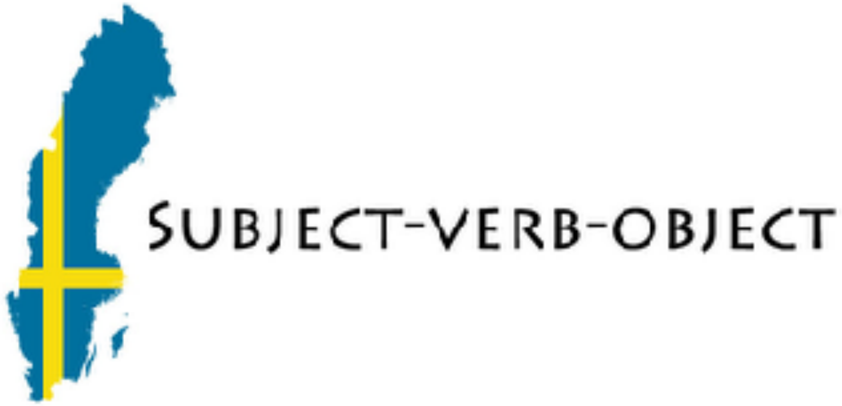
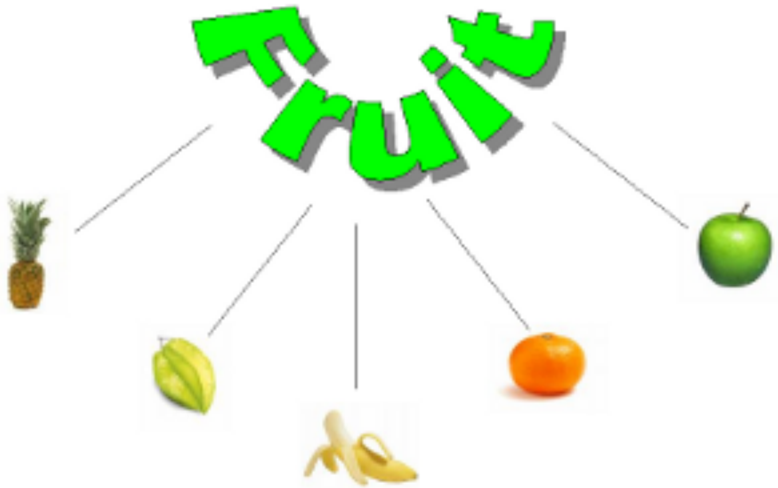


LAUNDRY LIST

Topi/ Hat	Rp. 5.000
Baju Anak/ Chid Shirt	Rp. 5.000
Pengering/ Drying	Rp. 5.000
Penyetrikaan/ Ironing	Rp. 5.000
Jas/ Jacket/ Blazer	Rp. 25.000
Kemeja/ Shirt	Rp. 10.000
Kaos/ T-Shirt	Rp. 8.000
Kaos Dalam/ Undershirt	Rp. 5.000
Celana Panjang/ Trousers/ Slack	Rp. 11.000
Celana Pendek/ Shorts	Rp. 8.000

Object Examples and Linked Lists Intro



Warmup: Objects and Names

Question:

What does this code print?

```
class MyClass:
  def __init__(self,x):
    self.x = x

# Plain function, not method
def foo(o,x):
  o.x = x

def bar(o,x):
  o = MyClass(x)

x = MyClass(2)
y = MyClass(3)
foo(x,4)
bar(y,5)
print(x.x)
print(y.x)
```

Example: Rectangle

- Build a class with the following properties / fields:
  - Width
  - Height

- And the following methods:
  - __init__(self,width,height)
  - calculateArea(self)
  - setHeight(self,height)
  - setWidth(self,width)
  - getWidth(self)
  - getHeight(self)

Example: Using Rectangle

- Construct 2 rectangles:
    - 8 x 12
    - 4 x 4
- Calculate their areas

Example: Caching Area

- Might not want to recompute area every time
- Add another field (in __init__) called cachedArea
- When calculateArea() called return cachedArea

Example: Circle Object

- Create a “circle” object
    - Needs a “center”
    - Can either have a radius or a diameter (you pick)
    - Must support “calculateArea” method

Example: ShapeList

- Create a class ShapeList:
  - One field: underlying array (call this list)
  - __init__(self):
    - Initialize list (to empty list)
  - length(self): calculates the length of the list
  - add(self,shape):
    - Adds a shape to the underlying list
  - sumOfAreas(self):
    - Sum of the areas of all of the shapes

Testing ShapeList

- Create empty ShapeList
- Add a 8 x 12 rectangle
- Add an 4 x 5 CachedRectangle
- Add a circle centered at (1,3) whose radius is 2
- Call sumOfAreas

Example: Array insertion is O(n)

`l` =

1	2	17	18	19	-4

When we do `[i] + l`, we get…

Example: Array insertion is O(n)

