Applying Java FutureTask to Design a Memoizer Cache

Douglas C. Schmidt

d.schmidt@vanderbilt.edu

www.dre.vanderbilt.edu/~schmidt

Professor of Computer Science

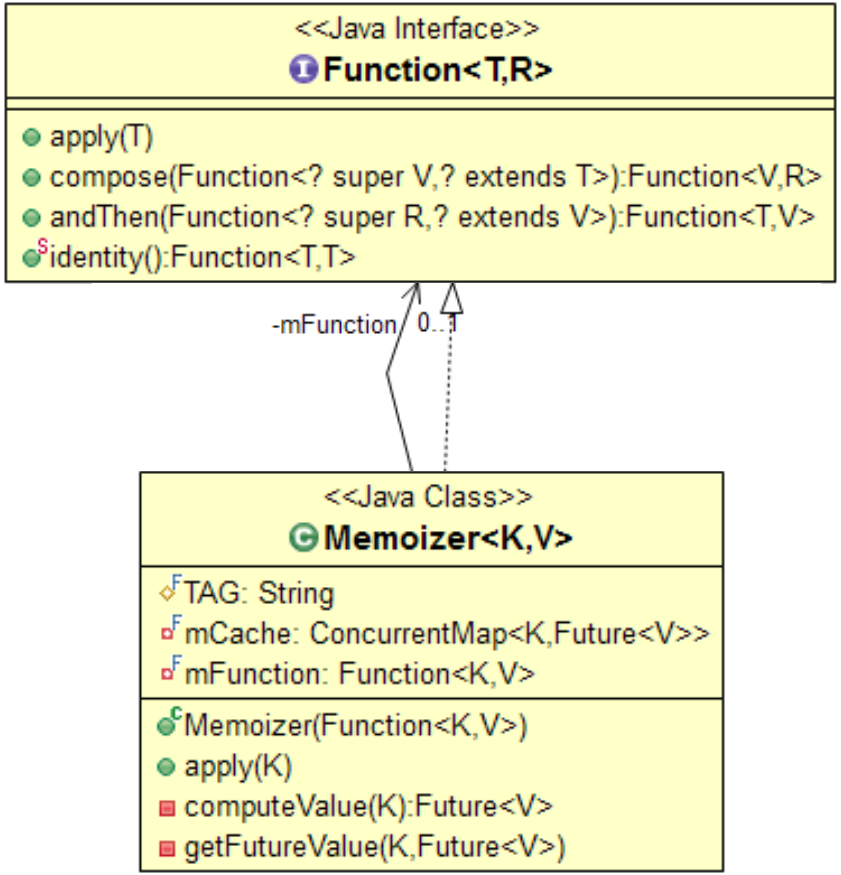
Institute for Software Integrated Systems

Vanderbilt University

Nashville, Tennessee, USA

Learning Objectives in this Part of the Lesson

- Understand how Java FutureTask conveys a result from a computation running in a thread to thread(s) retrieving the result
- Recognize key methods in Java FutureTask
- Know what a Memoizer is & motivates how FutureTask can optimize its performance in concurrent programs



Memoizer caches function call results & returns cached results for same inputs

Motivating FutureTask with a Memoizer

Motivating FutureTask with a Memoizer

- Memoization is optimization technique used to speed up programs

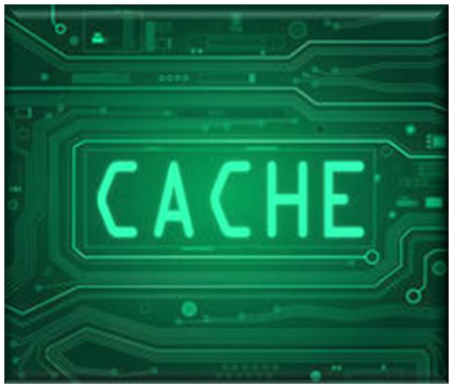
See en.wikipedia.org/wiki/Memoization

Motivating FutureTask with a Memoizer

- Memoization is optimization technique used to speed up programs
  - It caches the results of expensive function calls

```
V computeIfAbsent(K key, Function func) {
   1. If key doesn't exist in cache perform a
      long-running function associated w/key
      & store the resulting value via the key
   2. Return value associated with key
}
```

