```
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  xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
  xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
  xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
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```

Miss Pumpkin’s solution is shown step by step

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class MergeSort {
  public <T extends Comparable<? super T>> List<T> sort(List<T> c) {
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The sort method looks standard

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It allocates space for the result
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The sort method looks standard

It allocates space for the result
and delegates to ‘sorted’

‘sorted’ returns an iterator

so we use forEachRemaining
to extract the sorted data

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PeekIterator?

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PeekIterator?

What is a PeekIterator?
I had no idea it existed

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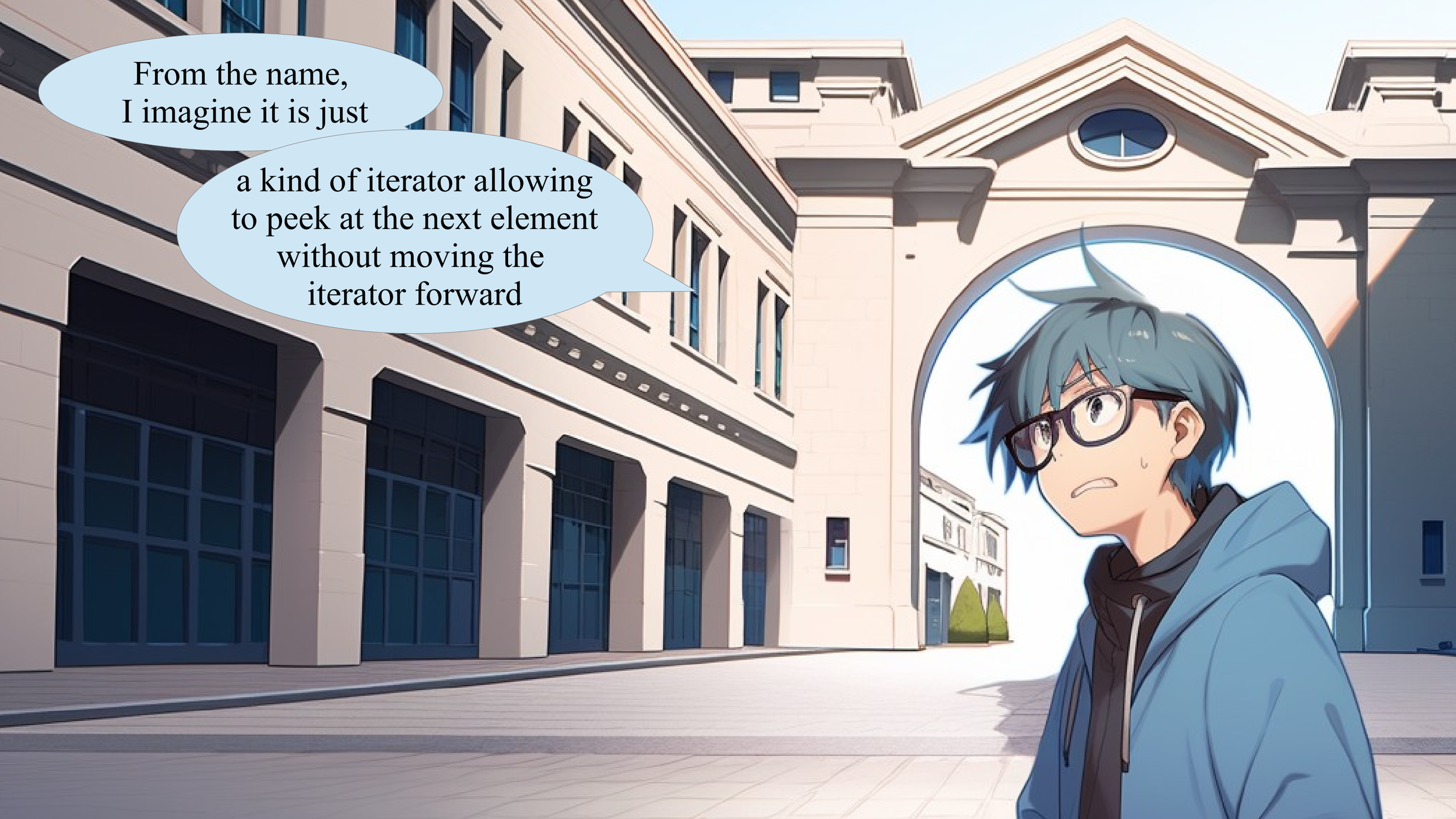
}
```

PeekIterator?

What is a PeekIterator?
I had no idea it existed

Is there a limit to the breadth
of the Java standard library?


