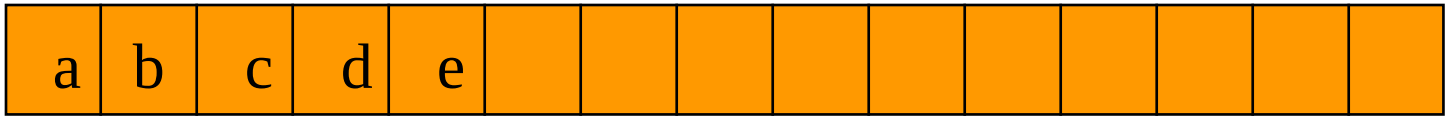
Жагсаалт. Холбоост суурилсан дүрслэл

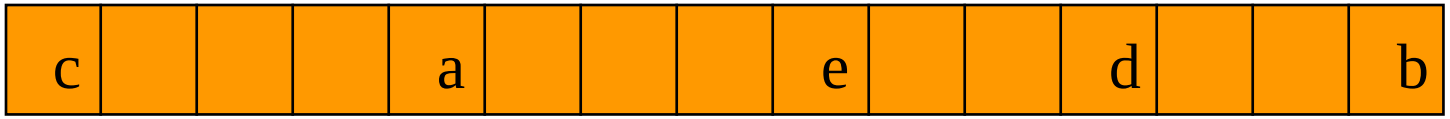
- Жагсаалтын элемент ойд зоргоороо байрлана
- Элементээс элементед шилжихдээ нэмэлт мэдээлэл (холбоос) ашиглана

Ойн байршил

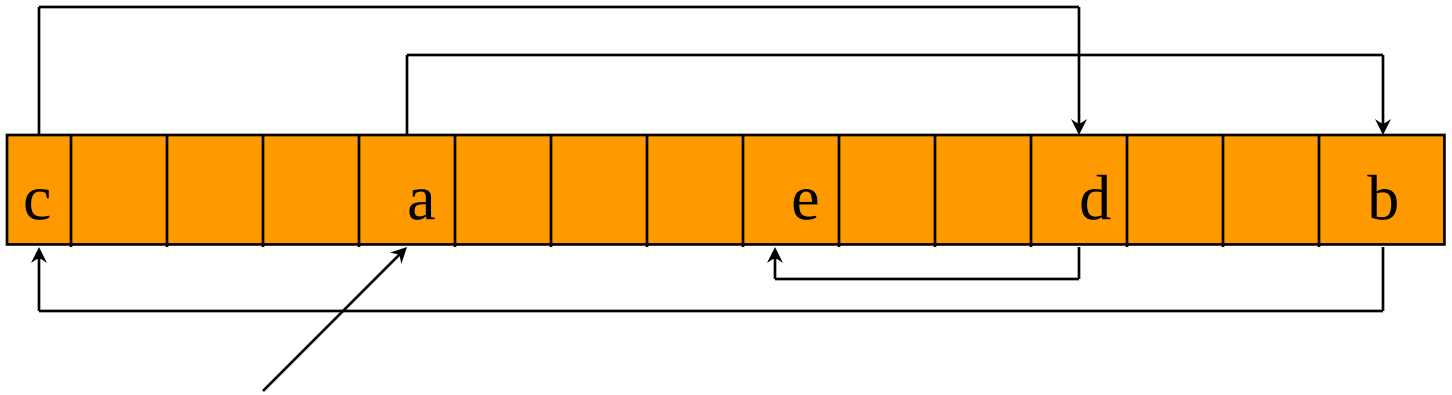
L = (a,b,c,d,e) жагсаалт массив дүрслэлээр.



Холбоост дүрслэлд зоргоороо/санамсаргүй байршина.



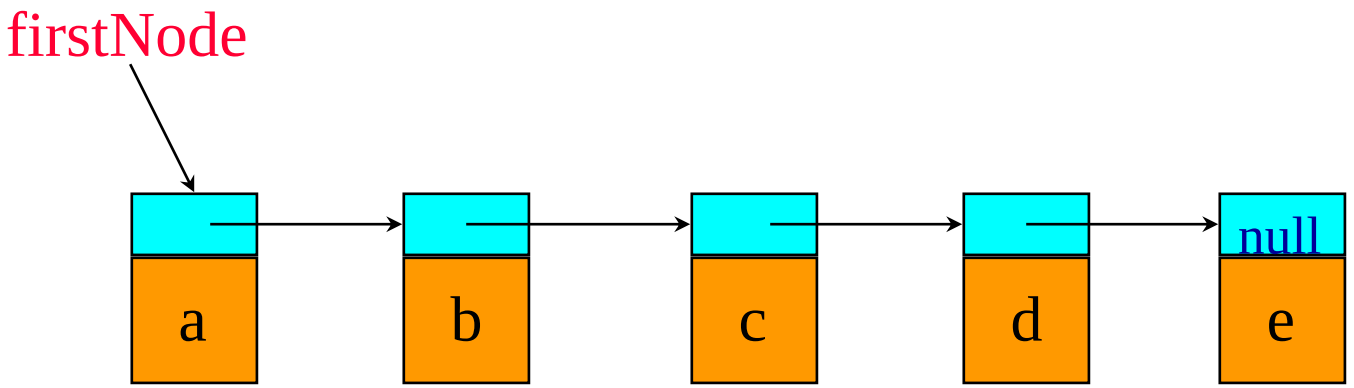
Холбоост дүрслэл

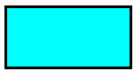


e –ийн заагч (холбоос) null

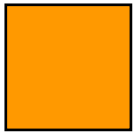
хувьсагч firstNode эхний элемент a –д хүрэхэд ашиглагдана

Холбоост жагсаалтыг зурах арга



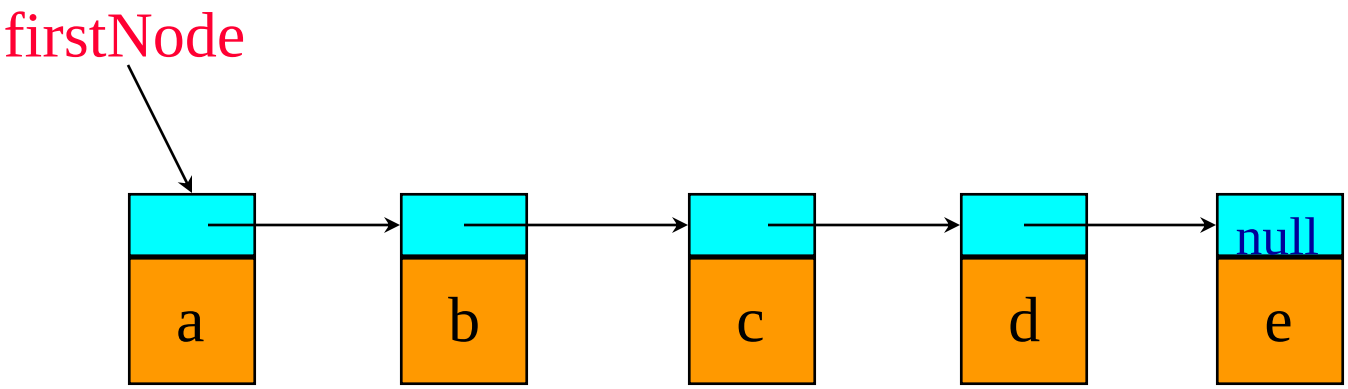


Зангилааны холбоос буюу заагчийн талбар



Зангилааны өгөгдлийн талбар

Гинж



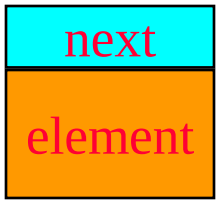
•Гинж бол зангилаа бүр нэг элементийг илэрхийлэх холбоост жагсаалт.

• Энд холбоос буюу заагч нэг элементээс нөгөөд хүрэхийг зааж байна.

• Сүүлийн зангилааний заагч null байна.

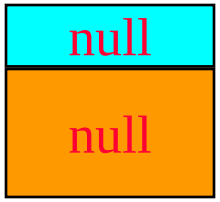
Зангилааг дүрслэх

```
package dataStructures;

class ChainNode
{
   // багцын харагдах өгөгдөл гишүүд
   Object element;
   ChainNode next;

   // байгуулагчид
}
```