Memoizer

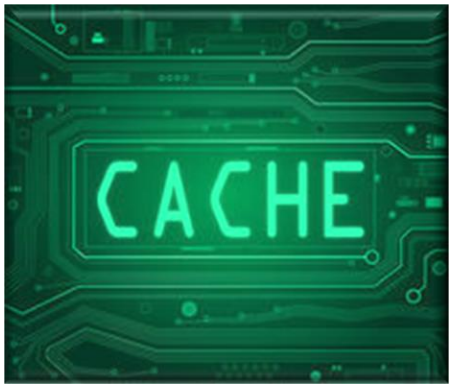


Motivating FutureTask with a Memoizer

- Memoization is optimization technique used to speed up programs
  - It caches the results of expensive function calls

```
V computeIfAbsent(K key, Function func) {
   1. If key doesn't exist in cache perform a
      long-running function associated w/key
      & store the resulting value via the key
   2. Return value associated with key
}
```

Memoizer

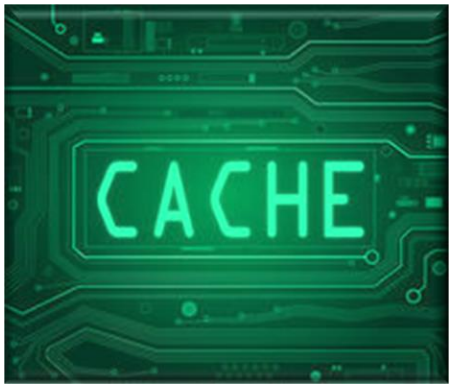


Motivating FutureTask with a Memoizer

- Memoization is optimization technique used to speed up programs
  - It caches the results of expensive function calls

```
V computeIfAbsent(K key, Function func) {
   1. If key doesn't exist in cache perform a
      long-running function associated w/key
      & store the resulting value via the key
   2. Return value associated with key
}
```

Memoizer

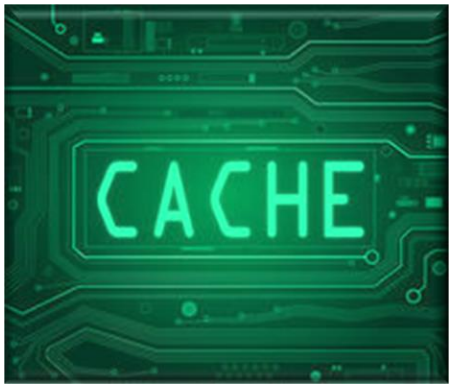


Motivating FutureTask with a Memoizer

- Memoization is optimization technique used to speed up programs
  - It caches the results of expensive function calls
  - When the same inputs occur again the cached results are simply returned

```
V computeIfAbsent(K key, Function func) {
   1. If key already exists in cache
      return cached value associated w/key
}
```

Memoizer

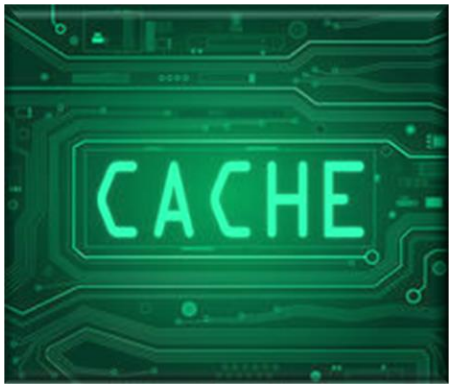


Motivating FutureTask with a Memoizer

- Memoization is optimization technique used to speed up programs
  - It caches the results of expensive function calls
  - When the same inputs occur again the cached results are simply returned