From the name,
I imagine it is just


From the name,
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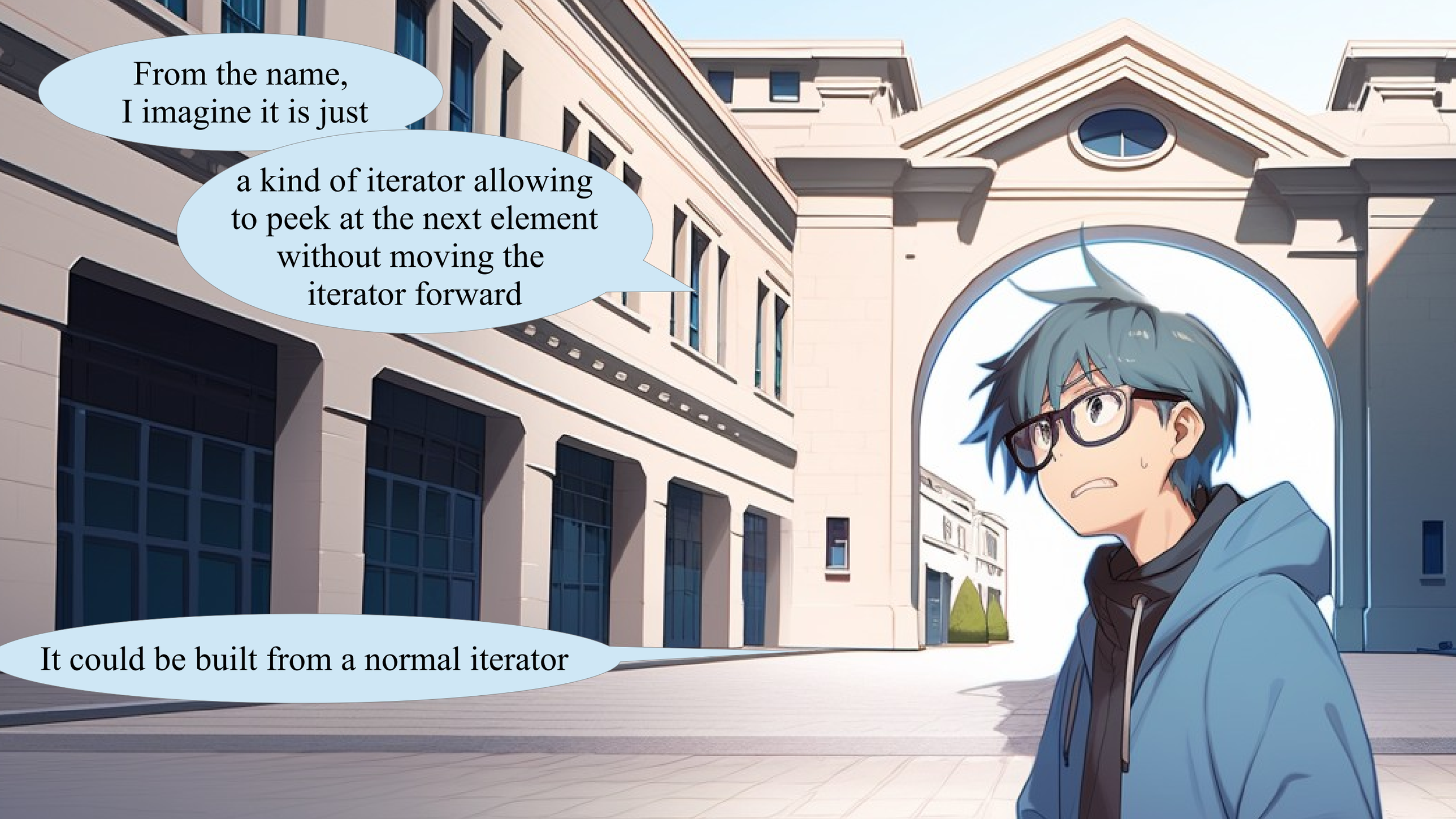