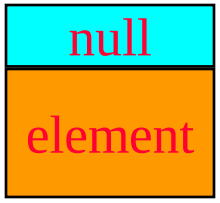


ChainNode –ийн байгуулагчид

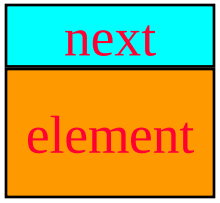
ChainNode() {}



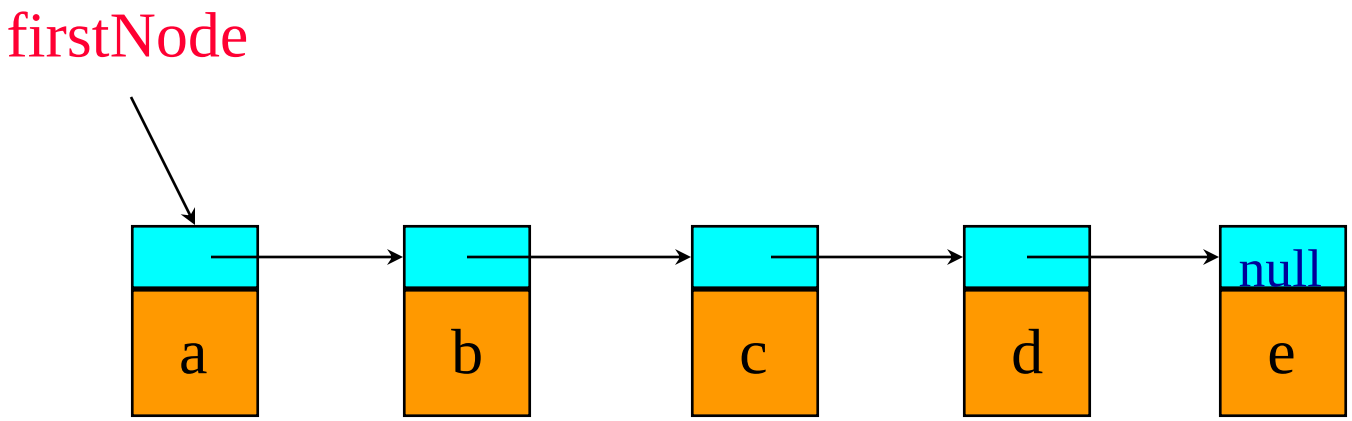
ChainNode(Object element)
{this.element = element;}



ChainNode(Object element, ChainNode next)
{this.element = element;
this.next = next;}



get(0)

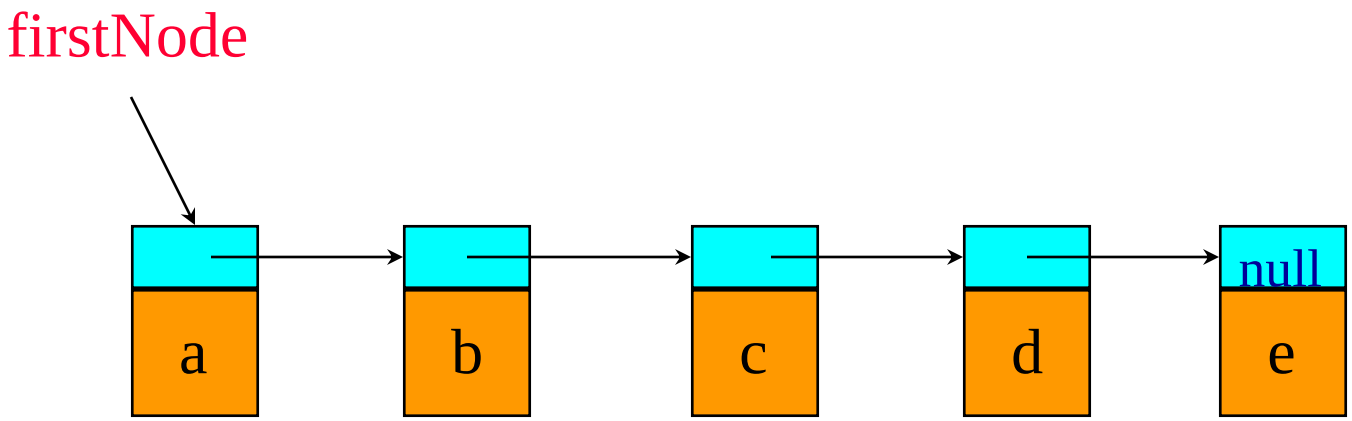


checkIndex(0);

desiredNode = firstNode; // эхний зангилааг авах

return desiredNode.element;

get(1)

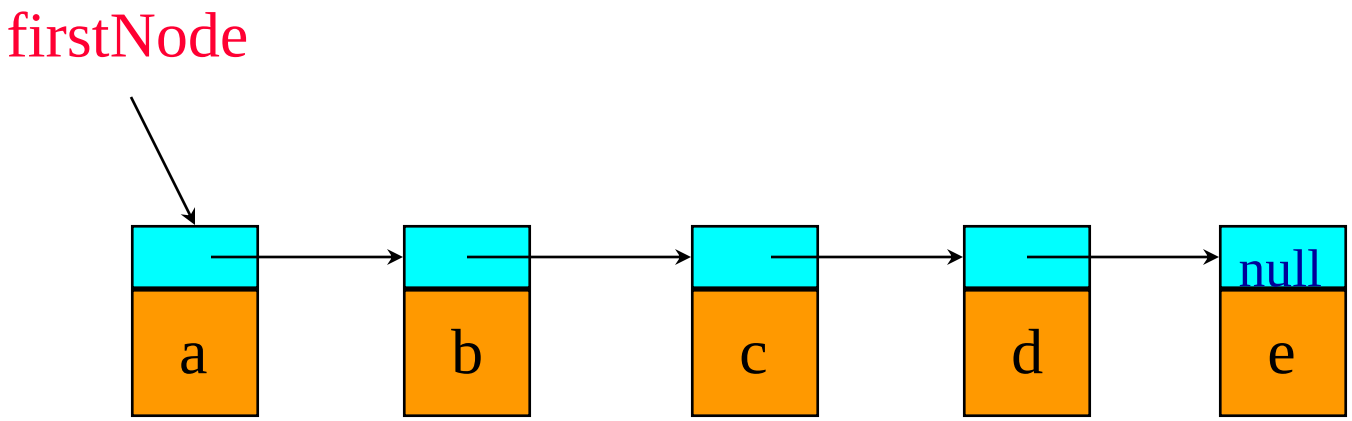


checkIndex(1);

desiredNode = firstNode.next; // хоёр дахь зангилааг авах

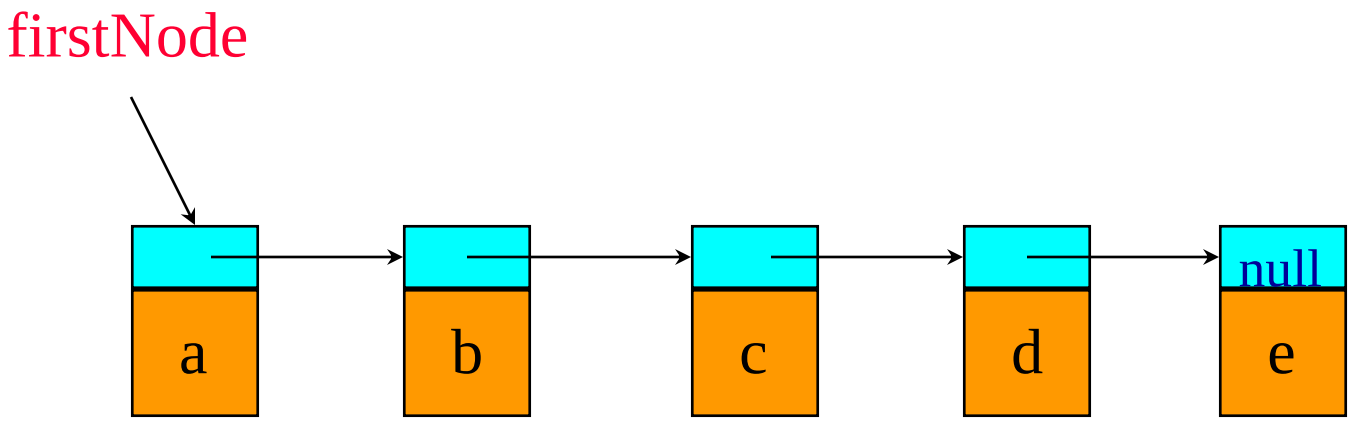
return desiredNode.element;

get(2)




```
checkIndex(2);
desiredNode = firstNode.next.next; // гурав дахь зангилааг авах
return desiredNode.element;
```

get(5)



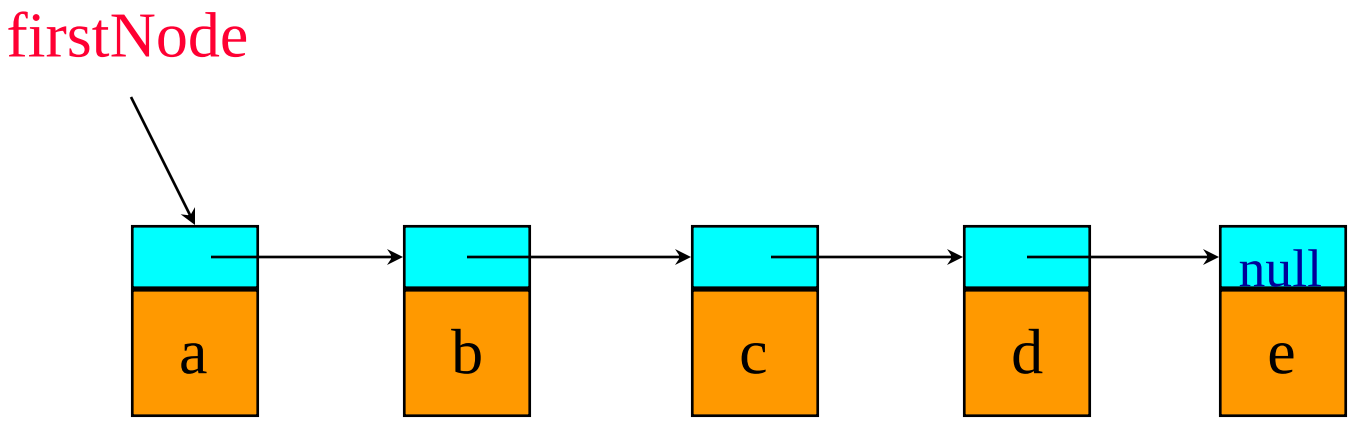
checkIndex(5); // онцгой тохиолдол унана

desiredNode = firstNode.next.next.next.next.next;