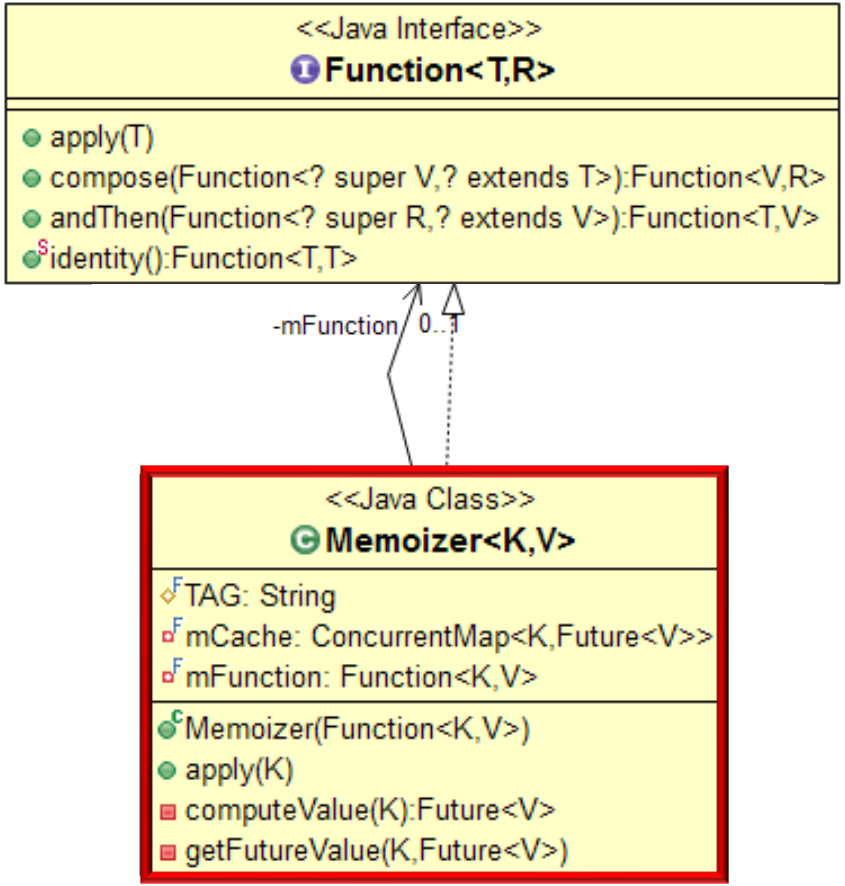
```
V computeIfAbsent(K key, Function func) {
   1. If key already exists in cache
      return cached value associated w/key
}
```

Memoizer



Motivating FutureTask with a Memoizer

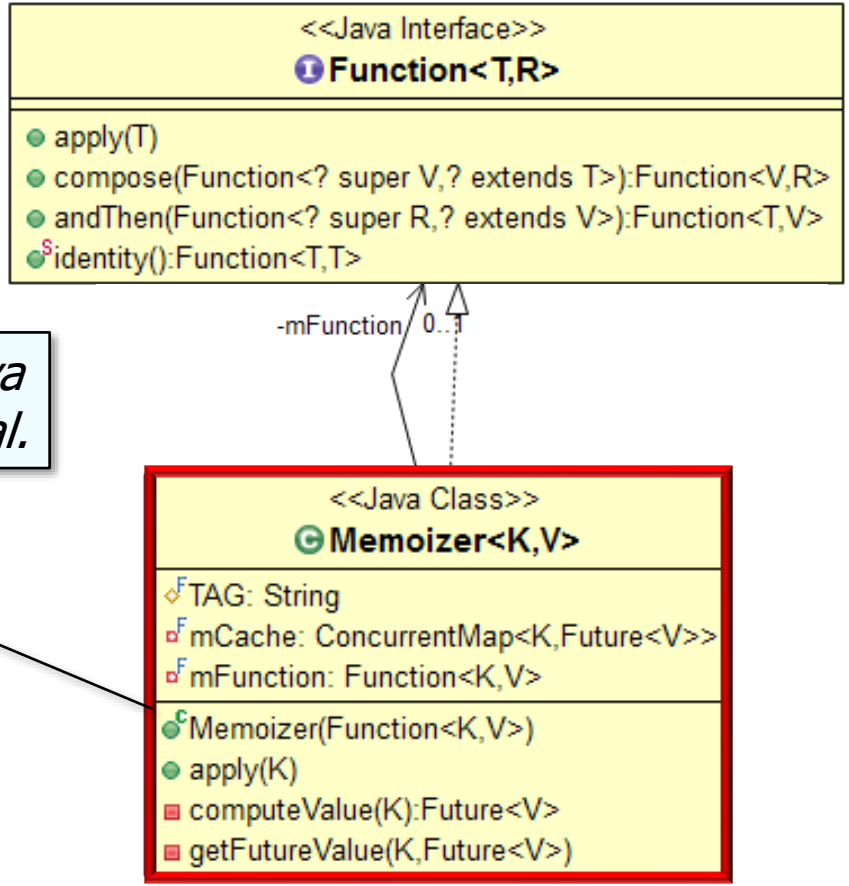
- Memoizer defines a cache that returns a value produced by applying a (long-running) function to a key



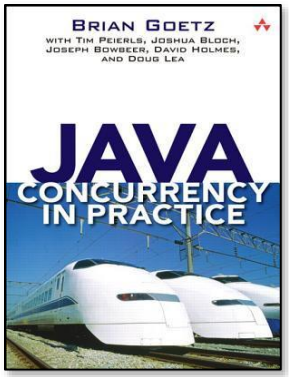
See PrimeExecutorServiceFutureTask/app/src/main/java/vandy/mooc/prime/utils/Memoizer.java