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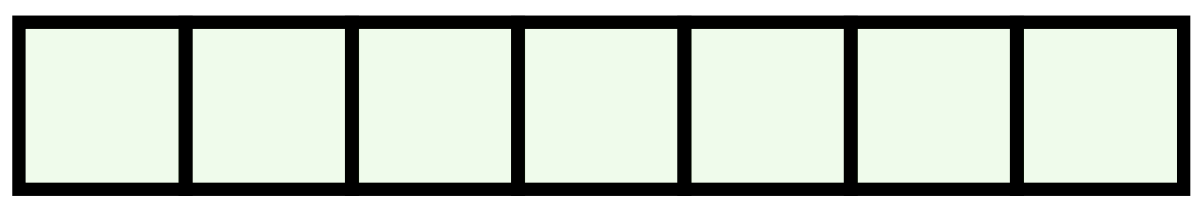
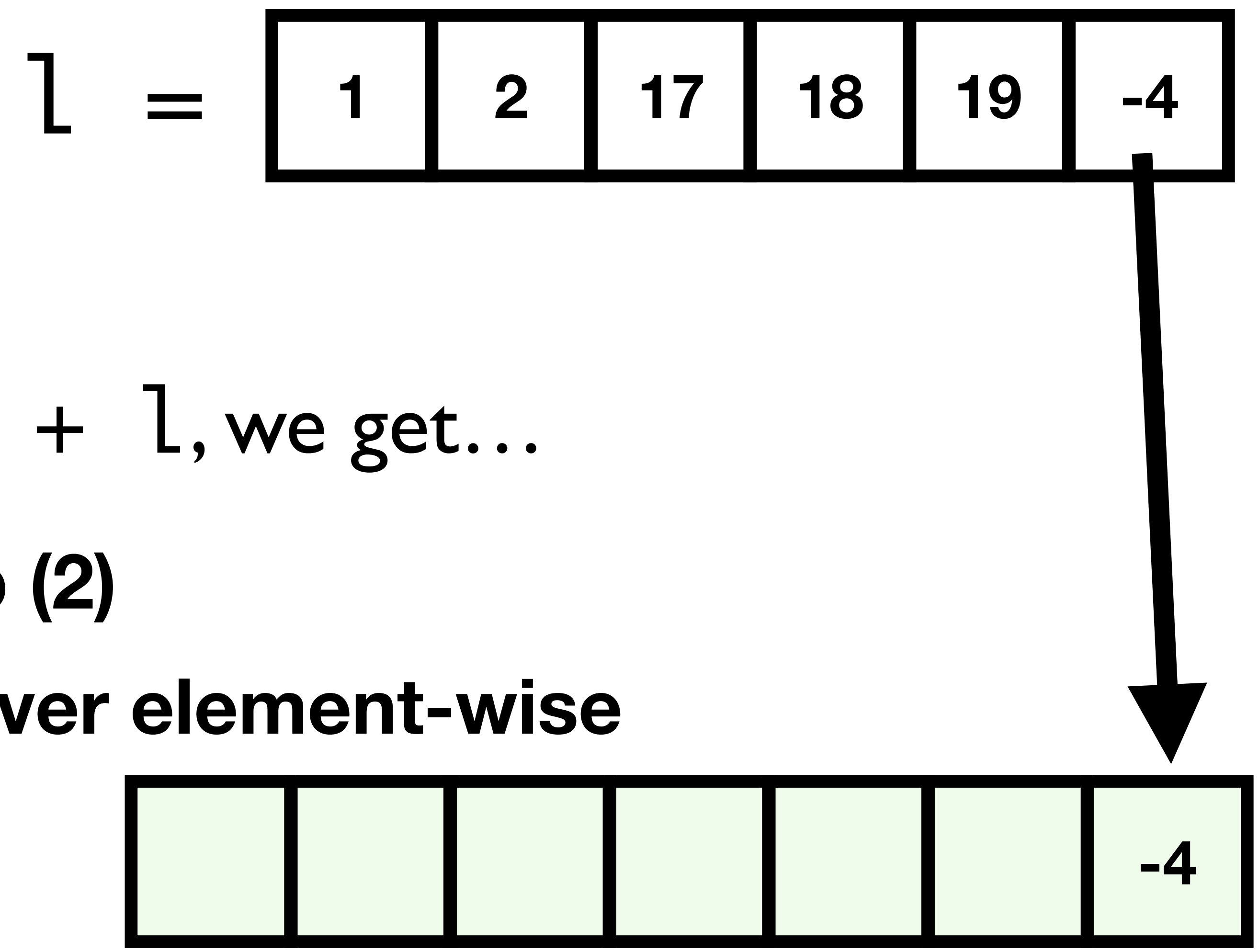
When we do `[i] + l`, we get…



Step (1)

Allocate fresh memory for new array….

Example: Array insertion is O(n)



When we do `[i] + l`, we get…

Step (2)

Copy array over element-wise

Example: Array insertion is O(n)

`l` =

1	2	17	18	19	-4

When we do `[i] + l`, we get…

Step (2)

Copy array over element-wise

`i`	1	2	17	18	19	-4

Example: Array insertion is O(n)

`l` =

1	2	17	18	19	-4

When we do `[i] + l`, we get…

Takes O(n) time!

