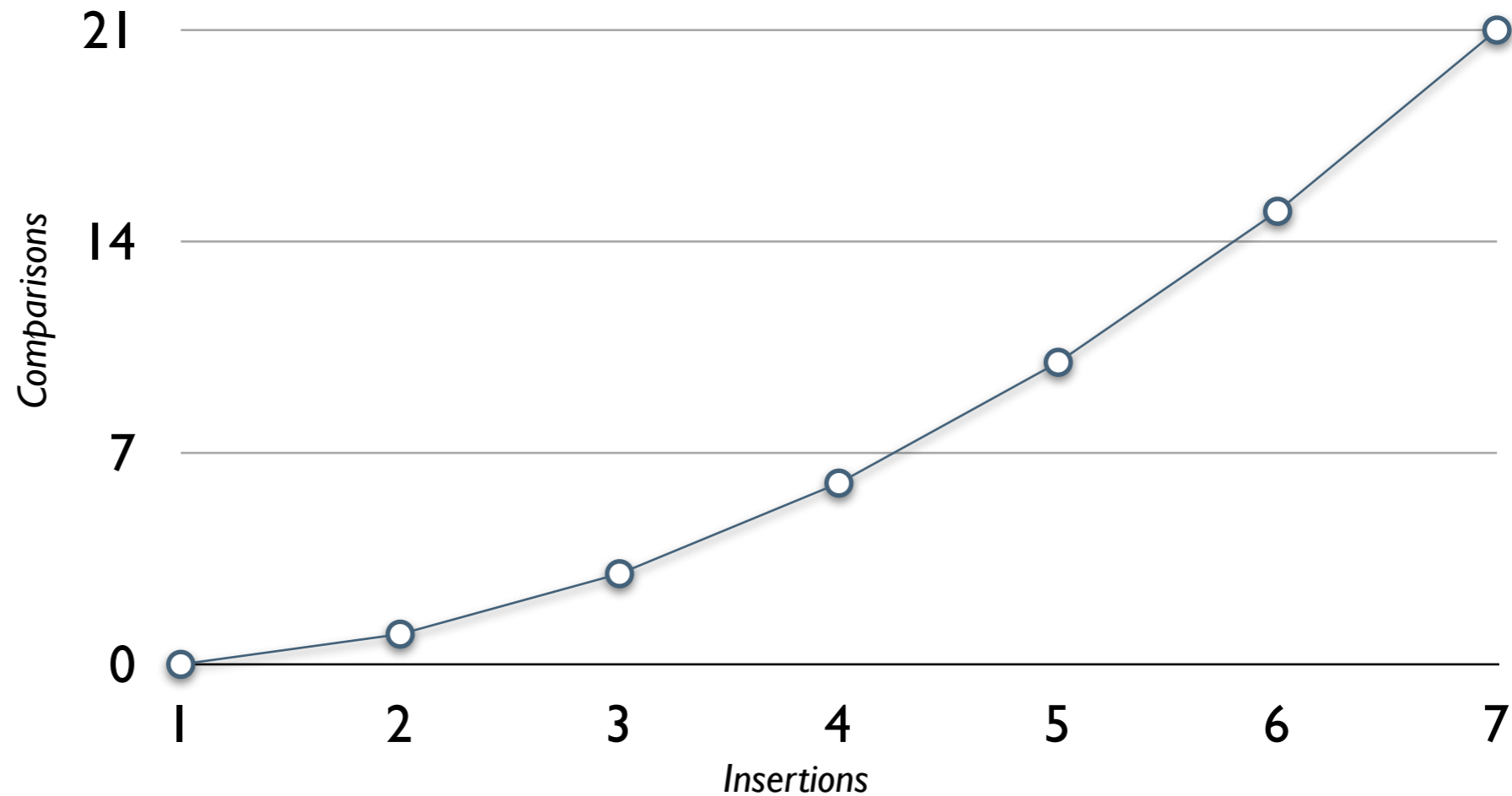
So, what's going on?