Motivating FutureTask with a Memoizer

- Memoizer defines a cache that returns a value produced by applying a (long-running) function to a key



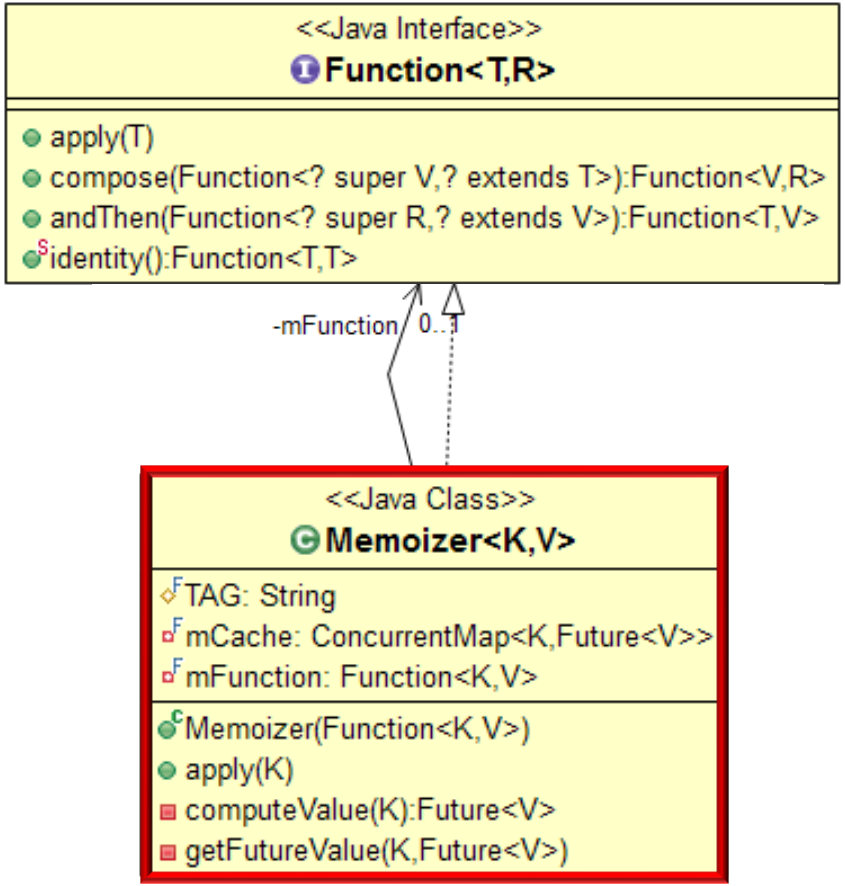
This class is based heavily on the book "Java Concurrency in Practice" by Brian Goetz et al.