`i`	1	2	17	18	19	-4

Upshot: Performing n insertions takes $O(n^2)$ time

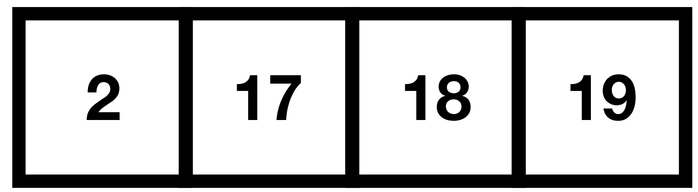
(But: Random-Access is $O(1)$ time!)

Observation

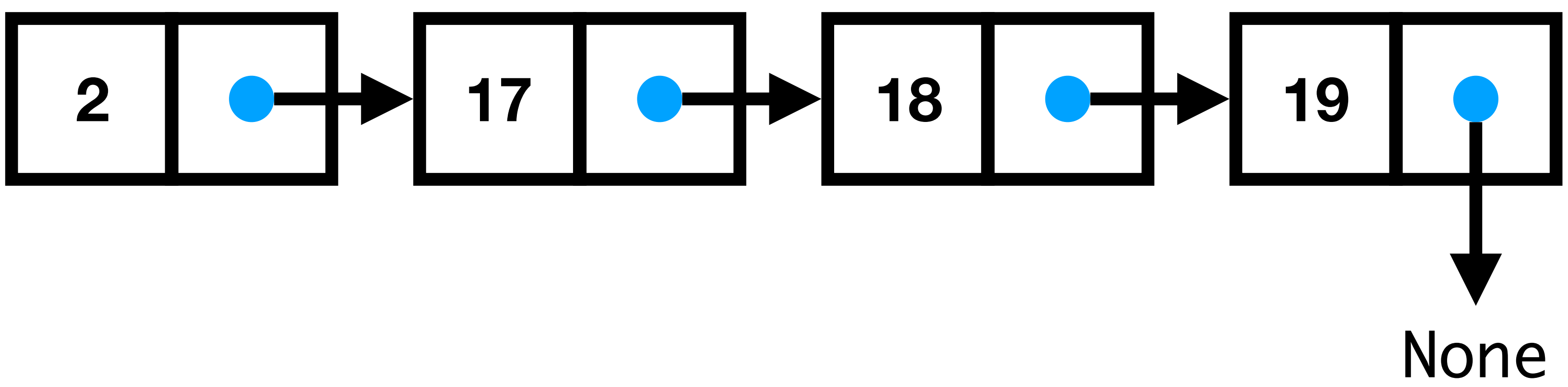
2	17	18	19

We can get O(1) insertion time if we change the structure of the list!