Map Value

Key
Value

NY 11	NC 12	AK 49	CA 31	NM 47	WA 42	DC 51
----------	----------	----------	----------	----------	----------	----------

Comparisons: 21
Operations: 7

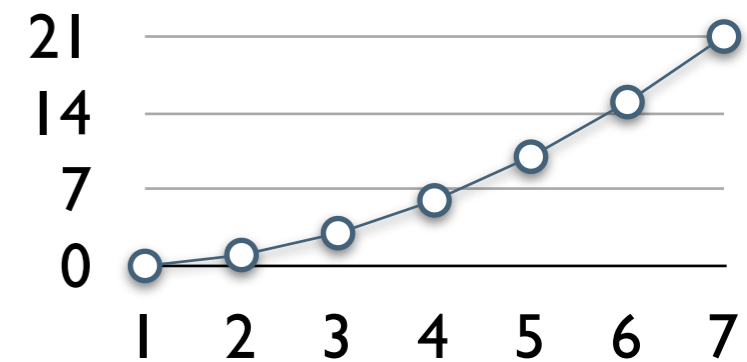


$$1 + 2 + 3 + \dots + N$$

Key
Value

NY 11	NC 12	AK 49	CA 31	NM 47	WA 42	DC 51
----------	----------	----------	----------	----------	----------	----------

1 2 3 98 99 100



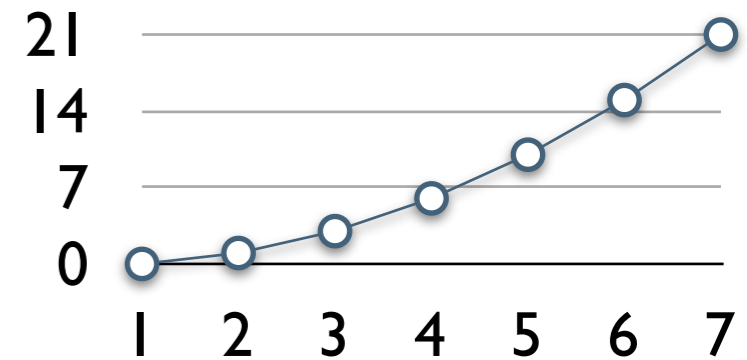
This story might be true.

$$1 + 2 + 3 + \dots + N$$

Key
Value

NY 11	NC 12	AK 49	CA 31	NM 47	WA 42	DC 51
----------	----------	----------	----------	----------	----------	----------

1 2 3 98 99 100



$$\sum_{i=1}^n i = \frac{n(n+1)}{2} = \frac{n^2 + n}{2}$$

N insertions run in time quadratic in N



AKA "Quadratic time"

Was this fair?

Key
Value

NY 11	NC 12	AK 49	CA 31	NM 47	WA 42	DC 51
----------	----------	----------	----------	----------	----------	----------



Different Case

Map Value

Key
Value

Comparisons: 0
Operations: 0

Code to run next

```
m.put("NY", 11);
```



Different Case

Map Value



Comparisons: 0
Operations: 1

Code to run next

```
m.put("NY", 12);
```



Different Case

Map Value



Comparisons: 1
Operations: 2

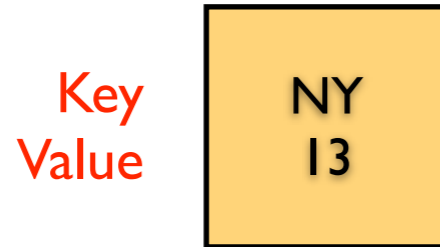
Code to run next

```
m.put("NY", 13);
```