// desiredNode = null

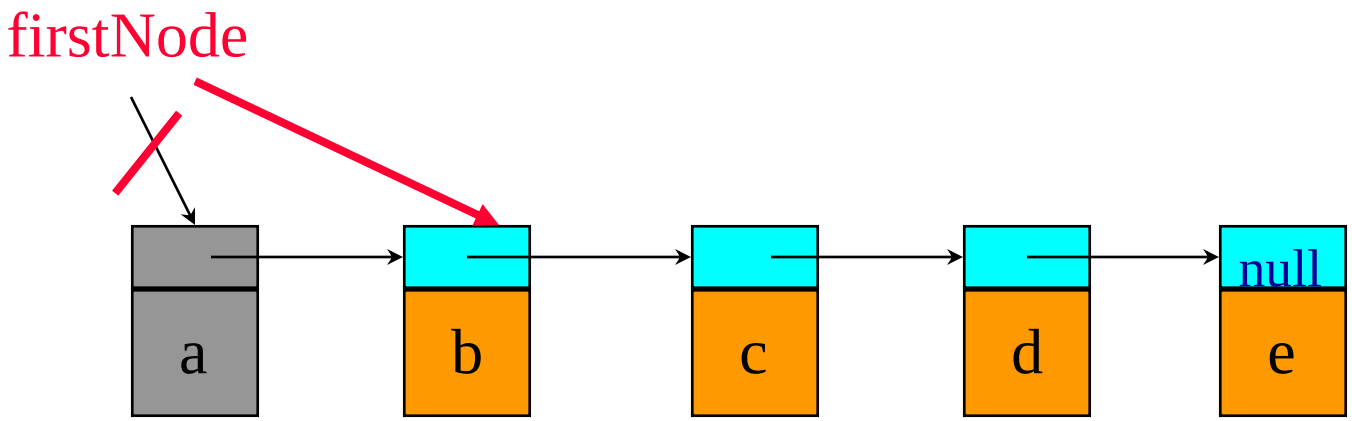
return desiredNode.element; // null.element

NullPointerException




```
desiredNode =
    firstNode.next.next.next.next.next.next;
      // компьютер тэнэг байдалд орж
      // NullPointerException унана
```

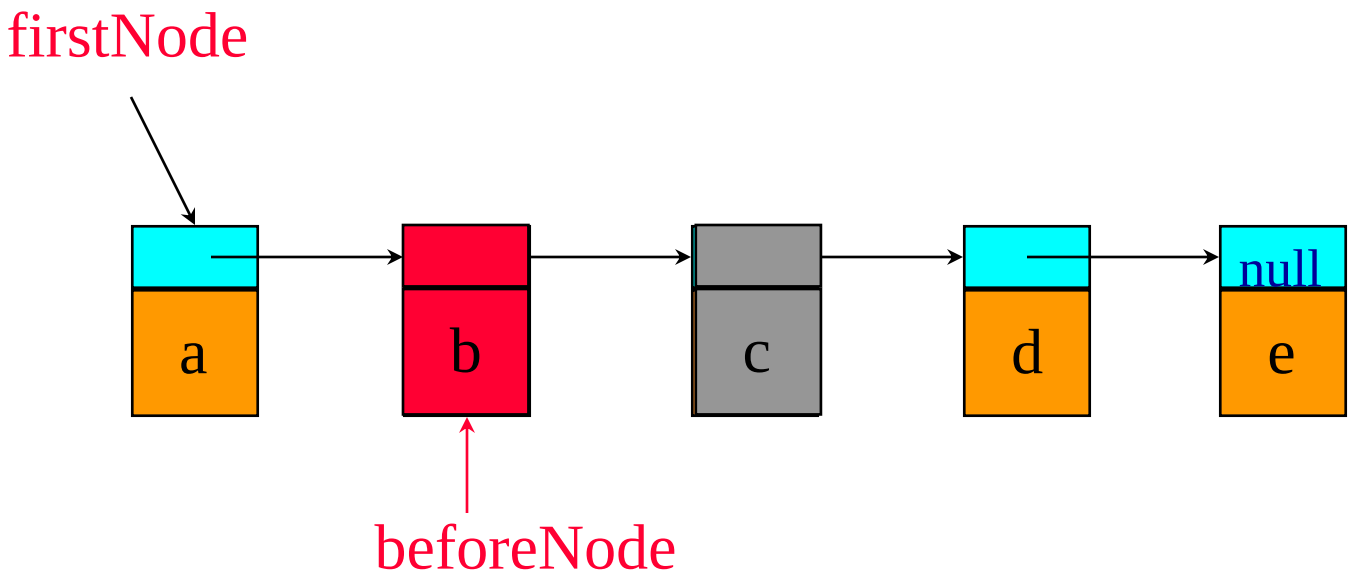
Элемент устгах



remove(0)

firstNode = firstNode.next;

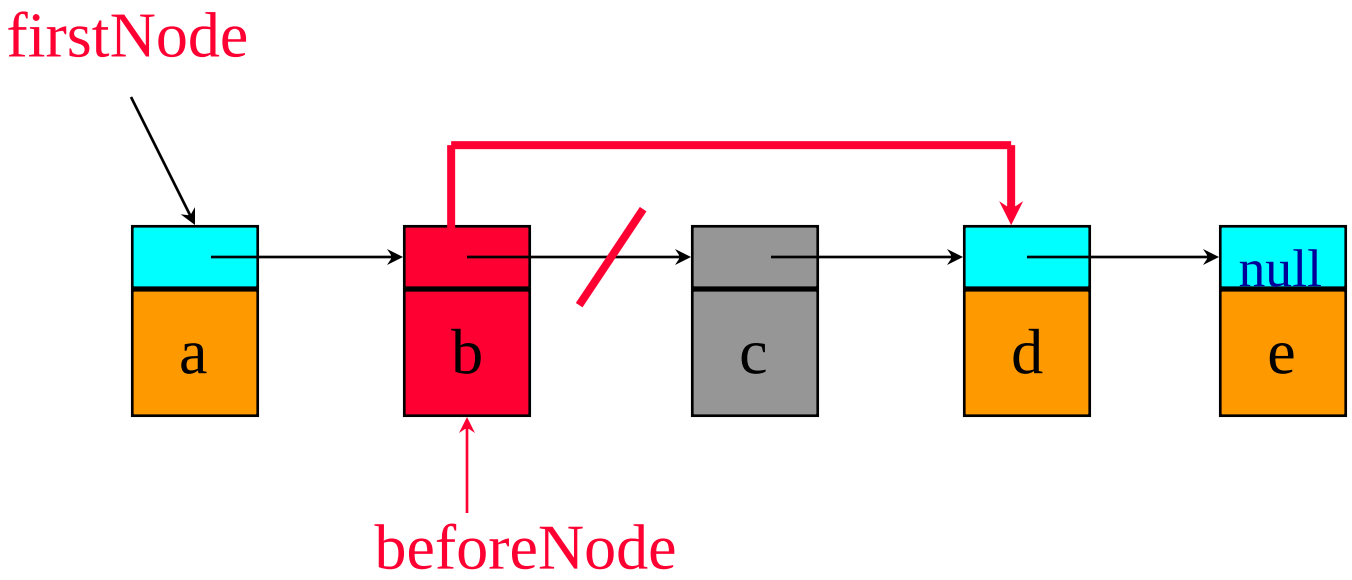
remove(2)



Зангилааг устгахаас өмнө түүнд хүрэх ёстой

beforeNode = firstNode.next;

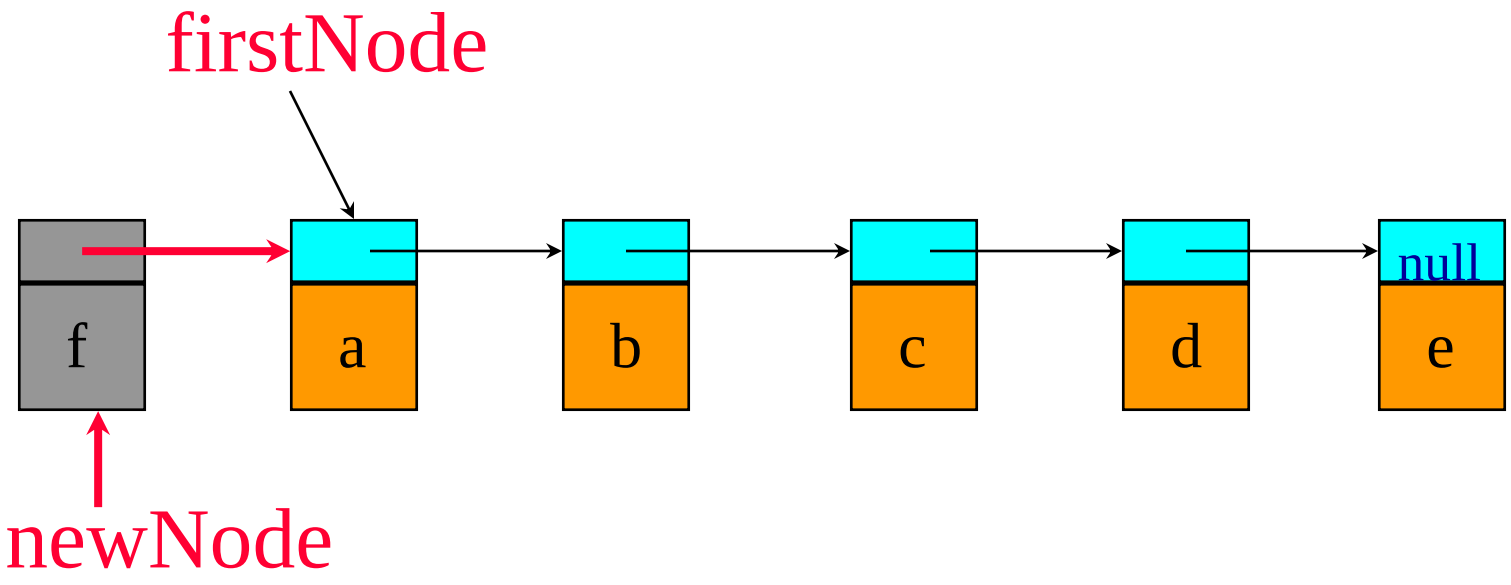
remove(2)