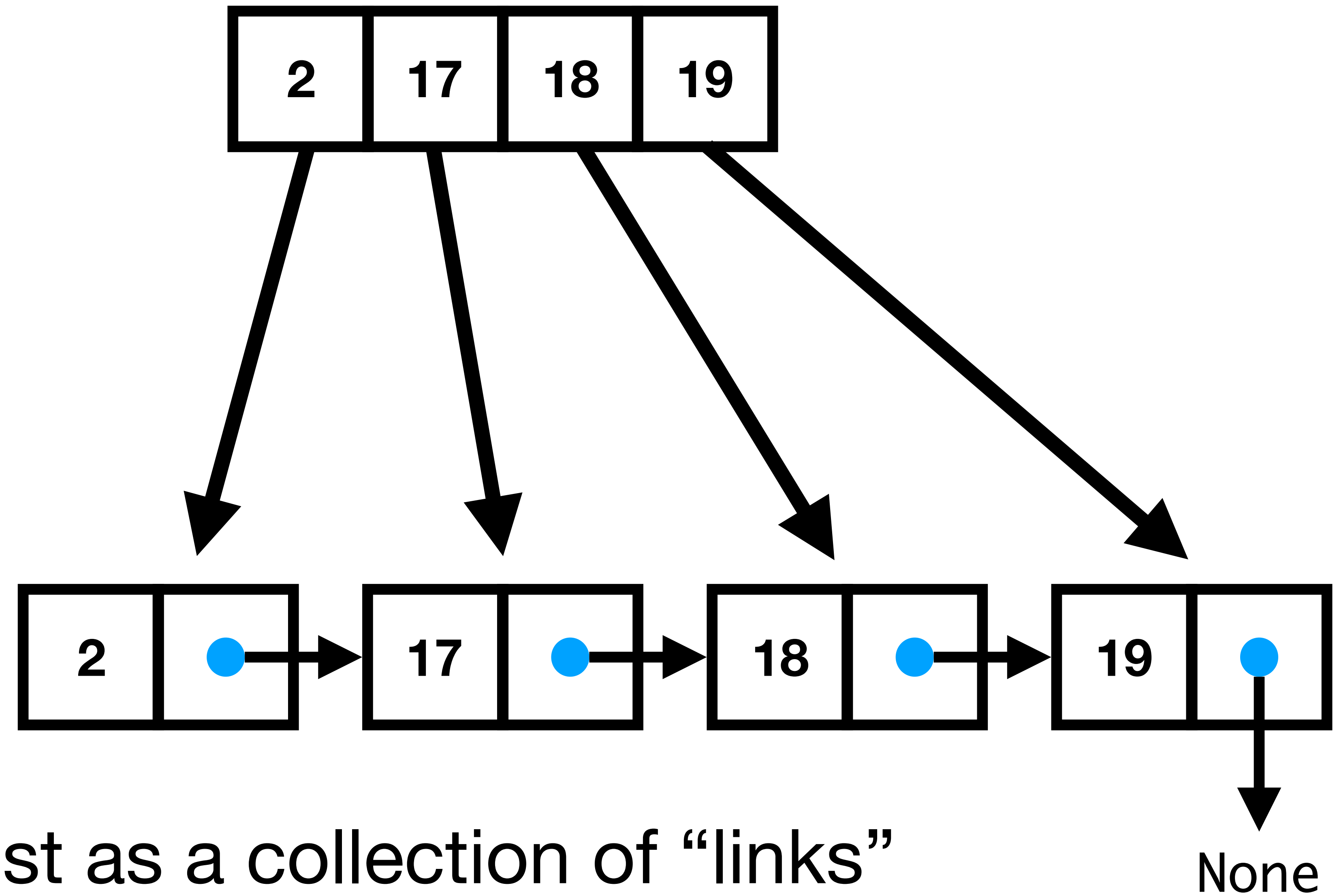
Observation



We can get O(1) insertion time if we change the structure of the list!



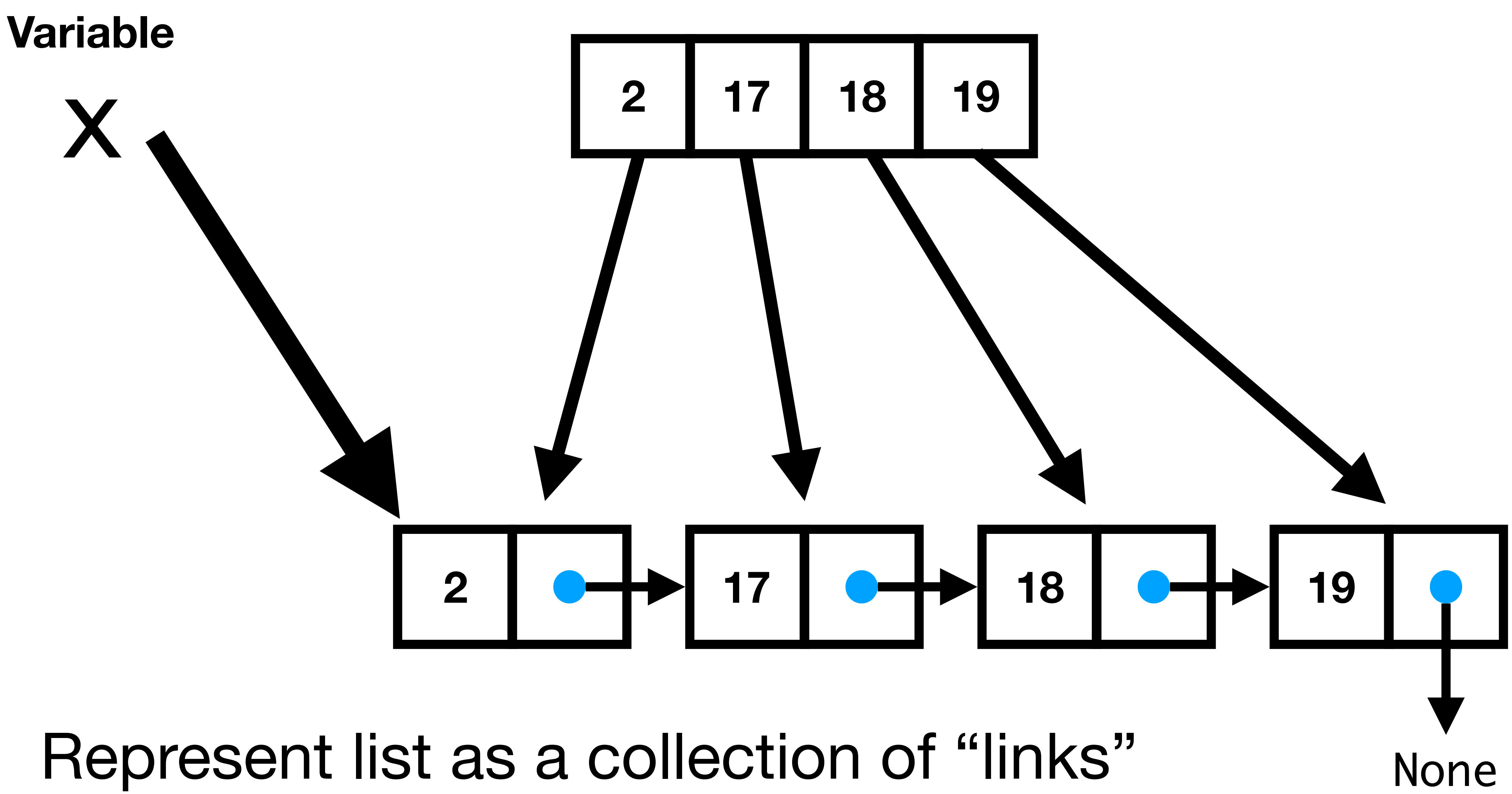
Observation



Represent list as a collection of “links”