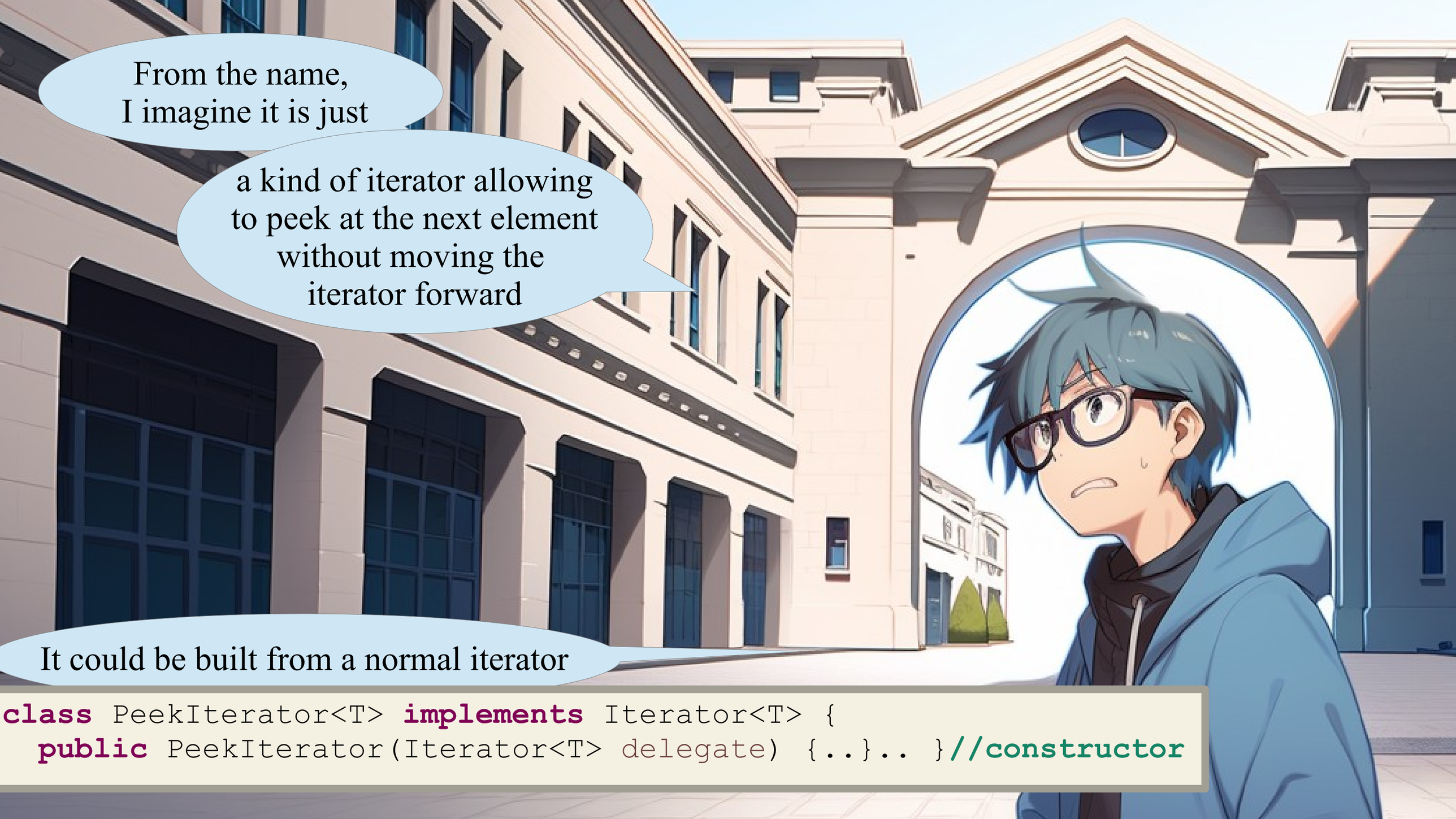
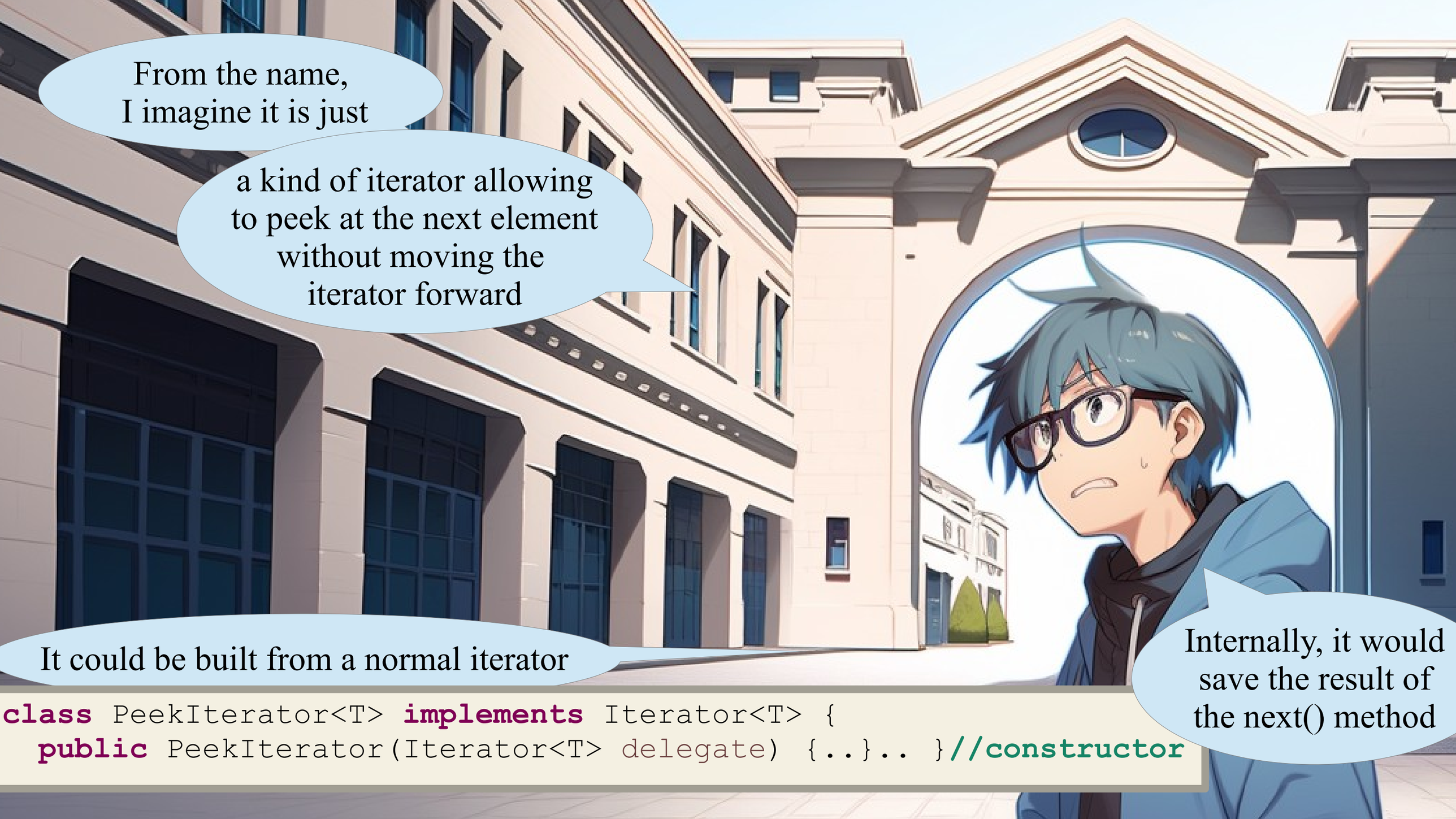