Одоо beforeNode –д байгаа заагчийг өөрчилж болно

beforeNode.next = beforeNode.next.next;

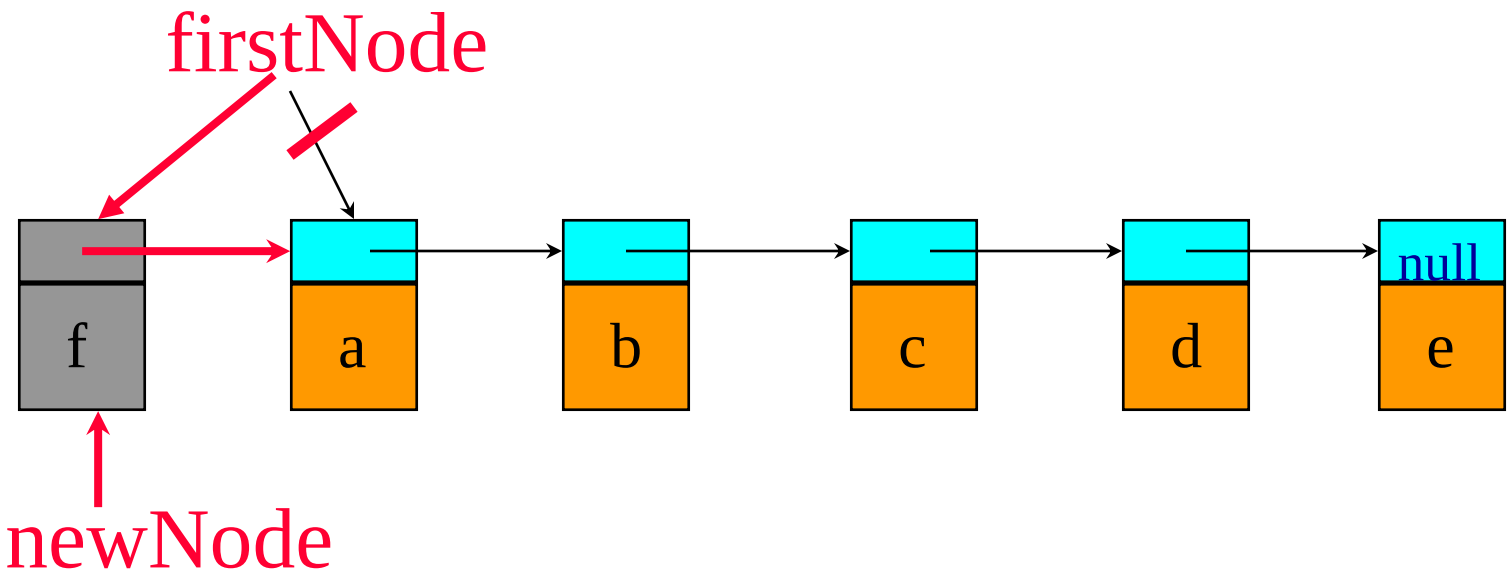
add(0,'f')



Алхам 1: зангилааг үүсгэн өгөгдөл, холбоосын талбарыг тогтооно

```
ChainNode newNode =
    new ChainNode(new Character('f'), firstNode);
```

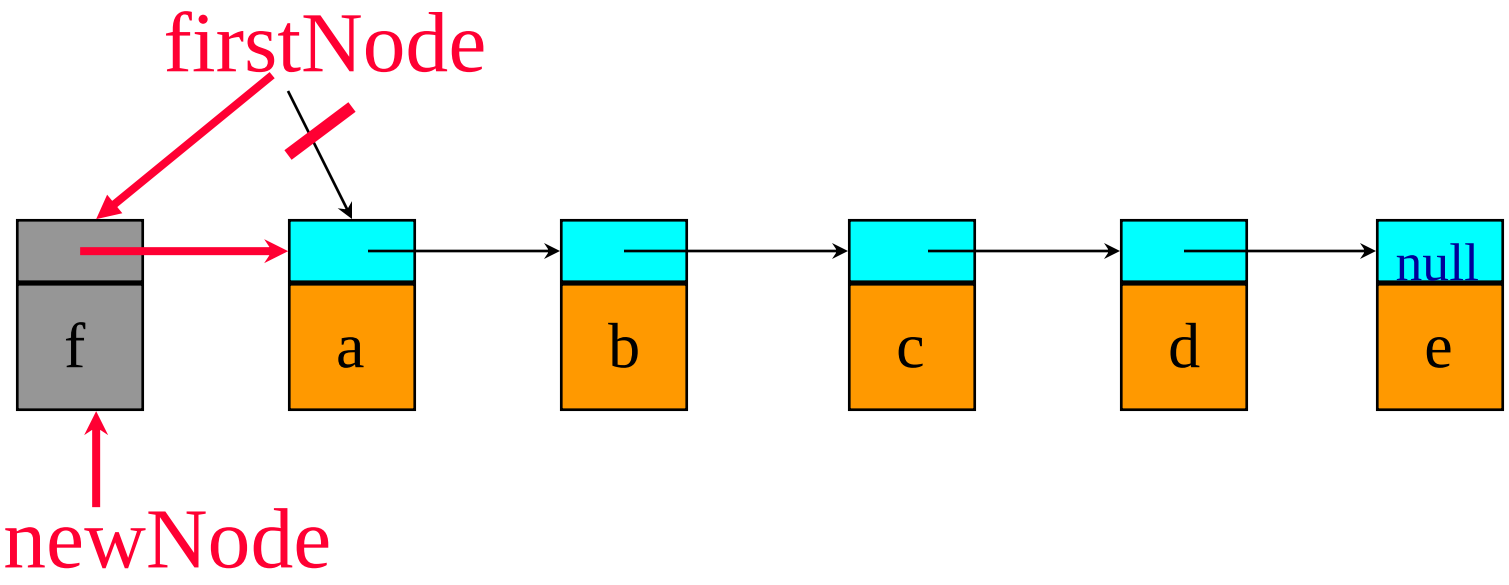
add(0,'f')



Алхам 2: firstNode –г шинэчлэнэ

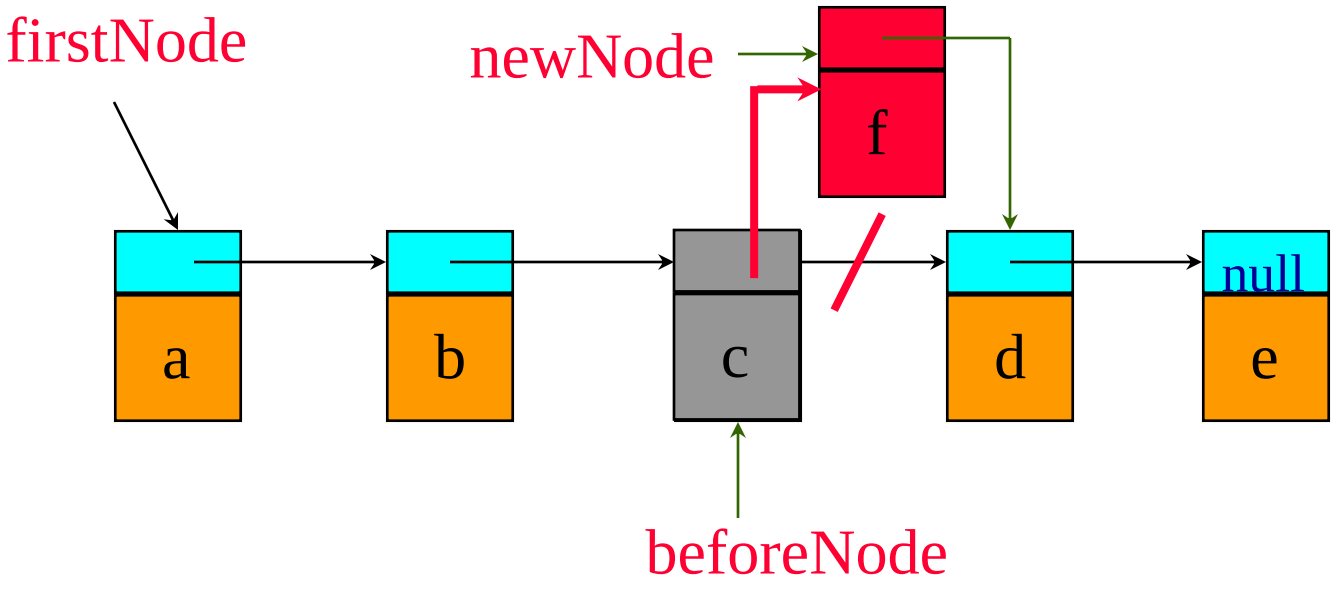
firstNode = newNode;