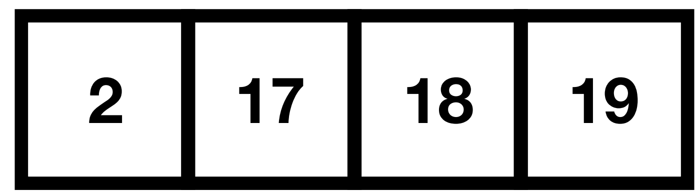
Each link consists of data + link to next link (or None)

Regard list as reference to first element

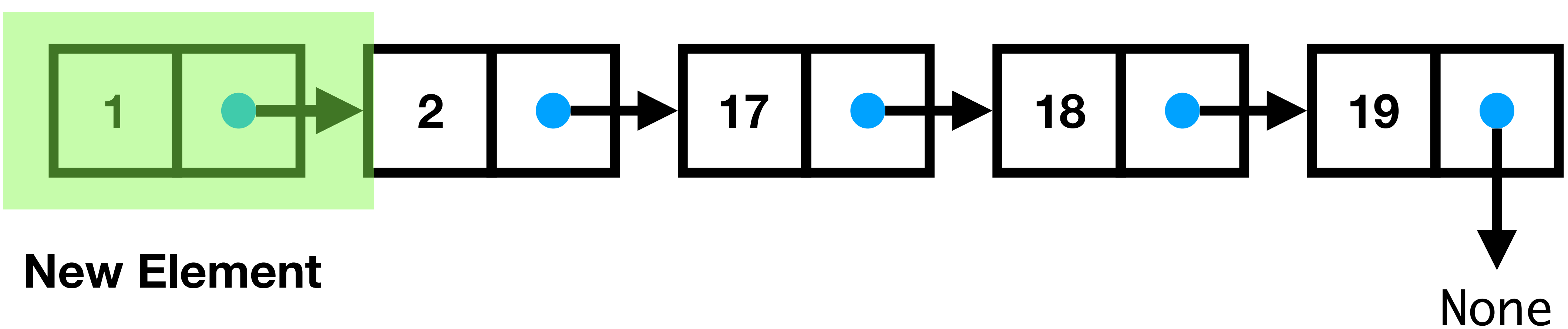


Represent list as a collection of “links”

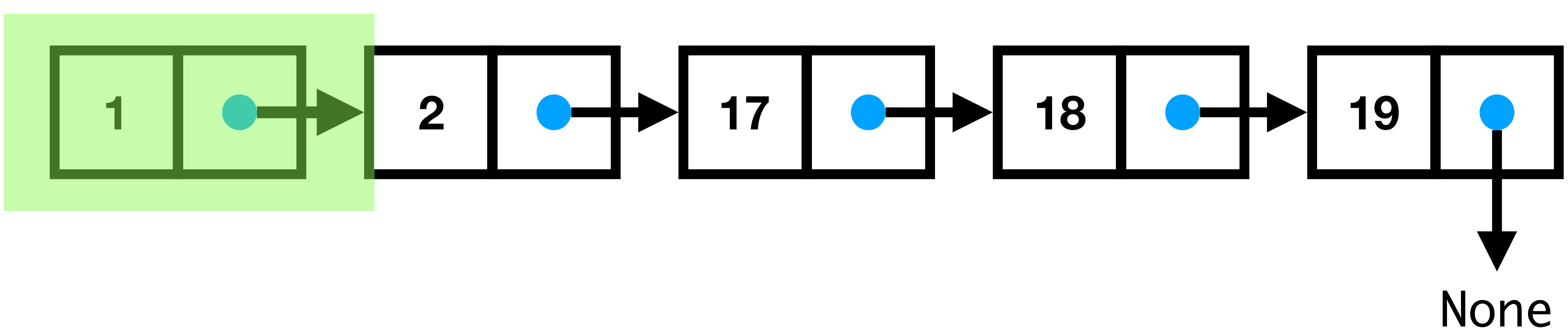
Each link consists of data + link to next link (or None)