From the name,
I imagine it is just
a kind of iterator allowing to peek at the next element without moving the iterator forward
It could be built from a normal iterator




```
class PeekIterator<T> implements Iterator<T> {
  public PeekIterator(Iterator<T> delegate) {..}.. }//constructor
```

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class MergeSort {
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  }

  <T extends Comparable<? super T>> PeekIterator<T> sorted(List<T> input) {
    int size = input.size();
    if (size < 2){ return new PeekIterator<>(input.iterator()); }
    int mid = size / 2;
    PeekIterator<T> left=  sorted(input.subList(0, mid));
    PeekIterator<T> right= sorted(input.subList(mid, size));
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}
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The sorted implementation
follows the same strategy as my code

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The sorted implementation follows the same strategy as my code

Lists of one or zero elements are intrinsically sorted

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```

The sorted implementation follows the same strategy as my code

Lists of one or zero elements are intrinsically sorted

Otherwise, we split the list in two and sort the two halves

```java
class MergeSort {
  public <T extends Comparable<? super T>> List<T> sort(List<T> c) {
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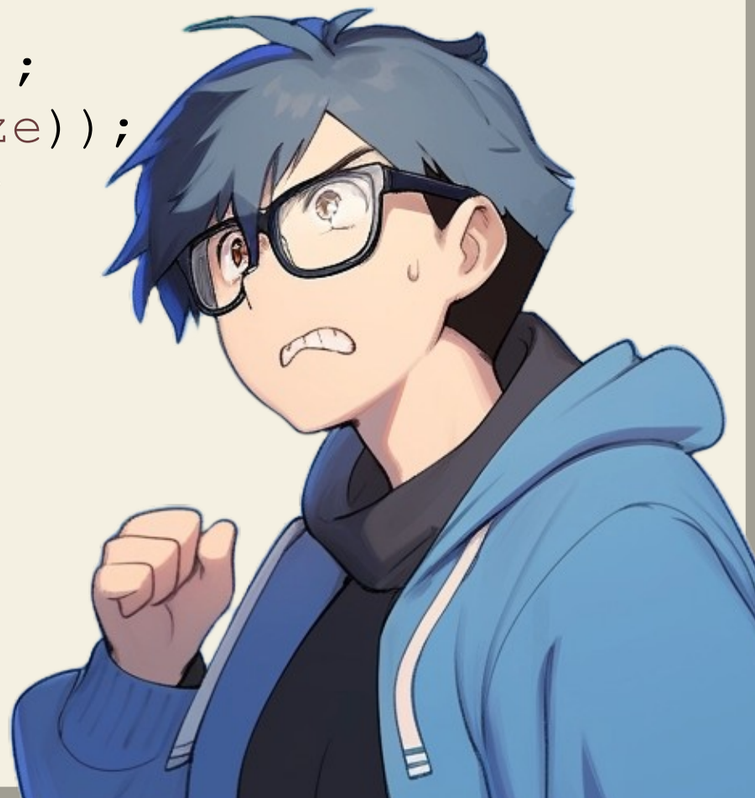

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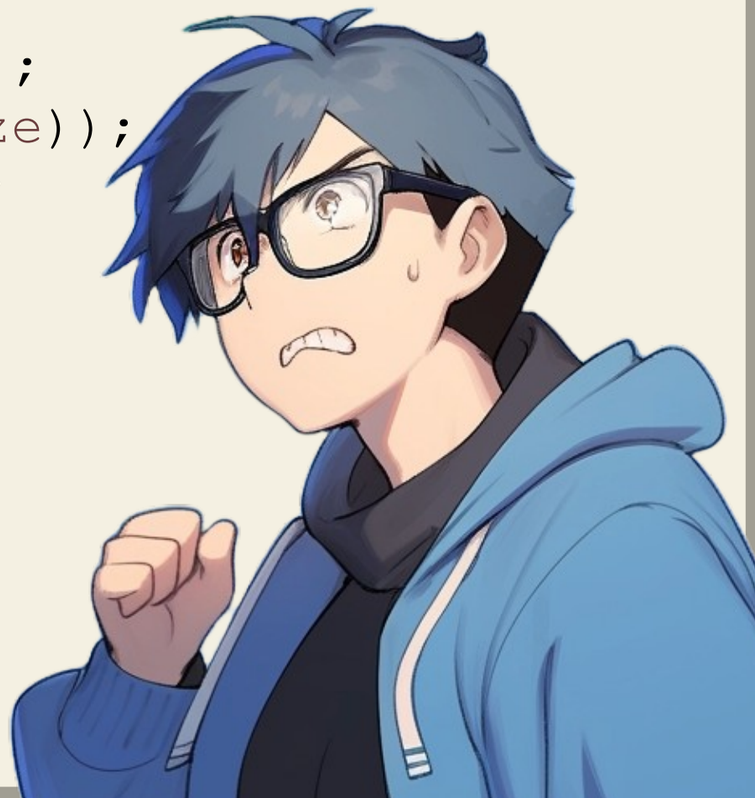
Finally, to merge the two halves..



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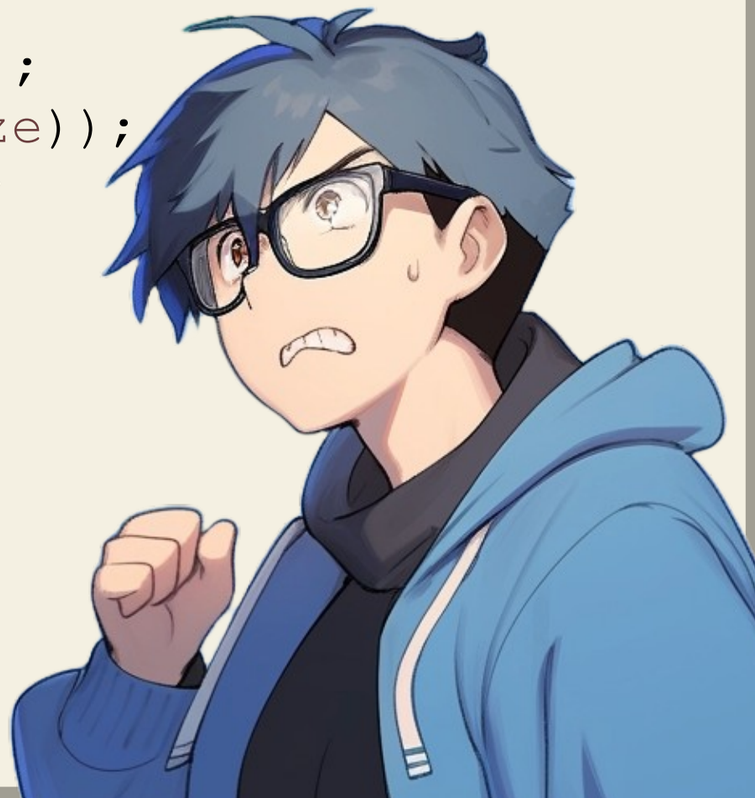
What?



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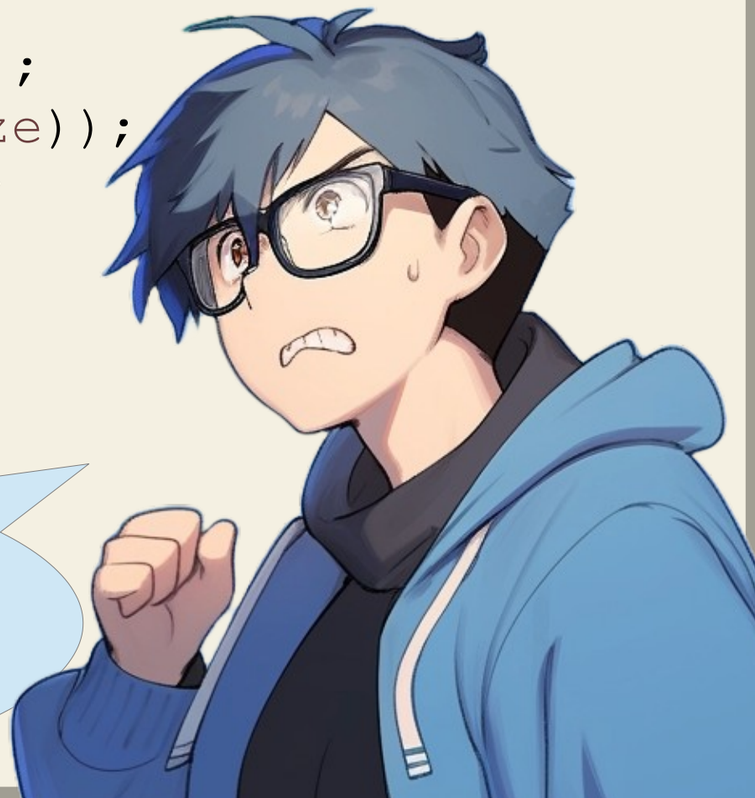
Finally, to merge the two halves..

What?

Merge is also an iterator?
How else could we be building
a PeekIterator from it?



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record Merge<T extends Comparable<? super T>>(