Different Case

Map Value



Comparisons: 2
Operations: 3

Code to run next

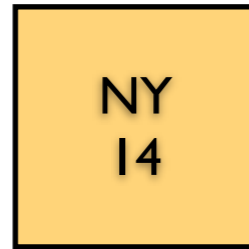
```
m.put("NY", 14);
```



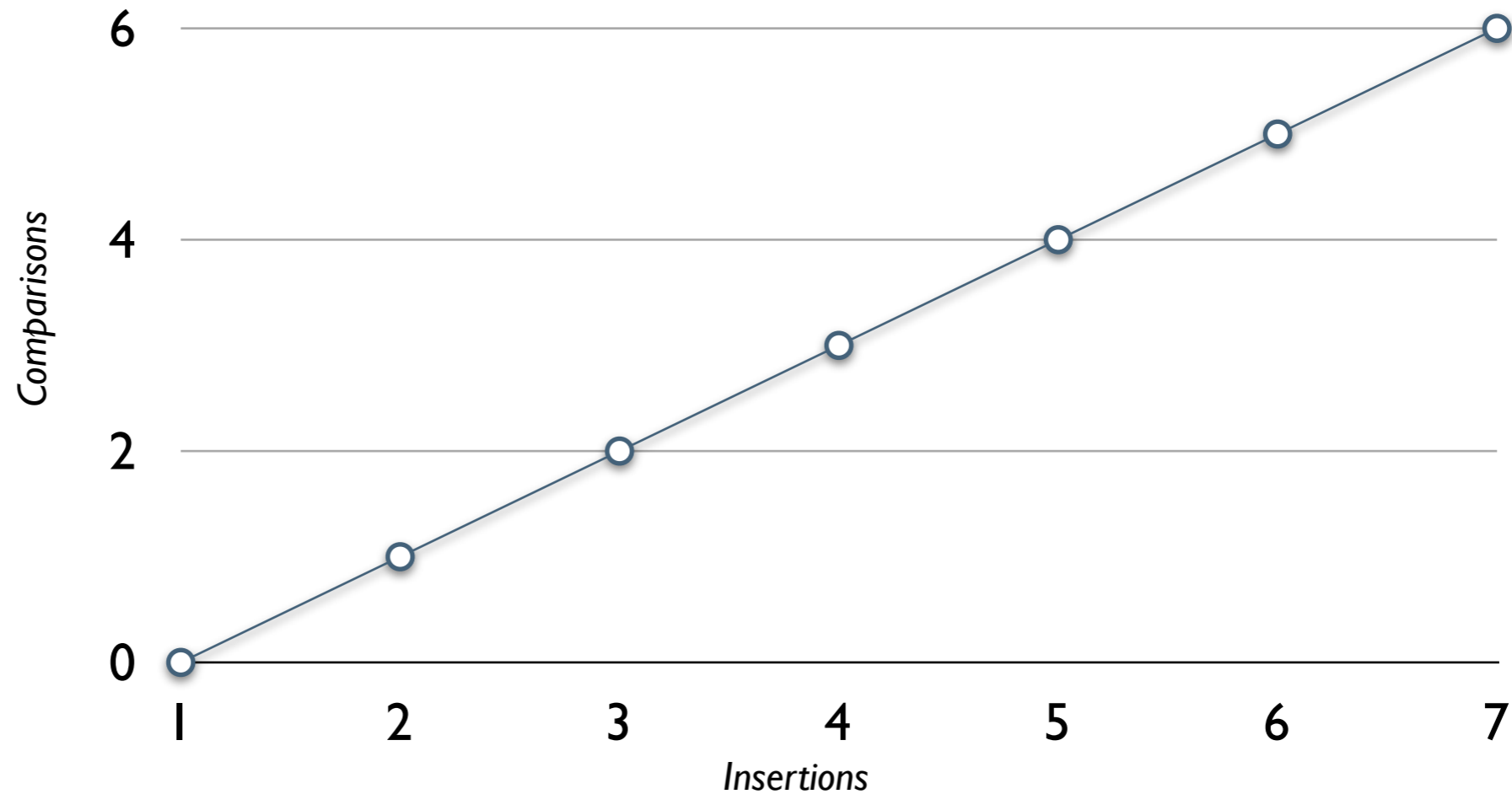
Different Case

Map Value

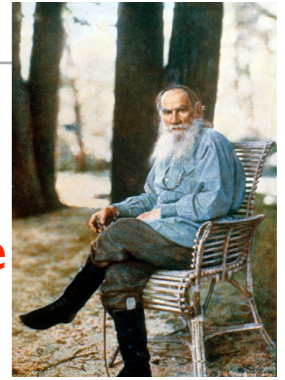
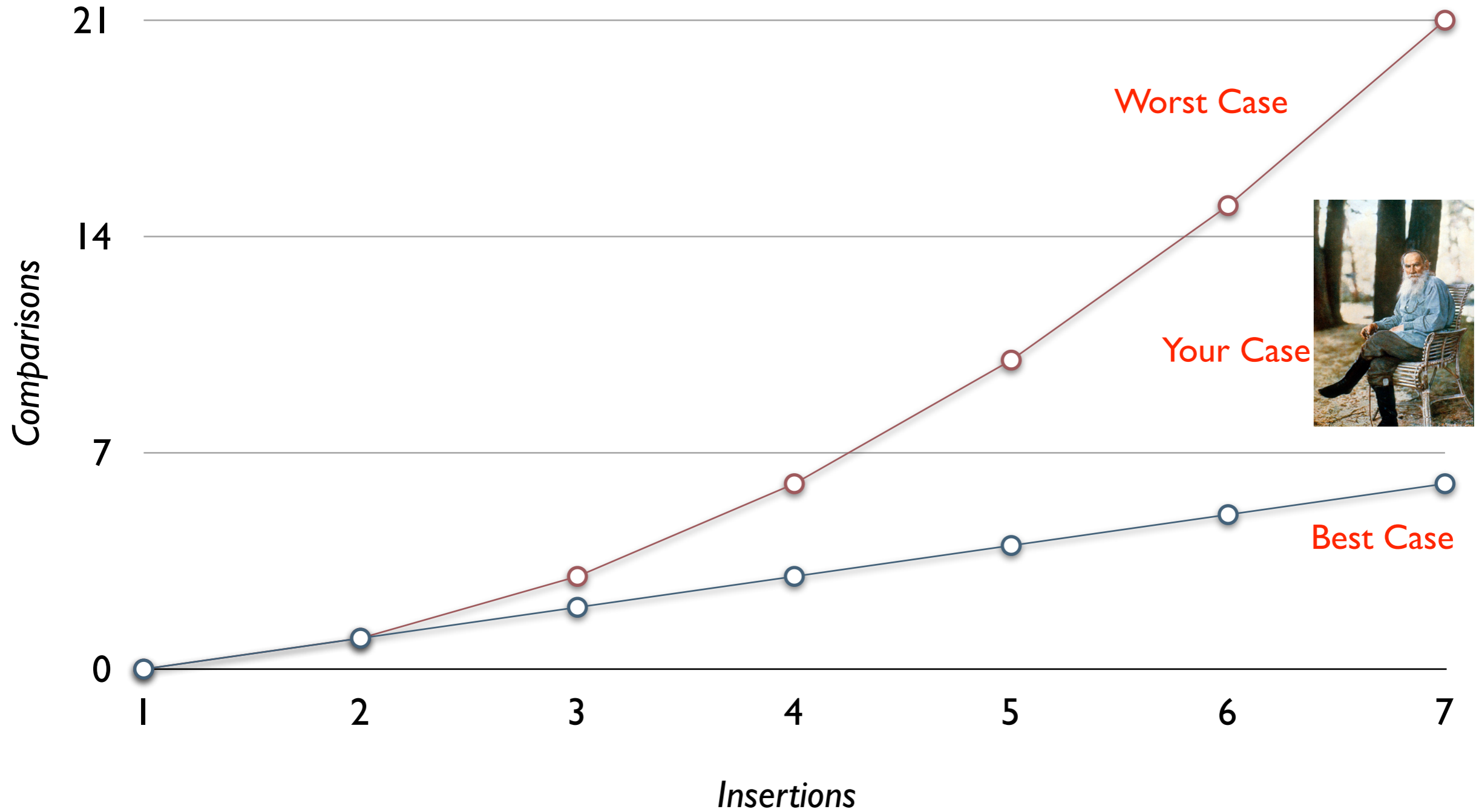
Key
Value



Comparisons: 3
Operations: 4



War & Peace



To Do: complete the graph

(in ms)

0. Time cheese.txt and random.txt for

- 100 words
- 500 words
- 2500 words
- 12,500 words
- 62,500 words
- 312,500 words
- 565,460 words

random is suffering by now; best to not try the bigger ones...

1. Plot the timings using your favorite tool.

2. Enter them in

<http://www.cs.duke.edu/courses/fall12/compsci201/charts/sep12.html>