Inserting data to front of list is just creating a new link



We can still “walk over” the list in linear time



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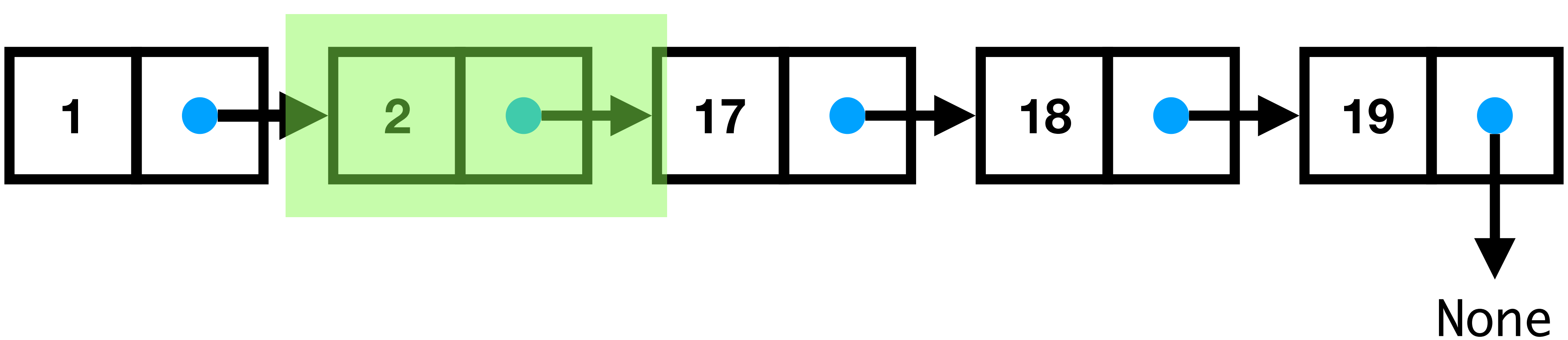

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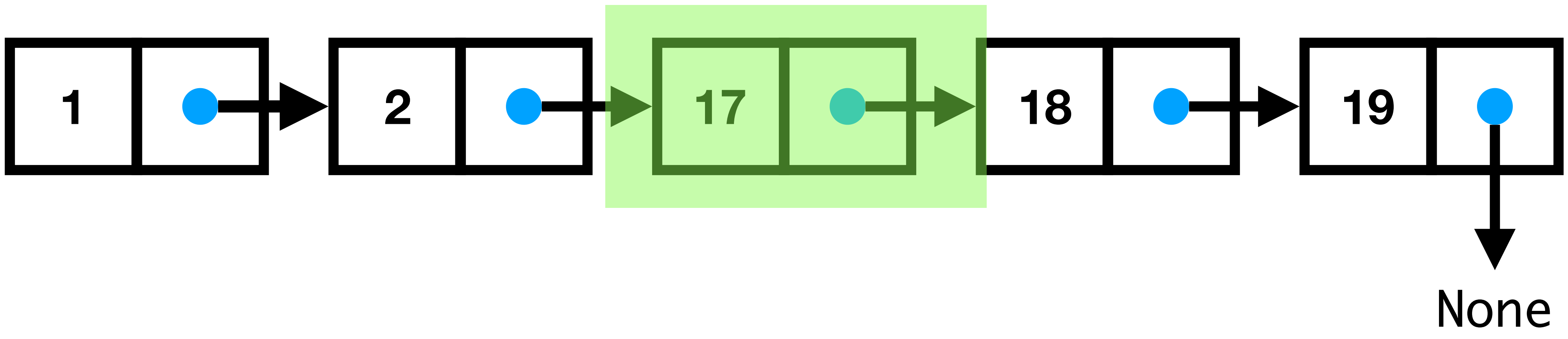
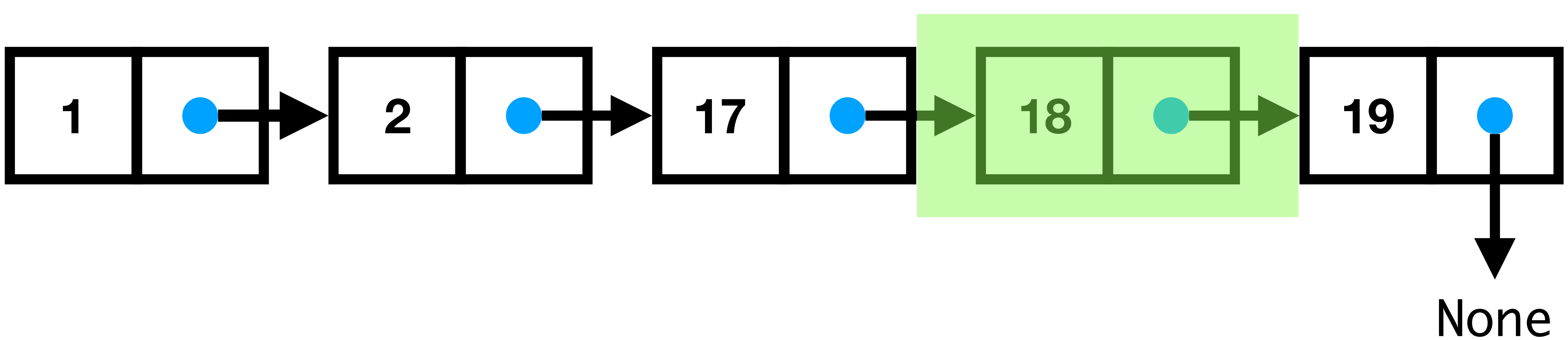
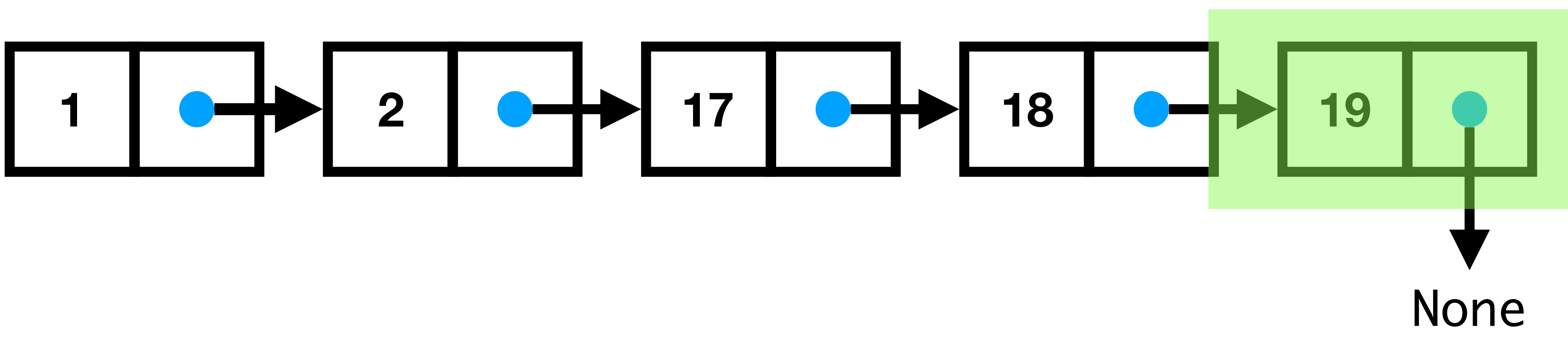