    PeekIterator<T> left, PeekIterator<T> right) implements Iterator<T> {

  public boolean hasNext() { return left.hasNext() || right.hasNext(); }

  public T next() {
    if (!left.hasNext()) { return right.next(); }
    if (!right.hasNext()) { return left.next(); }
    boolean leftWin= left.peek().compareTo(right.peek()) <= 0;
    return (leftWin ? left : right).next();
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}
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The definition of ‘Merge’ is part of the model solution!

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It is user defined code implementing Iterator

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The definition of ‘Merge’ is part of the model solution!

It is user defined code implementing Iterator

Wow!


They asked us to ‘use iterators’


They asked us to ‘use iterators’
And so I got stuck on only using the existing iterators


They asked us to ‘use iterators’
And so I got stuck on only using the existing iterators
Instead of relying on the infinite set of all possible iterators that we could code ourselves!


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And so I got stuck on only using the existing iterators
Instead of relying on the infinite set of all possible iterators that we could code ourselves!
It feels like I’m still unable to understand what real programming is!

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Merge has two PeekIterators and implements Iterator

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Merge has two PeekIterators and implements Iterator

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Merge has two PeekIterators and implements Iterator

hasNext holds if either left or right have a next

To go next we take the smallest between the left and the right next values

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This is where we peek!

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  }
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```

This is where we peek!

We observe both Iterators, but we move forward only one of the two