See jcip.net

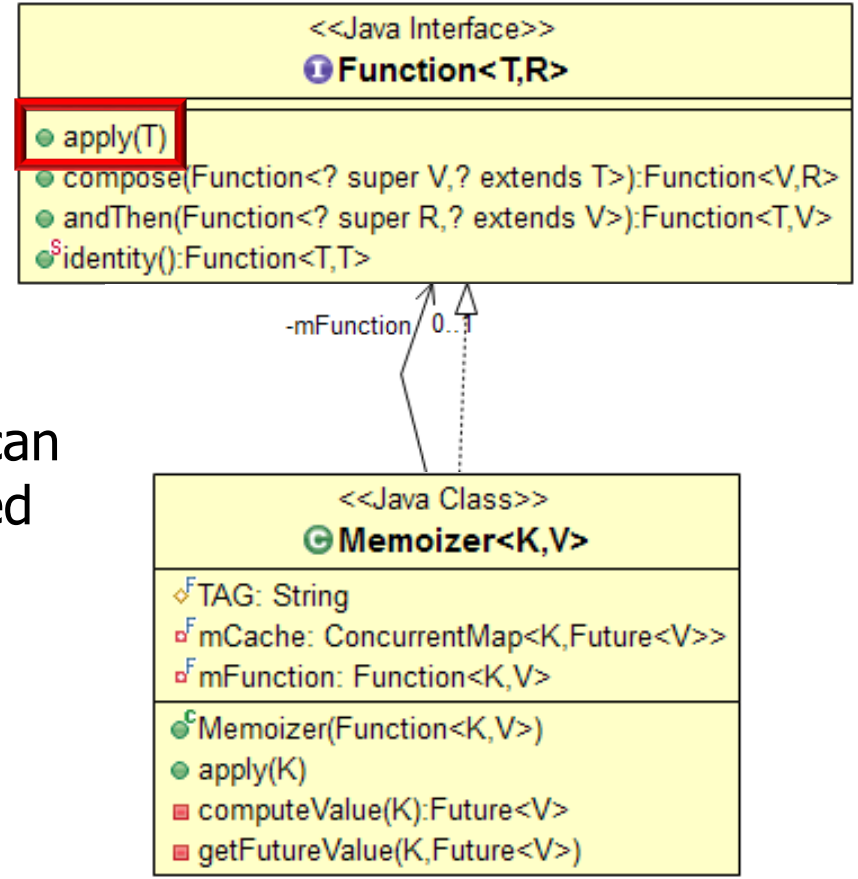
Motivating FutureTask with a Memoizer

- Memoizer defines a cache that returns a value produced by applying a (long-running) function to a key
  - A value that's already been computed for a key is just returned, rather than applying the function to recompute it



Motivating FutureTask with a Memoizer

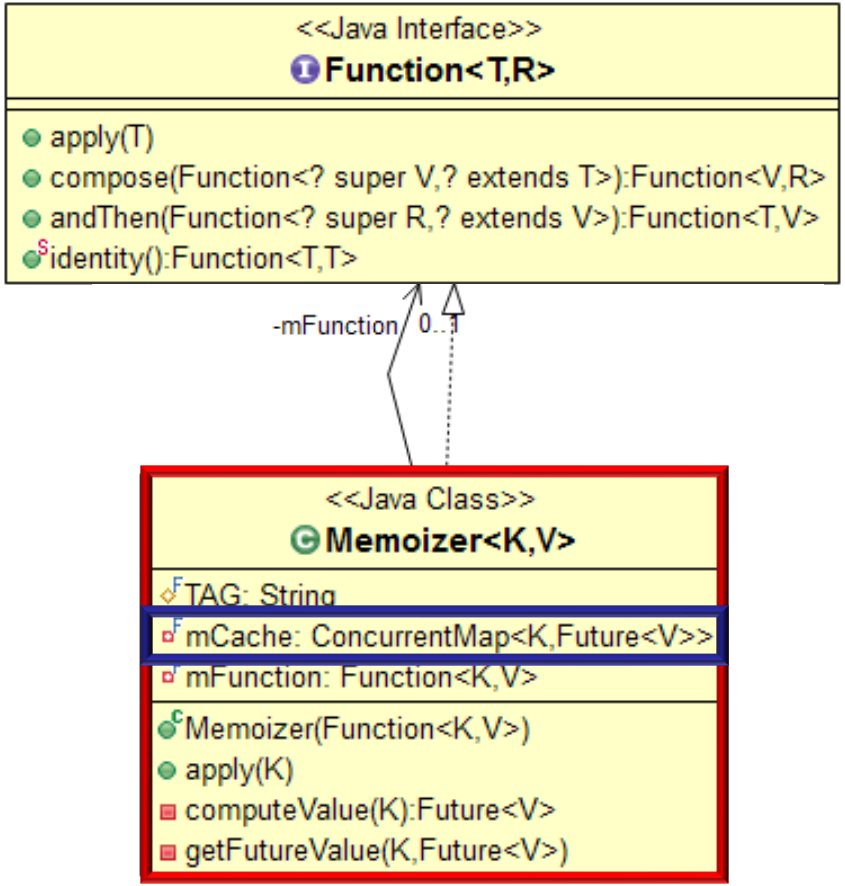
- Memoizer defines a cache that returns a value produced by applying a (long-running) function to a key
  - A value that's already been computed for a key is just returned, rather than applying the function to recompute it
  - By implementing Function a memoizer can be used whenever a Function is expected



See docs.oracle.com/javase/8/docs/api/java/util/function/Function.html

Motivating FutureTask with a Memoizer

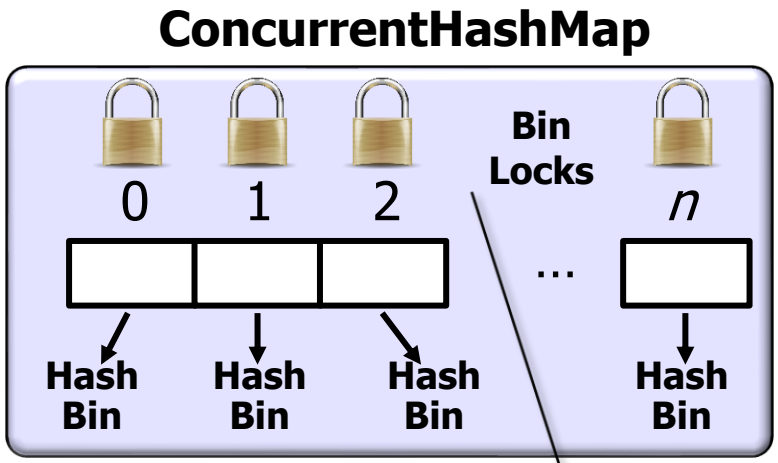
- Memoizer uses a ConcurrentHashMap to minimize synchronization overhead