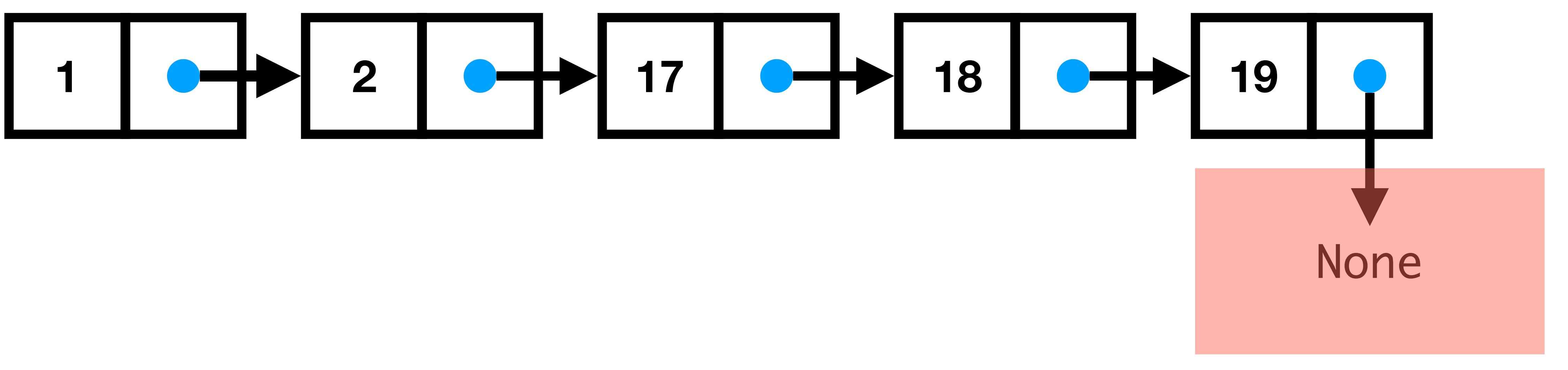
We can still "walk over" the list in linear time