```java
final class PeekIterator<T> implements Iterator<T> {
  public boolean hasNext(){ return top != null; }
  public T next() {
    try { return top; }
    finally{ top = (delegate.hasNext() ? delegate.next() : null); }
  }
  private T top;
  final private Iterator<T> delegate;
  public PeekIterator(Iterator<T> delegate) {
    this.delegate = delegate;
    next();
  }
  public T peek(){ return top; }
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  public boolean hasNext(){ return top != null; }
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  private T top;
  final private Iterator<T> delegate;
  public PeekIterator(Iterator<T> delegate) {
    this.delegate = delegate;
    next();
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}
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And here we find PeekIterator

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  public boolean hasNext(){ return top != null; }
  public T next() {
    try { return top; }
    finally{ top = (delegate.hasNext() ? delegate.next() : null); }
  }
  private T top;
  final private Iterator<T> delegate;
  public PeekIterator(Iterator<T> delegate) {
    this.delegate = delegate;
    next();
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  public T peek(){ return top; }
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And here we find PeekIterator

Yes, PeekIterator is user-defined code, too

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final class PeekIterator<T> implements Iterator<T> {
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  private T top;
  final private Iterator<T> delegate;
  public PeekIterator(Iterator<T> delegate) {
    this.delegate = delegate;
    next();
  }
  public T peek(){ return top; }
}
```

And here we find PeekIterator

Yes, PeekIterator is user-defined code, too

Significantly, its ‘hasNext’ and ‘next’ methods operate in constant time, regardless of the type of iterator it encapsulates

Riky and Hanton are also discussing the solution

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'sorted' recursively
constructs a binary tree


'sorted' recursively constructs a binary tree
Peak(Merge(_,_))


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Peak


'sorted' recursively constructs a binary tree
Leaves are PeekIterators
wrapping single-element iterators
Peak(Merge(_,_))
Peak
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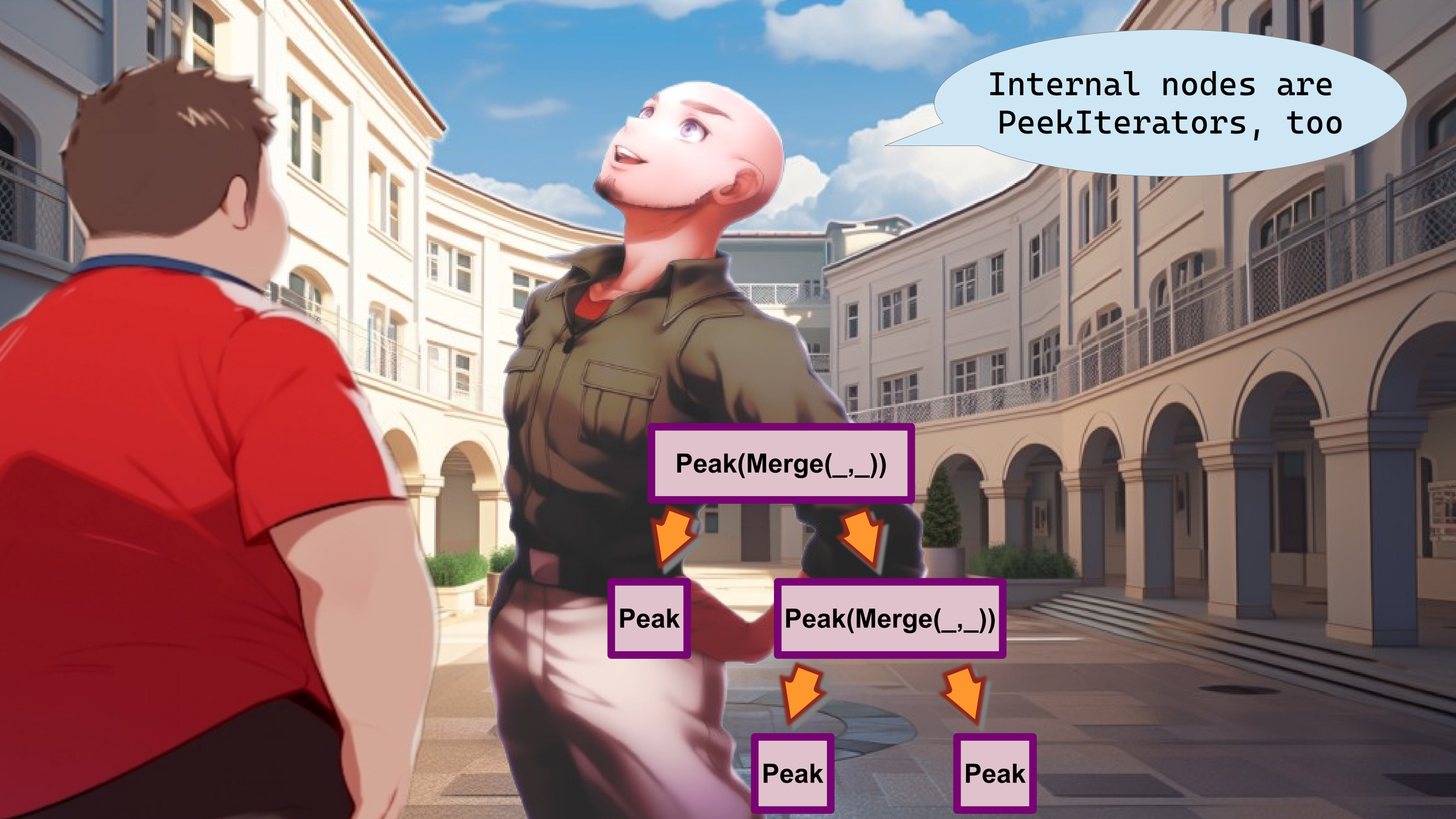
Internal nodes are PeekIterators, too
Peak(Merge(_,_))
Peak
Peak(Merge(_,_))
Peak
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Internal nodes are PeekIterators, too
Wrapping Merge instances, which in turn wrap two child iterators
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Yes


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The tree lays out in memory the merge sort divide-and-conquer strategy before running it


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The tree lays out in memory the merge sort divide-and-conquer strategy before running it
The leafs are the base cases and the internal nodes represent merge operations to be performed