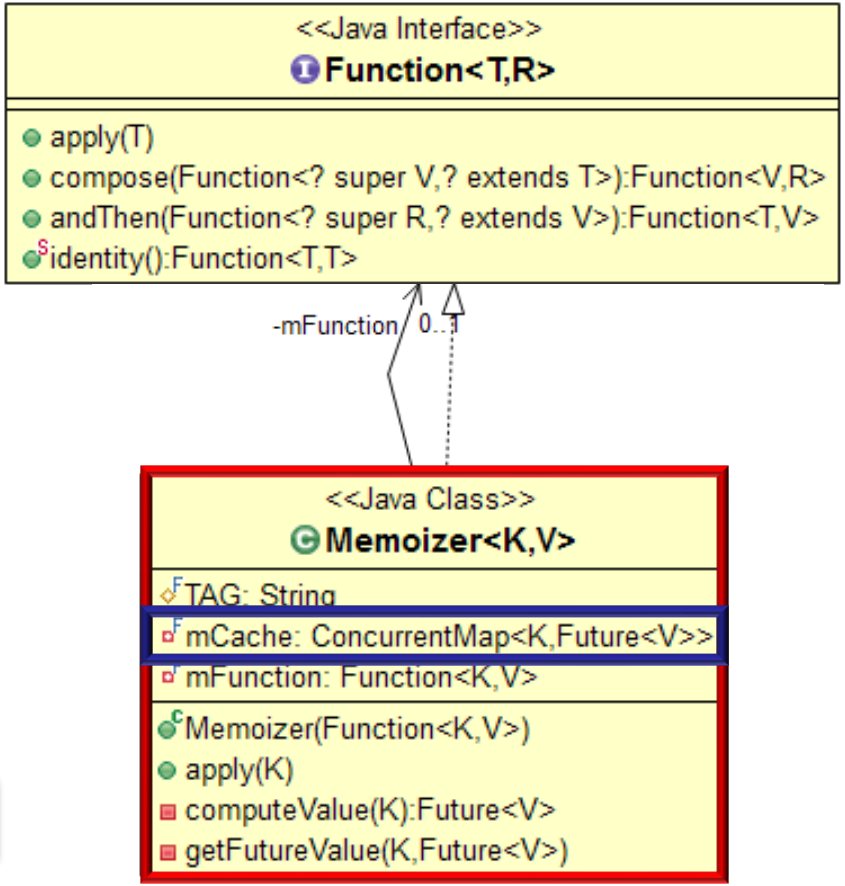
See docs.oracle.com/javase/7/docs/api/java/util/concurrent/ConcurrentHashMap.html

Motivating FutureTask with a Memoizer

- Memoizer uses a ConcurrentHashMap to minimize synchronization overhead
  - A different lock guards each hash bin



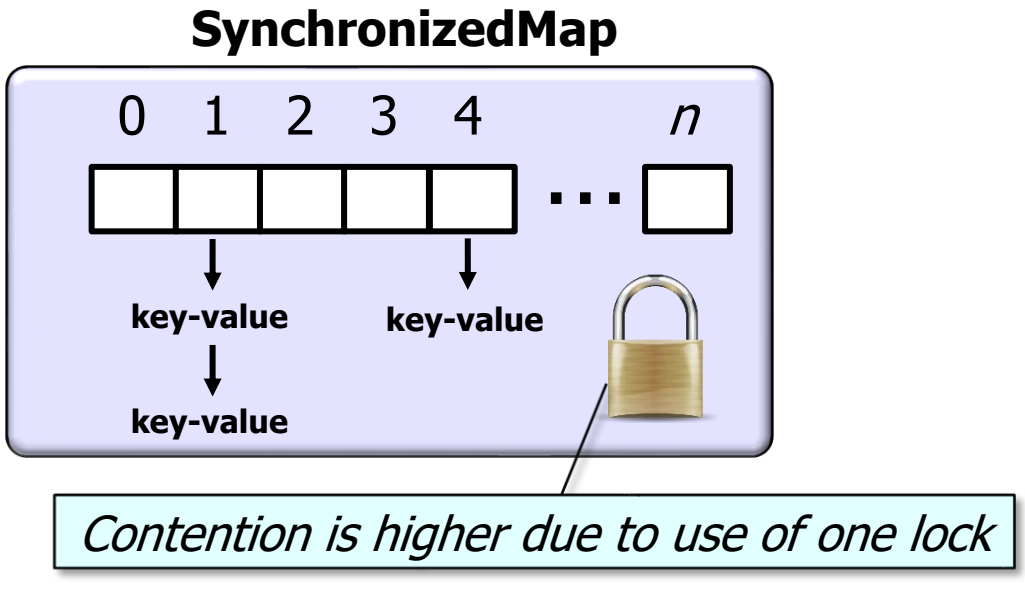
Contention is low due to use of multiple locks