Нэг алхмын add(0,’f’)




```
firstNode = new ChainNode(
                    new Character(‘f’), firstNode);
```

add(3,'f')



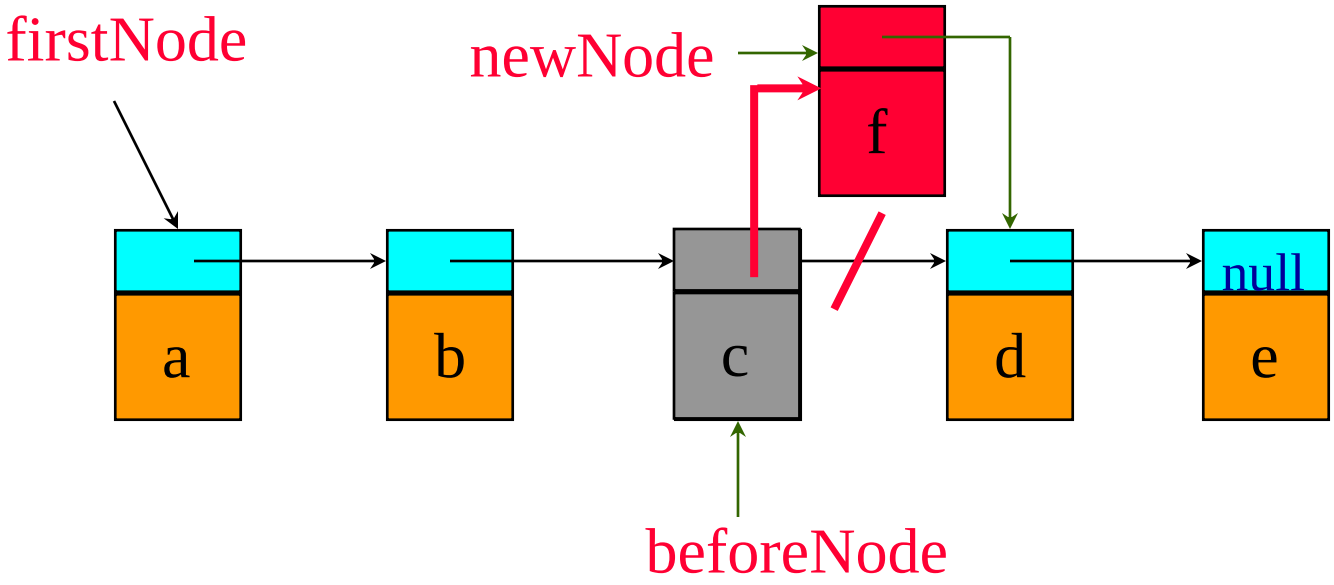
- эхлээд 2 гэсэн индекстэй зангилааг олох
- дараа нь зангилааг үүсгэн өгөгдөл, холбоосын талбарыг тогтооно

```
ChainNode newNode = new ChainNode(new Character('f'),
                                  beforeNode.next);
```

- эцэст нь beforeNode -г newNode –тай холбоно

```
beforeNode.next = newNode;
```

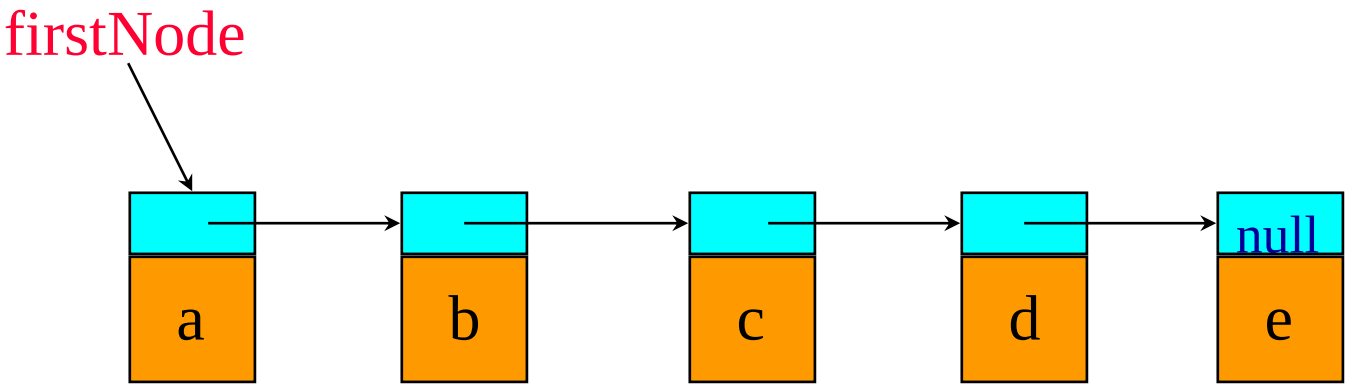
Хоёр алхмын add(3,’f’)




```
beforeNode = firstNode.next.next;
beforeNode.next = new ChainNode(new Character(‘f’),
                                 beforeNode.next);
```

Класс Chain

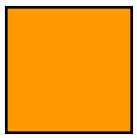
Класс Chain



size = элементийн тоо

ChainNode –г ашиглах

next (datatype ChainNode)



element (datatype Object)

Класс Chain

```
/** LinearList холбоост хэрэгжүүлэлт*/
package dataStructures;
import java.util.*;  // Iterator –г ашиглана
public class Chain implements LinearList
{
   // өгөгдөл гишүүд
   protected ChainNode firstNode;
   protected int size;

   // Chain –ий аргууд
}
```

Байгуулагчид

```
/** хоосон жагсаалт үүсгэх */
public Chain(int initialCapacity)
{
      // firstNode болон size –ий анхны утга
      // null болон 0 байх болно
}

public Chain()
   {this(0);}
```

isEmpty арга

```
/** @return жагсаалт хоосон бол true */
public boolean isEmpty()
   {return size == 0;}
```

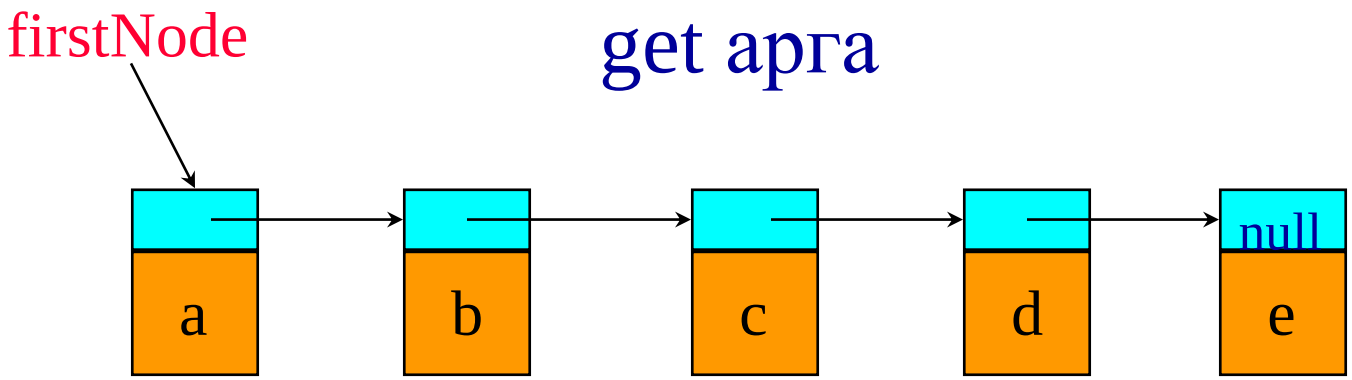
size() арга

```
/** @return элементийн тоо */
public int size()
   {return size;}
```

checkIndex арга

```
/** @throws index –н утга 0, size – 1 –н хооронд биш
 бол  IndexOutOfBoundsException унана*/
void checkIndex(int index)
{
  if (index < 0 || index >= size)
     throw new IndexOutOfBoundsException
          ("index = " + index + "  size = " + size);
}
```

get арга




```
public Object get(int index)
{
   checkIndex(index);

   // хэрэгтэй зангилаанд хүрэх
   ChainNode currentNode = firstNode;
   for (int i = 0; i < index; i++)
      currentNode = currentNode.next;

   return currentNode.element;
}
```

