

# Queue

*dequeue*

*Getting Data Out of a Queue*

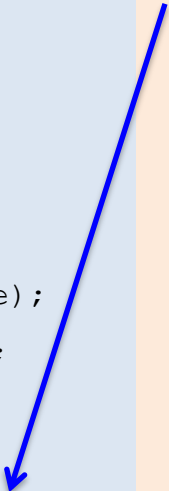
One of the 5 Queue Specific Operations

# The Queue Component

Let's look at the *dequeue* operation

All C++ *container* components have an operation that allows the client to extract data from the container, for Queue this operation is *dequeue*

```
template <class T>
class Queue1
{
public: // Standard Operations
    Queue1();
    ~Queue1();
    void clear (void);
    void transferFrom (Queue1& source);
    Queue1& operator = (Queue1& rhs);
// Queue1 Specific Operations
    void enqueue (T& x);
    void dequeue (T& x);
    void replaceFront (T& x);
    T& front (void);
    Integer length (void);
private: // representation
    // ...
};
```



```

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// Queue1 Specific Operations
    void enqueue (T& x);
    void dequeue (T& x);
        //! updates self
        //! replaces x
        //! requires: self != <>
        //! ensures: <x> is prefix of #self
        //! and self = #self[1, |#self|)
    void replaceFront (T& x);
    T& front (void);
    Integer length (void);
private: // representation
    // ...
};

```

dequeue

The job of *dequeue* is to move the value stored at the front of the queue into parameter *x*

Note *dequeue*, moves the value, it does not copy it

# dequeue

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    void enqueue (T& x);
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        //! updates self
        //! replaces x
        //! requires: self /= <>
        //! ensures: <x> is prefix of #self
        //! and self = #self[1, |#self|)

    void replaceFront (T& x);

    T& front (void);
    Integer length (void);
private: // representation
    // ...
};
```

*dequeue*'s ensures clause indicates:

- The outgoing value of *x* is equal to the front of *#self* (the incoming queue)
- The outgoing value of *self* equals the *#self* with the item at the front of *#self* removed

# dequeue

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        //! and self = #self[1, |#self|)

    void replaceFront (T& x);
    T& front (void);
    Integer length (void);
private: // representation
    // ...
};
```

*dequeue* is called in the client below and the lines following the call contain comments based on *dequeue*'s spec

*Example client:*

```
{
1  typedef Queue1<Integer> IntegerQueue;
2  IntegerQueue q1;
3  Integer y2;
4  // ...
5  // Suppose q1 = <7,33,18>
6  q1.dequeue(y2);
7  // <x> is prefix of #self
8  // self = #self[1, |#self|)
}
```

# dequeue

```
template <class T>
class Queue1
{
public: // Standard Operations
    Queue1();
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    void clear (void);
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    void enqueue (T& x);

    void dequeue (T& x);
        //! updates self
        //! replaces x
        //! requires: self != <>
        //! ensures: <x> is prefix of #self
        //! and self = #self[1, |#self|)

    void replaceFront (T& x);
    T& front (void);
    Integer length (void);
private: // representation
    // ...
};
```

Substitute:

- q1 for *self*
- y2 for *x*

This gives us

*Example client:*

```
{
1  typedef Queue1<Integer> IntegerQueue;
2  IntegerQueue q1;
3  Integer y2;
4  // ...
5  // Suppose q1 = <7,33,18>
6  q1.dequeue(y2);
7  // <y2> is prefix of #q1
8  // q1 = #q1[1, |#q1|)
}
```

# dequeue

```
template <class T>
class Queue1
{
public: // Standard Operations
    Queue1();
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    void clear (void);
    void transferFrom (Queue1& source);
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    void enqueue (T& x);
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        //! updates self
        //! replaces x
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        //! and self = #self[1, |#self|)
    void replaceFront (T& x);
    T& front (void);
    Integer length (void);
private: // representation
    // ...
};
```

Now substitute:

- <7,33,18> for #q1

This gives us

*Example client:*

```
{
1  typedef Queue1<Integer> IntegerQueue;
2  IntegerQueue q1;
3  Integer y2;
4  // ...
5  // Suppose q1 = <7,33,18>
6  q1.dequeue(y2);
7  // <y2> is prefix of <7,33,18>
8  // q1 = <7,33,18>[1, |<7,33,18>|)
}
```

# dequeue

```
template <class T>
class Queue1
{
public: // Standard Operations
    Queue1();
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    void clear (void);
    void transferFrom (Queue1& source);
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        //! and self = #self[1, |#self|)
    void replaceFront (T& x);
    T& front (void);
    Integer length (void);
private: // representation
    // ...
};
```

Evaluate: <y2> is prefix of <7,33,18>

Giving y2's outgoing value:  $y2 = 7$

This gives us

*Example client:*

```
{
1  typedef Queue1<Integer> IntegerQueue;
2  IntegerQueue q1;
3  Integer y2;
4  // ...
5  // Suppose q1 = <7,33,18>
6  q1.dequeue(y2);
7  // y2 = 7
8  // q1 = <7,33,18>[1, |<7,33,18>|)
}
```



# dequeue

```
template <class T>
class Queue1
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    Queue1();
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        //! updates self
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        //! requires: self != <>
        //! ensures: <x> is prefix of #self
        //! and self = #self[1, |#self|)
    void replaceFront (T& x);
    T& front (void);
    Integer length (void);
private: // representation
    // ...
};
```