```java
class MergeSort {
  public <T extends Comparable<? super T>> List<T> sort(List<T> c) {
    List<T> result = new ArrayList<>(c.size());
    sorted(c).forEachRemaining(e -> result.add(e));
    return Collections.unmodifiableList(result);
  }
  <T extends Comparable<? super T>> PeekIterator<T> sorted(List<T> input) {
    int size = input.size();
    if (size < 2){ return new PeekIterator<>(input.iterator()); }
    int mid = size / 2;
    PeekIterator<T> left=  sorted(input.subList(0, mid));
    PeekIterator<T> right= sorted(input.subList(mid, size));
    return new PeekIterator<>(new Merge<>(left, right));
  }
}
record Merge<T extends Comparable<? super T>>( … )
  implements Iterator<T>{ … }

final class PeekIterator<T> implements Iterator<T> { … }
```

Miss Pumpkin’s full solution 1/3

```java
record Merge<T extends Comparable<? super T>>(
    PeekIterator<T> left, PeekIterator<T> right) implements Iterator<T> {

  public boolean hasNext() { return left.hasNext() || right.hasNext(); }

  public T next() {
    if (!left.hasNext()) { return right.next(); }
    if (!right.hasNext()) { return left.next(); }
    boolean leftWin= left.peek().compareTo(right.peek()) <= 0;
    return (leftWin ? left : right).next();
  }
}
```

Miss Pumpkin’s full solution 2/3

```java
final class PeekIterator<T> implements Iterator<T> {
  public boolean hasNext() { return top != null; }
  public T next() {
    try { return top; }
    finally { top = (delegate.hasNext() ? delegate.next() : null); }
  }
  private T top;
  final private Iterator<T> delegate;
  public PeekIterator(Iterator<T> delegate) {
    this.delegate = delegate;
    next();
  }
  public T peek() { return top; }
}
```

Miss Pumpkin’s full solution 3/3


I'm looking at Pupon's solution of the Optionals question
No surprise Pumpkin made this question
She loves functional programming
I wonder how Pupon handled it since he clearly favors the imperative style

```java
record Some<T>(T get) implements Optional<T>{
  public T orElseGet(Supplier<T> unused){ return get; }
  public Optional<T> or(Supplier<Optional<T>> s){ return this; }
  public <U> Optional<U> map(Function<T, U> m){
    return Optional.ofNullable(m.apply(get));
  }
  public <U> Optional<U> flatMap(Function<T, Optional<U>> m){
    return Objects.requireNonNull(m.apply(get));
  }
}

enum Empty implements Optional<Object>{ Instance; }
```

Pupon’s full solution 1/2

```java
public sealed interface Optional<T>
    extends Serializable permits Empty, Some<T>{
  @SuppressWarnings("unchecked")
  static <E> Optional<E> empty(){ return (Optional<E>)Empty.Instance; }
  static <T> Optional<T> of(T value){
    return new Some<T>(Objects.requireNonNull(value));
  }
  static <T> Optional<T> ofNullable(T value){
    return value == null ? empty() : new Some<T>(value);
  }
  default T orElseGet(Supplier<T> s){ return s.get(); }
  default Optional<T> or(Supplier<Optional<T>> s){
    return Objects.requireNonNull(s.get());
  }
  default <U> Optional<U> map(Function<T, U> m){ return Optional.empty(); }
  default Optional<T> filter(Predicate<T> p){
    return map(e->p.test(e) ? e : null);
  }
  default <U> Optional<U> flatMap(Function<T, Optional<U>> m){
    return Optional.empty();
  }
}
```

Pupon’s full solution 2/2