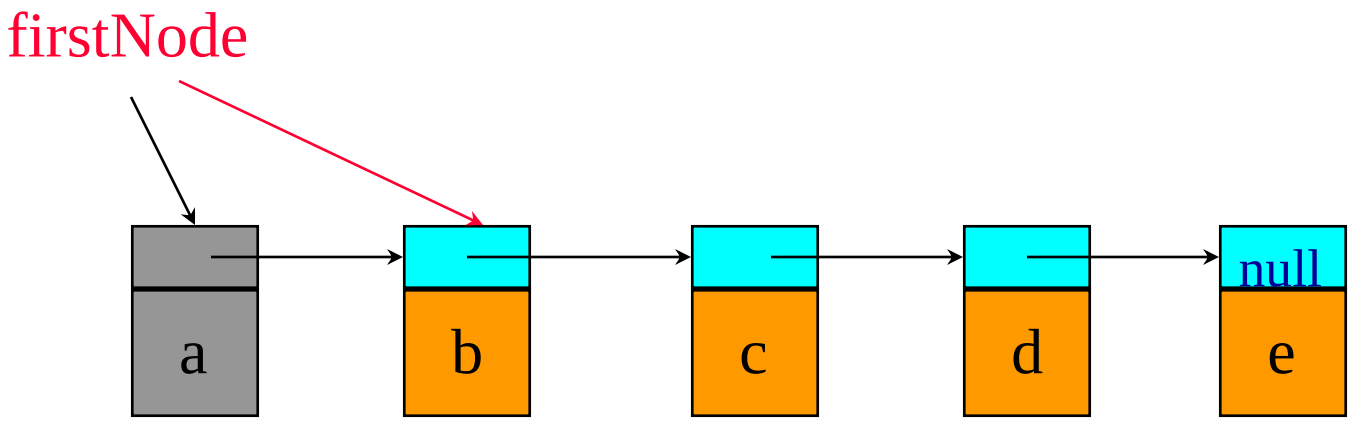
indexOf арга

```
public int indexOf(Object theElement)
 {
    // theElement –г хайх
    ChainNode currentNode = firstNode;
    int index = 0;  // currentNode –н индекс
    while (currentNode != null &&
          !currentNode.element.equals(theElement))
    {
      // дараагийн зангилаанд хүрэх
      currentNode = currentNode.next;
      index++;
    }
```

indexOf арга

```
    // элемент олдсон уу?
    if (currentNode == null)
        return -1;
    else
        return index;
}
```

Элементийг устгах



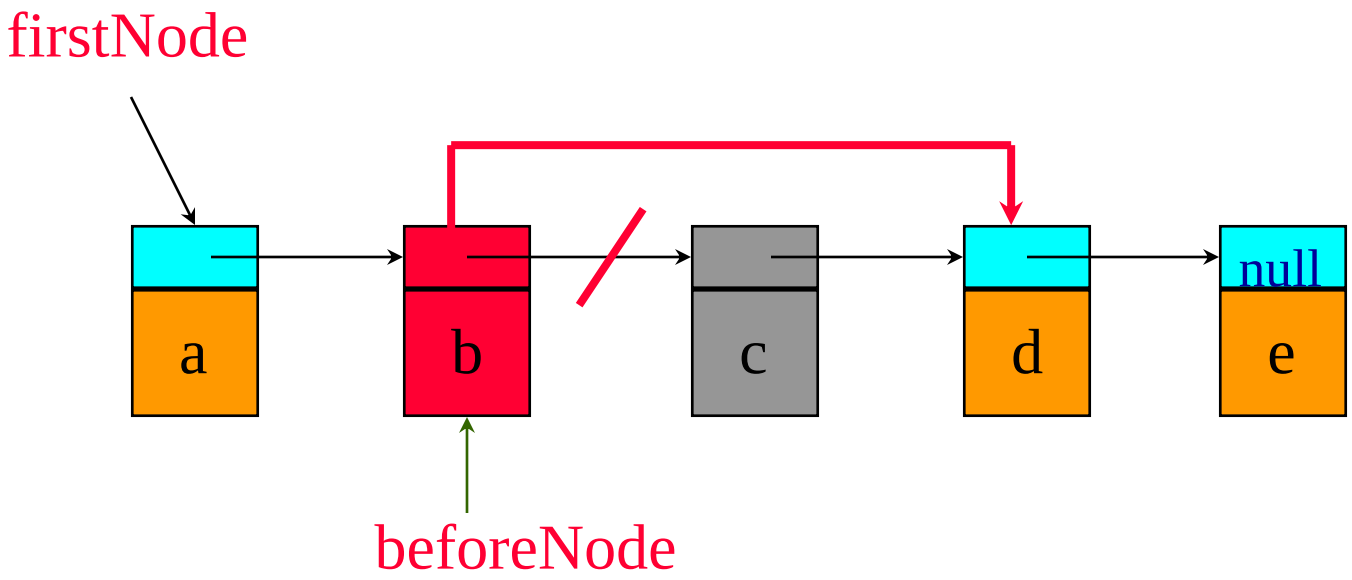
remove(0)

firstNode = firstNode.next;

Элементийг устгах

```
public Object remove(int index)
{
  checkIndex(index);

  Object removedElement;
  if (index == 0) // эхний зангилааг устгах
  {
    removedElement = firstNode.element;
    firstNode = firstNode.next;
  }
```

remove(2)



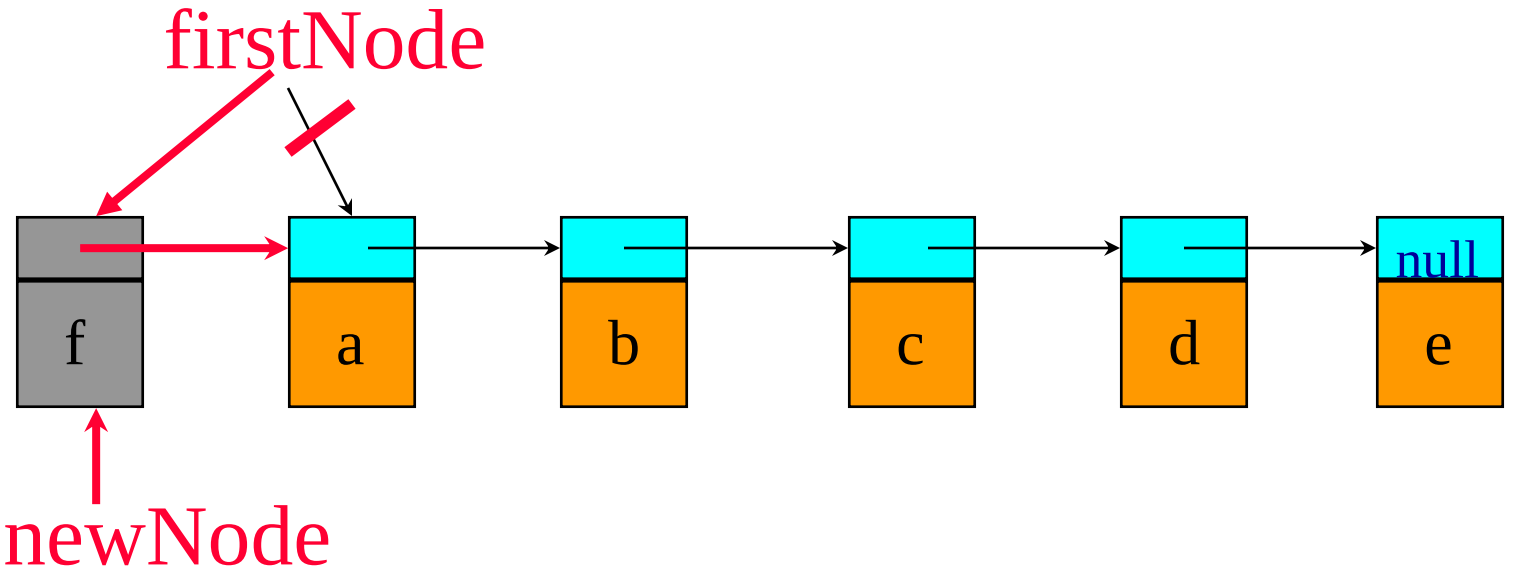
beforeNode –г олж, заагчийг өөрчилнө.

beforeNode.next = beforeNode.next.next;

Элементийг устгах

```
else
   {  // хэрэгтэй зангилааны өмнөхыг олоход q –г ашиглана
      ChainNode q = firstNode;
      for (int i = 0; i < index - 1; i++)
         q = q.next;

      removedElement = q.next.element;
      q.next = q.next.next; // хайсан зангилаагаа устгах
   }
   size--;
   return removedElement;
}
```

Нэг алхмын add(0,’f’)

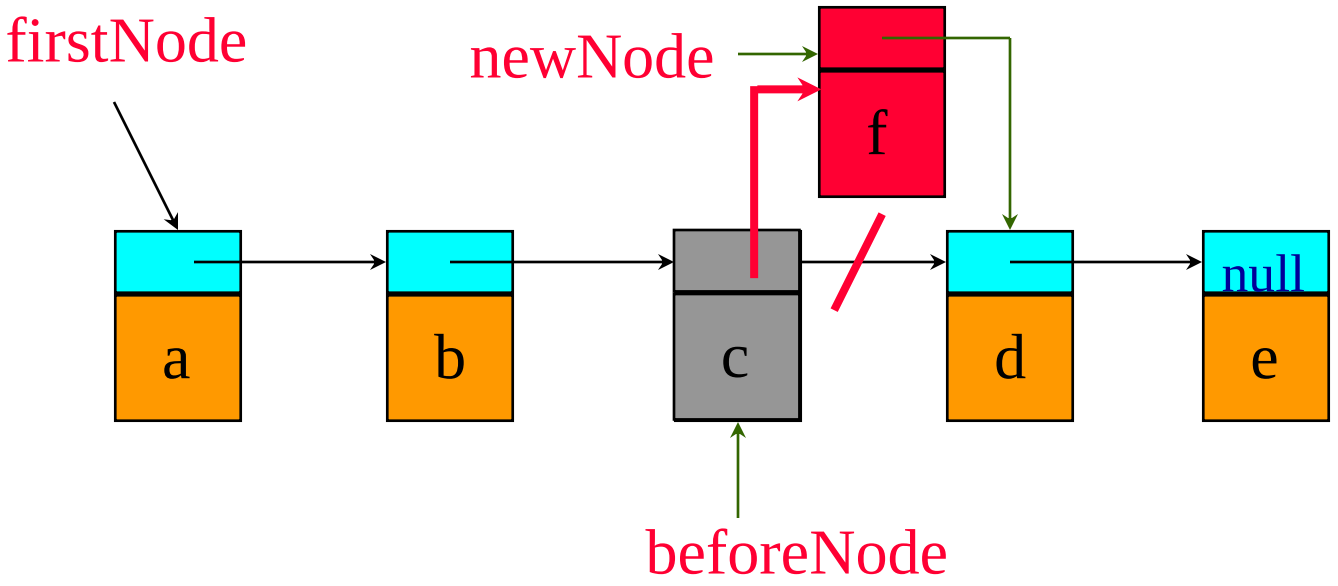


firstNode = new ChainNode(‘f’, firstNode);