Evaluate:  $q1 = \langle 7, 33, 18 \rangle [1, |\langle 7, 33, 18 \rangle|]$   
 $= \langle 7, 33, 18 \rangle [1, 3]$   
 $= \langle 33, 18 \rangle$

Giving  $q1$ 's outgoing value:  $q1 = \langle 33, 18 \rangle$

This gives us

*Example client:*

```
{
1  typedef Queue1<Integer> IntegerQueue;
2  IntegerQueue q1;
3  Integer y2;
4  // ...
5  // Suppose q1 = <7, 33, 18>
6  q1.dequeue(y2);
7  // y2 = 7
8  // q1 = <33, 18>
}
```

# dequeue

```
template <class T>
class Queue1
{
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    Queue1();
    ~Queue1();

    void clear (void);
    void transferFrom (Queue1& source);
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        //! updates self
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        //! requires: self != <>
        //! ensures: <x> is prefix of #self
        //! and self = #self[1, |#self|)

    void replaceFront (T& x);
    T& front (void);
    Integer length (void);
private: // representation
    // ...
};
```

*dequeue's* ensures clause allows us to reason that the outgoing values of y2 and q1 are:

- $y2 = 7$
- $q1 = \langle 33, 18 \rangle$

*Example client:*

```
{
1  typedef Queue1<Integer> IntegerQueue;
2  IntegerQueue q1;
3  Integer y2;
4  // ...
5  // Suppose q1 = <7, 33, 18>
6  q1.dequeue(y2);
7  // y2 = 7
8  // q1 = <33, 18>
}
```

# dequeue

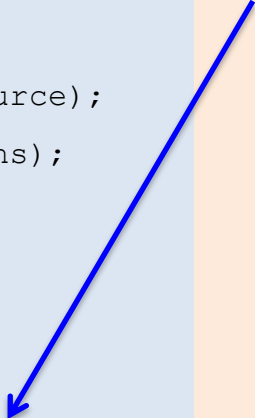
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class Queue1
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    void enqueue (T& x);
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        //! updates self
        //! replaces x
        //! requires: self /= <>
        //! ensures: <x> is prefix of #self
        //! and self = #self[1, |#self|)

    void replaceFront (T& x);

    T& front (void);
    Integer length (void);
private: // representation
    // ...
};
```

Now examine *dequeue*'s requires clause



# dequeue

```
template <class T>
class Queue1
{
public: // Standard Operations
    Queue1();
    ~Queue1();

    void clear (void);
    void transferFrom (Queue1& source);
    Queue1& operator = (Queue1& rhs);
// Queue1 Specific Operations
    void enqueue (T& x);
    void dequeue (T& x);
        //! updates self
        //! replaces x
        //! requires: self != <>
        //! ensures: <x> is prefix of #self
        //! and self = #self[1, |#self|)
    void replaceFront (T& x);
    T& front (void);
    Integer length (void);
private: // representation
    // ...
};
```

*dequeue*'s requires clause indicates the incoming value of *self* must not be empty

We must check the client's call to *dequeue* to make sure it satisfies *dequeue*'s requires clause

*Example client:*

```
{
1  typedef Queue1<Integer> IntegerQueue;
2  IntegerQueue q1;
3  Integer y2;
4  // ...
5  // Suppose q1 = <7,33,18>
6  q1.dequeue(y2);
}
```

# dequeue

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template <class T>
class Queue1
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        //! updates self
        //! replaces x
        //! requires: self != <>
        //! ensures: <x> is prefix of #self
        //! and self = #self[1, |#self|)
    void replaceFront (T& x);
    T& front (void);
    Integer length (void);
private: // representation
    // ...
};
```

In the client below a comment containing the *dequeue*'s requires clause has been inserted prior to the call to *dequeue*

*Example client:*

```
{
1  typedef Queue1<Integer> IntegerQueue;
2  IntegerQueue q1;
3  Integer y2;
4  // ...
5  // Suppose q1 = <7,33,18>
6  // self != <>
7  q1.dequeue(y2);
}
```

# dequeue

```
template <class T>
class Queue1
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public: // Standard Operations
    Queue1();
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        //! and self = #self[1, |#self|)
    void replaceFront (T& x);
    T& front (void);
    Integer length (void);
private: // representation
    // ...
};
```

Substitute:

- q1 for *self*

This gives us

*Example client:*

```
{
1  typedef Queue1<Integer> IntegerQueue;
2  IntegerQueue q1;
3  Integer y2;
4  // ...
5  // Suppose q1 = <7,33,18>
6  // q1 != <>
7  q1.dequeue(y2);
}
```

# dequeue

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template <class T>
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    void replaceFront (T& x);
    T& front (void);
    Integer length (void);
private: // representation
    // ...
};
```

Now substitute:

- <7,33,18> for q1

This gives us

*dequeue*'s requires clause allows us to reason that the incoming queue q1 is not empty

*Example client:*

```
{
1  typedef Queue1<Integer> IntegerQueue;
2  IntegerQueue q1;
3  Integer y2;
4  // ...
5  // Suppose q1 = <7,33,18>
6  // <7,33,18> /= <>
7  q1.dequeue(y2);
}
```