We can still "walk over" the list in linear time



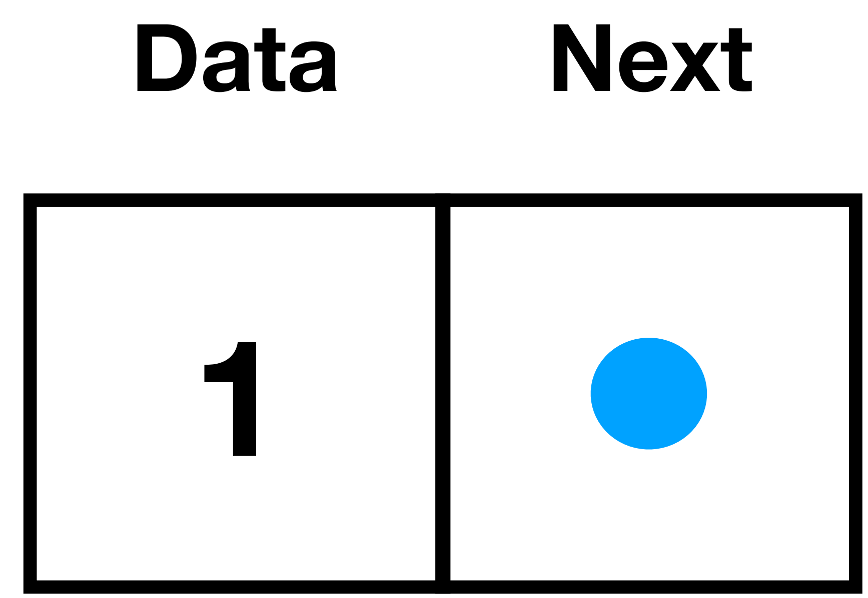
We can still "walk over" the list in linear time



Creating a `Link` class

We need…

- The data itself
- A reference to "next" node

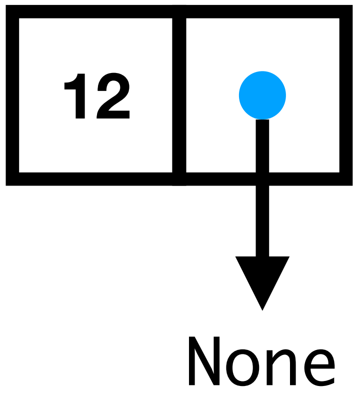


```python
class Link:
    def __init__(self,data,next):
        self.data = data
        self.next = next

    def getData(self): return self.data
    def getNext(self): return self.next
```

```
class Link:
    def __init__(self,data,next):
        self.data = data
        self.next = next

    def getData(self): return self.data
    def getNext(self): return self.next
```

Example Usage:

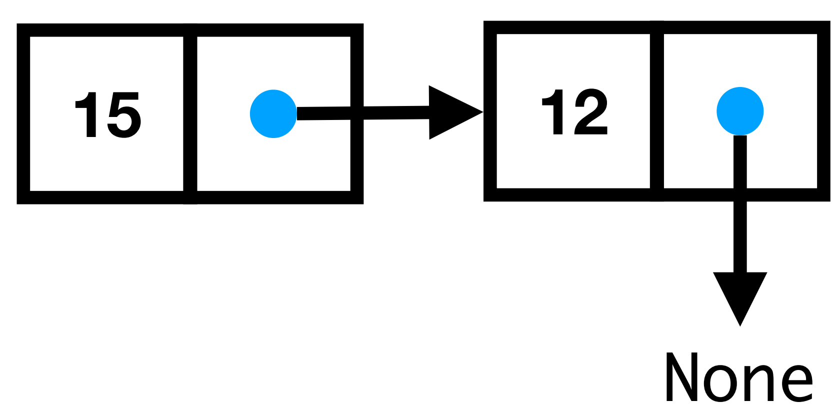
```
l1 = Link(12,None)
```



```python
class Link:
    def __init__(self,data,next):
        self.data = data
        self.next = next

    def getData(self): return self.data
    def getNext(self): return self.next
```

Example Usage:

```python
l1 = Link(12,None)
l2 = Link(15, l1)
```



Challenge: write a **function** (not a method) to check if the list contains a negative num

```
class Link:
    def __init__(self,data,next):
        self.data = data
        self.next = next

    def getData(self): return self.data
    def getNext(self): return self.next

def containsNeg(link):
  … # Your code here
```

Building a **List**

- Can **encapsulate** first link in a class called **List**
- Then, we can support the following operations:
  - Add
  - Contains
  - Remove

```
class List:
    def __init__(self):
        self.first = None

    def add(self, data):
        self.first = Link(data, self.first)
```

We can see that add is O(1) since it simply:

- Creates a new Link
  - The constructor for Link runs in constant time
- Sets the first element of the list to that new link

```
class List:
    def __init__(self):
        self.first = None

    def add(self, data):
        self.first = Link(data, self.first)
```

Exercise: Implement **contains**

```
class List:
    def __init__(self):
        self.first = None

    def add(self, data):
        self.first = Link(data, self.first)
```

Hint: think about using loop to follow links from next…

Exercise: Implement **getIth**

```
class List:
    def __init__(self):
        self.first = None

    def add(self, data):
        self.first = Link(data, self.first)
```

Question: what is runtime of getIth?

Exercise: Implement **remove**

```
class List:
    def __init__(self):
        self.first = None

    def add(self, data):
        self.first = Link(data, self.first)
```

Brainstorm

- What’s an example application where you would perform **frequent insertions**
- What’s an example where data is relatively fixed?

Observations

- All data structures are about trade offs
- Linked lists trade random-access for O(1) insertion
- Can still “go through” (iterate over) lists in linear time
- But random-access is O(n)
  - Good for applications that don’t require random-access
  - Many don’t!