Элемент нэмэх

```
public void add(int index, Object theElement)
 {
   if (index < 0 || index > size)
     // индекс буруу байна
     throw new IndexOutOfBoundsException
           ("index = " + index + "  size = " + size);

   if (index == 0)
     // эхэнд оруулах
     firstNode = new ChainNode(theElement, firstNode);
```

Хоёр алхмын add(3,’f’)

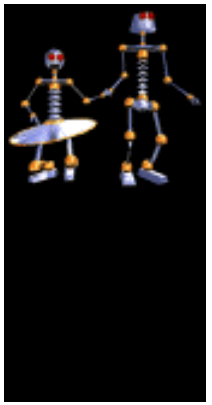



```
beforeNode = firstNode.next.next;
beforeNode.next = new ChainNode(‘f’, beforeNode.next);
```

Элемент нэмэх

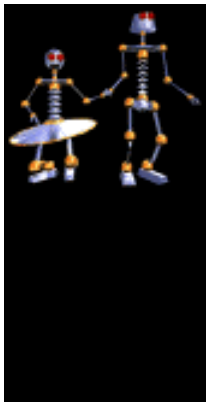
```
else
   { // шинэ элементийн өмнөхийг олох
     ChainNode p = firstNode;
     for (int i = 0; i < index - 1; i++)
        p = p.next;

     // p –ийн дараа оруулах
     p.next = new ChainNode(theElement, p.next);
   }
   size++;
 }
```

Чанарын үзүүлэлт



Үйлдэл бүрийг 40,000 давтлаа

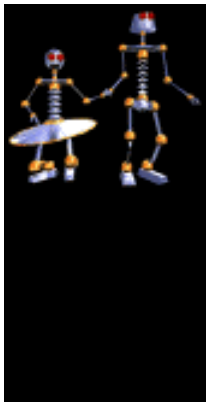
Чанарын үзүүлэлт



Үйлдэл бүрийг 40,000 давтлаа

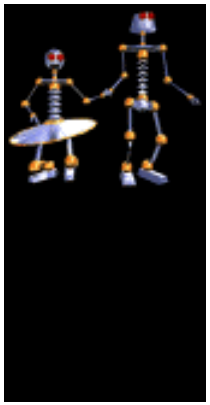
Үйлдэл	FastArrayLinearList	Chain
авах	5.6ms	157sec
нэмэх-сайн	31.2ms	304ms
нэмэх-дундаж	5.8sec	115sec
нэмэх-муу	11.8sec	157sec
устгах-сайн	8.6ms	13.2ms
устгах-дундаж	5.8sec	149sec
устгах-муу	11.7sec	157sec

Чанарын үзүүлэлт



Индексжүүлсэн AVL (‘62 - G.M **A**delson-**V**elsky & E.M **L**andis) мод (IAVL)

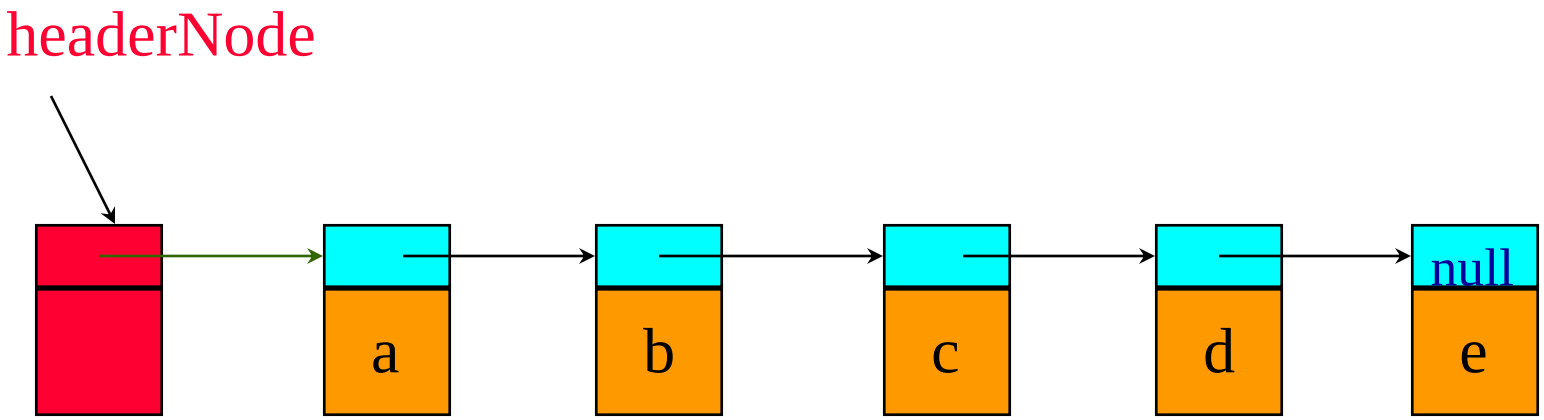
Чанарын үзүүлэлт



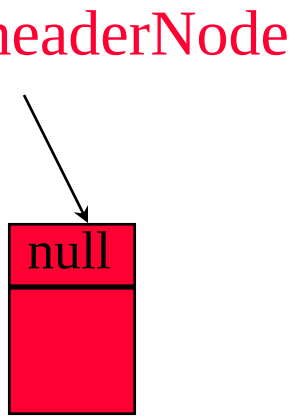
Индексжүүлсэн AVL мод (IAVL)

Үйлдэл	FastArrayLinearList	Chain	IAVL
авах	5.6ms	157sec	63ms
нэмэх-сайн	31.2ms	304ms	253ms
нэмэх-дундаж	5.8sec	115sec	392ms
нэмэх-муу	11.8sec	157sec	544ms
устгах-сайн	8.6ms	13.2ms	1.3sec
Устгах-дундаж	5.8sec	149sec	1.5sec
устгах-муу	11.7sec	157sec	1.6sec