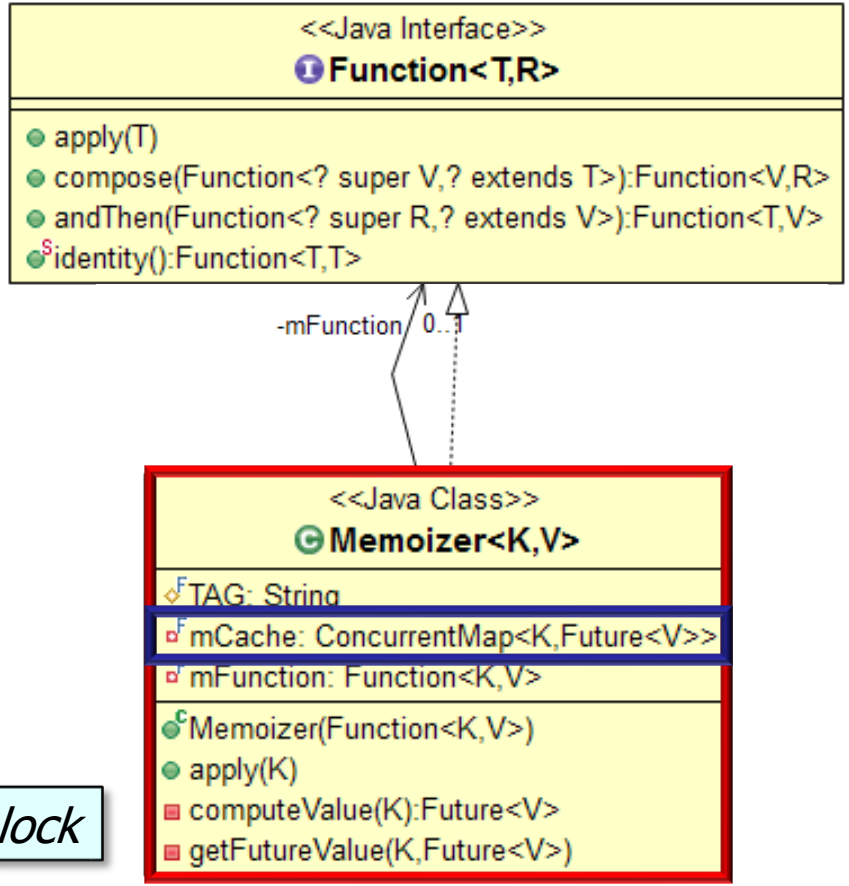


See www.ibm.com/developerworks/java/library/j-jtp08223

Motivating FutureTask with a Memoizer

- Memoizer uses a ConcurrentHashMap to minimize synchronization overhead
  - A different lock guards each hash bin
  - A SynchronizedMap just uses one lock