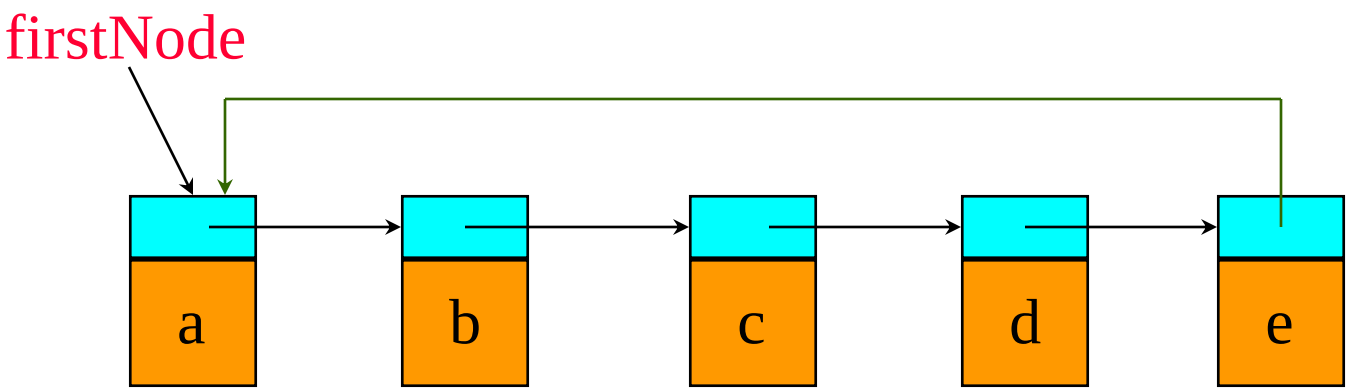
Толгойн зангилаатай гинж



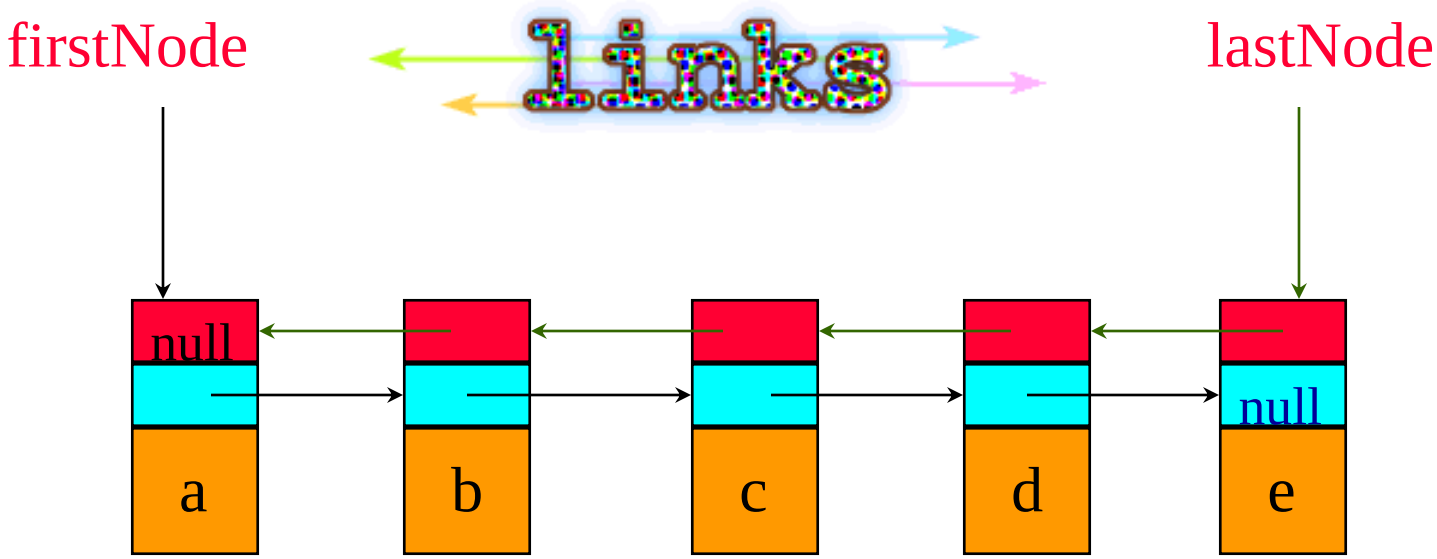
Толгойн зангилаатай хоосон гинж



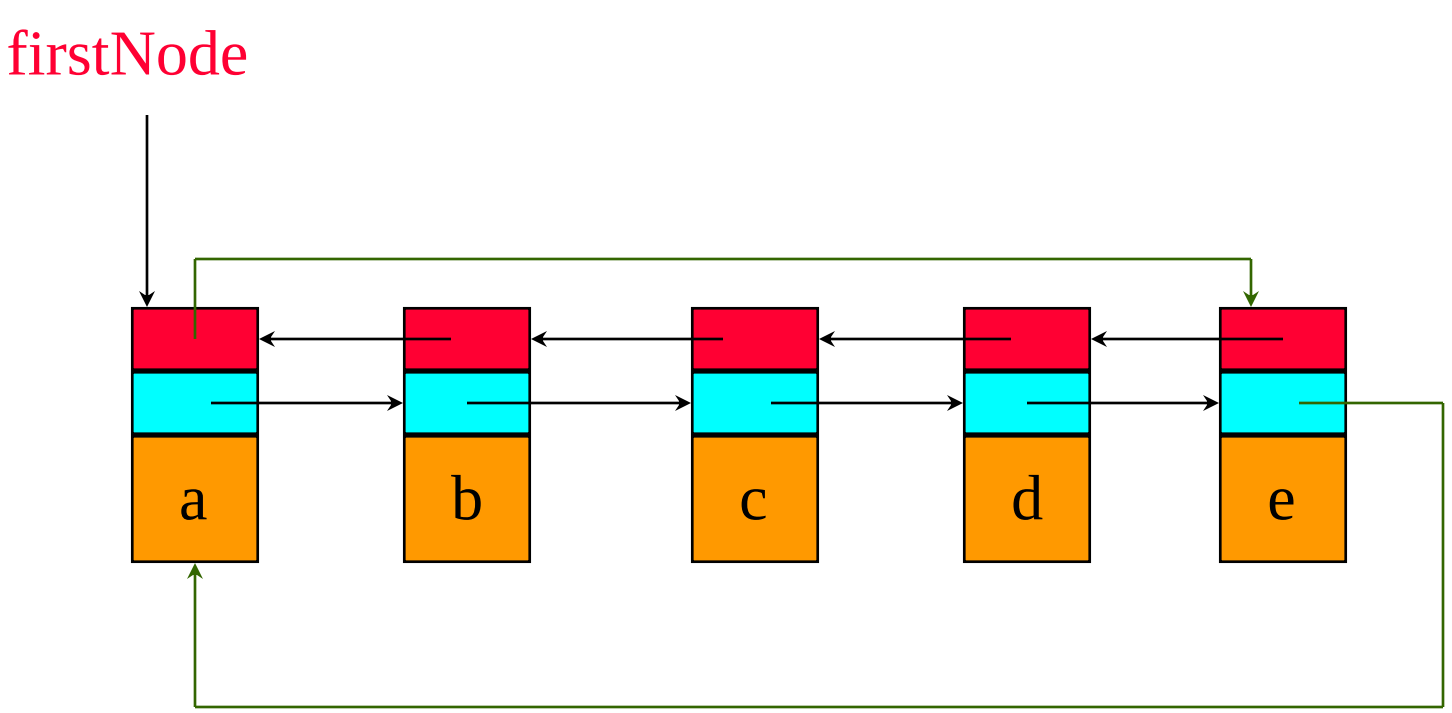
Цагириг жагсаалт



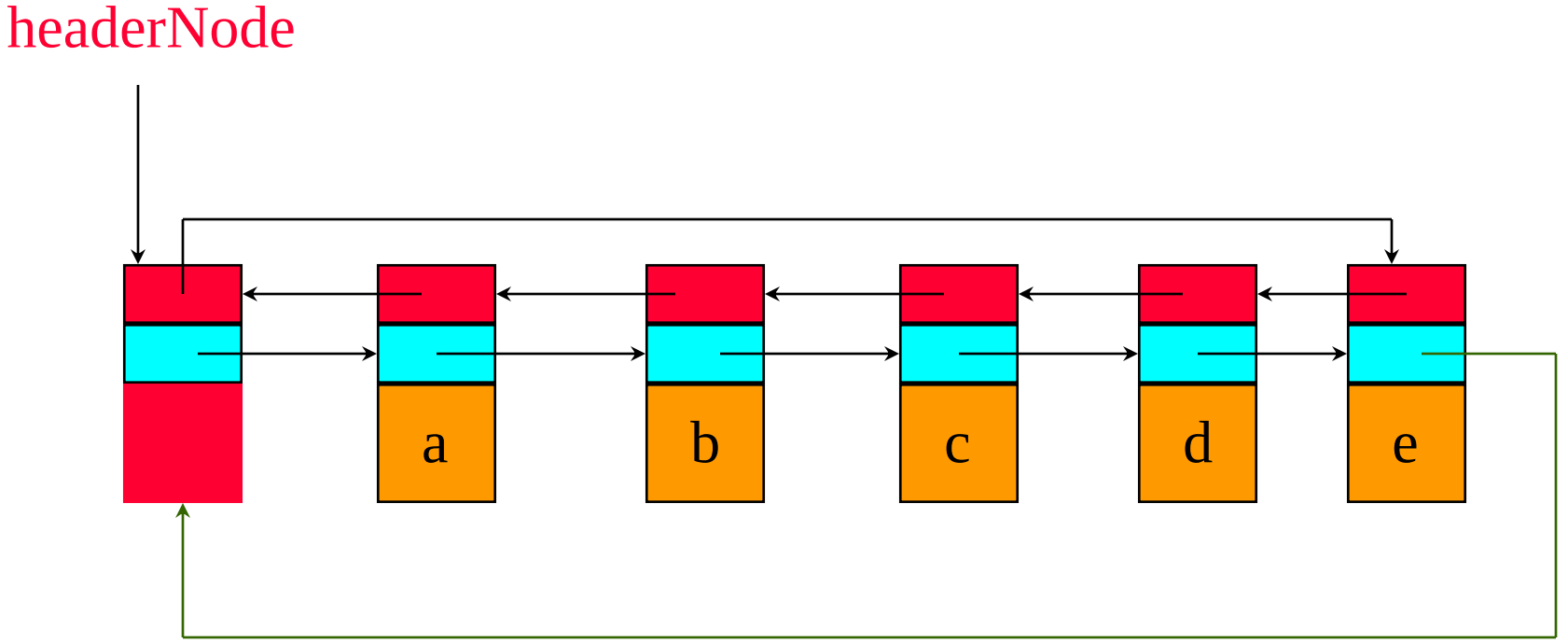
Хос холбоост жагсаалт



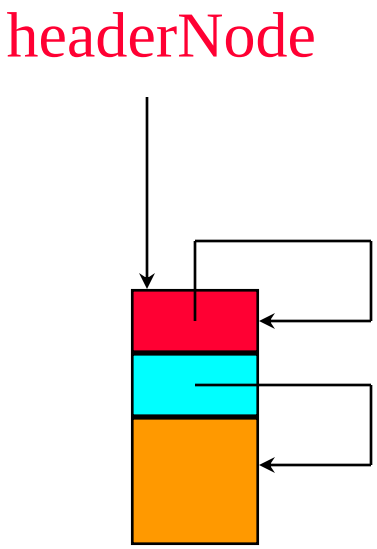
Хос холбоост цагариг жагсаалт



Толгойн зангилаатай хос холбоост цагариг жагсаалт



Толгойн зангилаатай хос холбоост цагариг хоосон жагсаалт



java.util.LinkedList

- Шугаман жагсаалтын холбоост хэрэгжүүлэлт.
- Толгойн зангилаатай хос холбоост цагариг жагсаалт.
- LinearList –ийн бүх аргаас гадна олон зүйл энд бий.