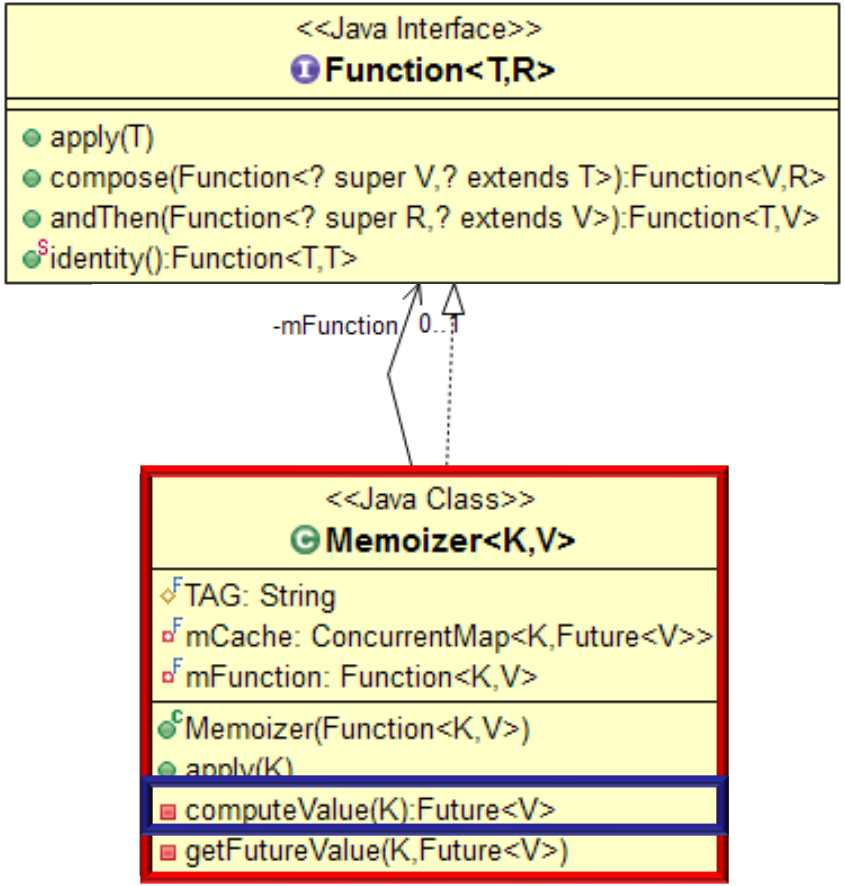




See codepumpkin.com/hashtable-vs-synchronizedmap-vs-concurrenthashmap

Motivating FutureTask with a Memoizer

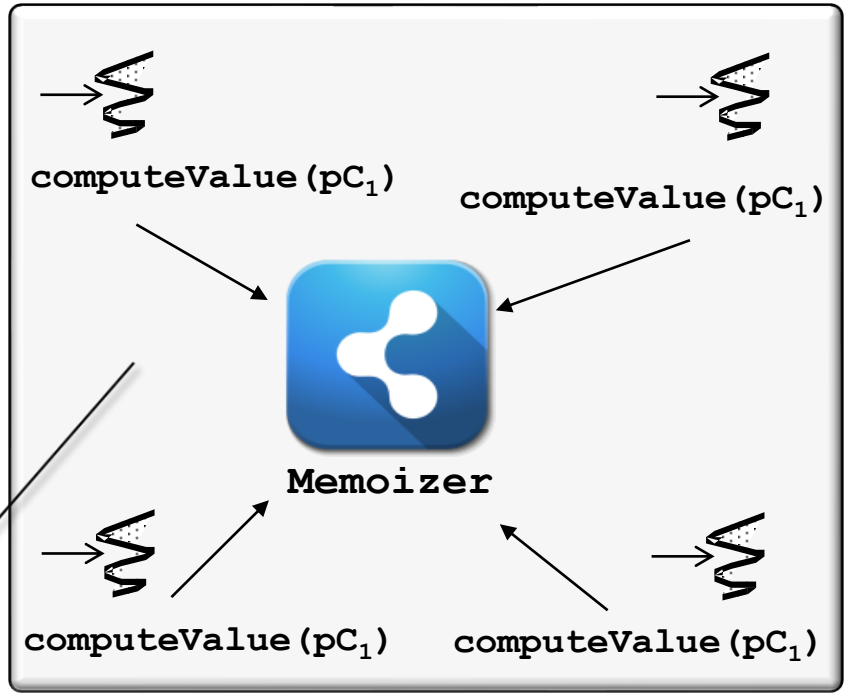
- Memoizer uses a ConcurrentHashMap to minimize synchronization overhead
  - A different lock guards each hash bin
  - computeValue() uses FutureTask to ensure a function runs only when key is first added to cache



See docs.oracle.com/javase/7/docs/api/java/util/concurrent/FutureTask.html

Motivating FutureTask with a Memoizer

- Memoizer uses a ConcurrentHashMap to minimize synchronization overhead
  - A different lock guards each hash bin
  - computeValue() uses FutureTask to ensure a function runs only when key is first added to cache



Only one computation occurs if multiple threads simultaneously call computeValue() for same key

End of Applying Java FutureTask to Design a Memoizer Cache