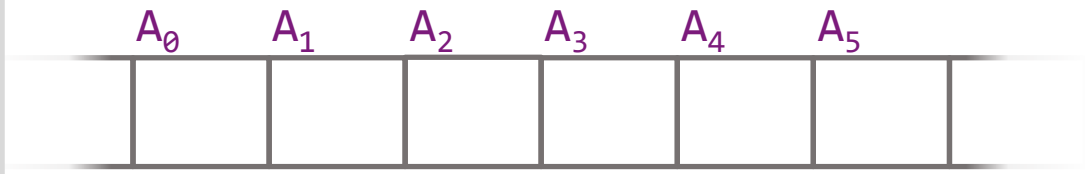
# Recap: Pointers

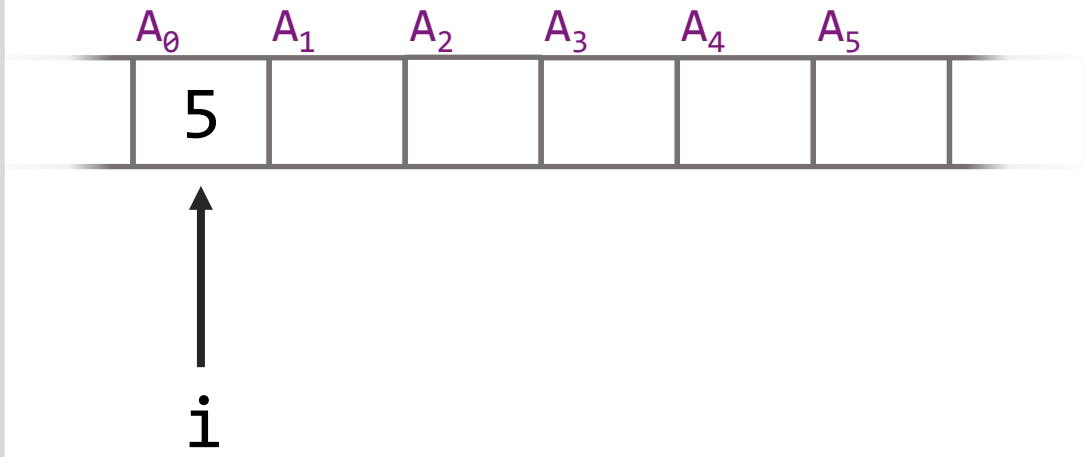
`int* int& *p &i &*&*` 

# Step-by-Step Example



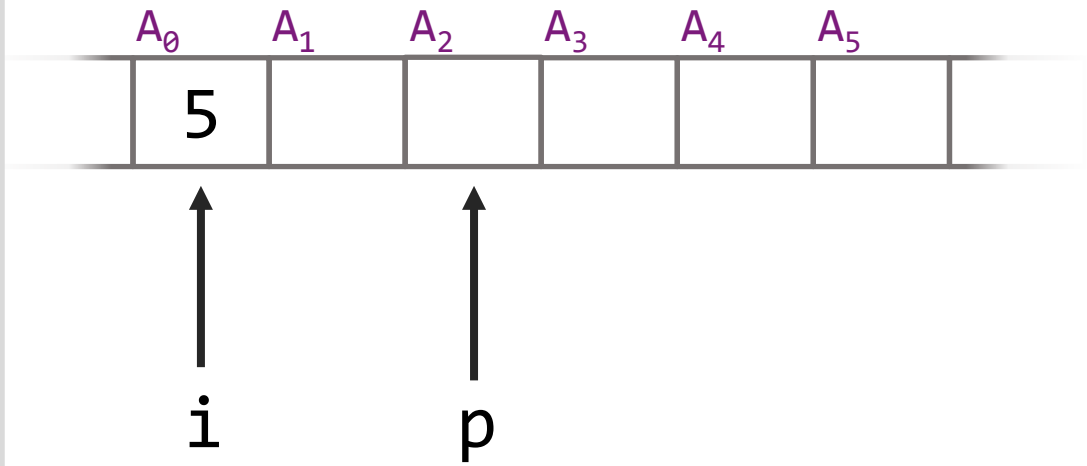
# Step-by-Step Example

```
int i = 5;
```



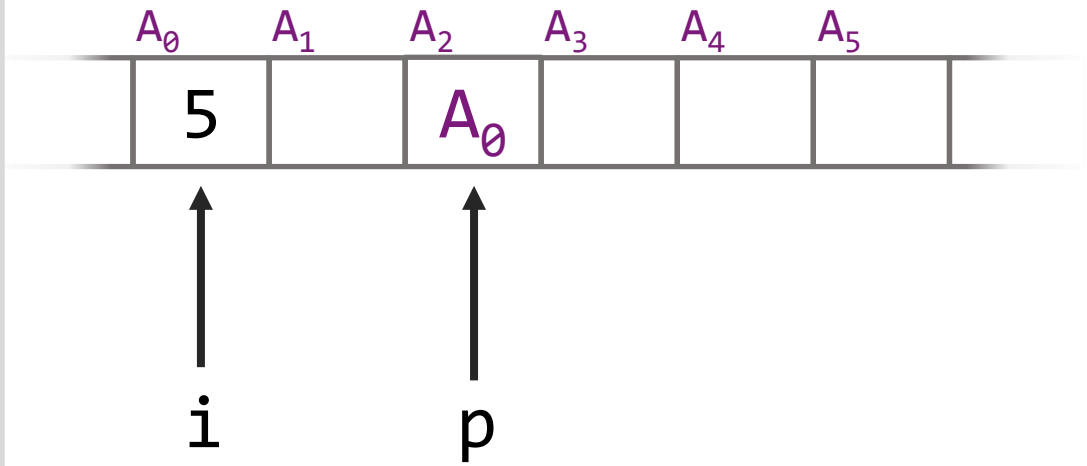
# Step-by-Step Example

```
int i = 5;
int* p;
```



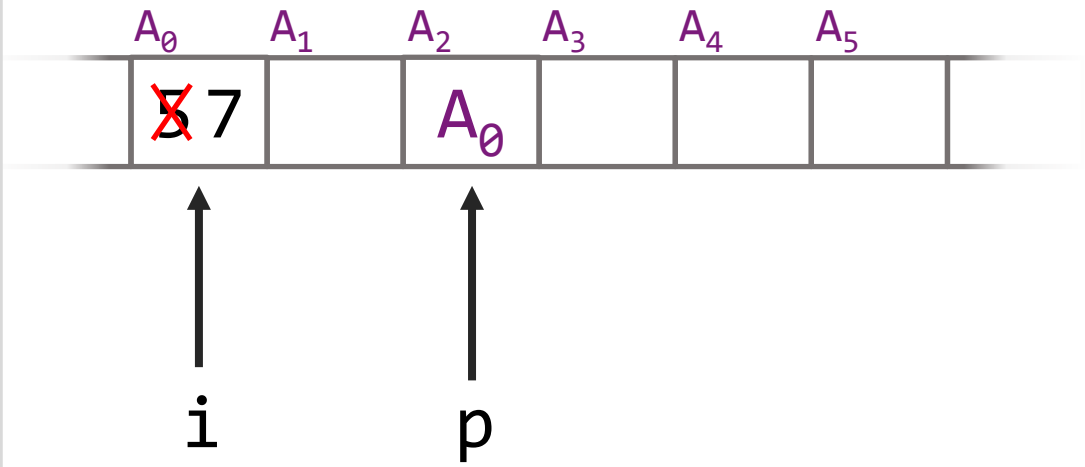
# Step-by-Step Example

```
int i = 5;
int* p;
p = &i;
```



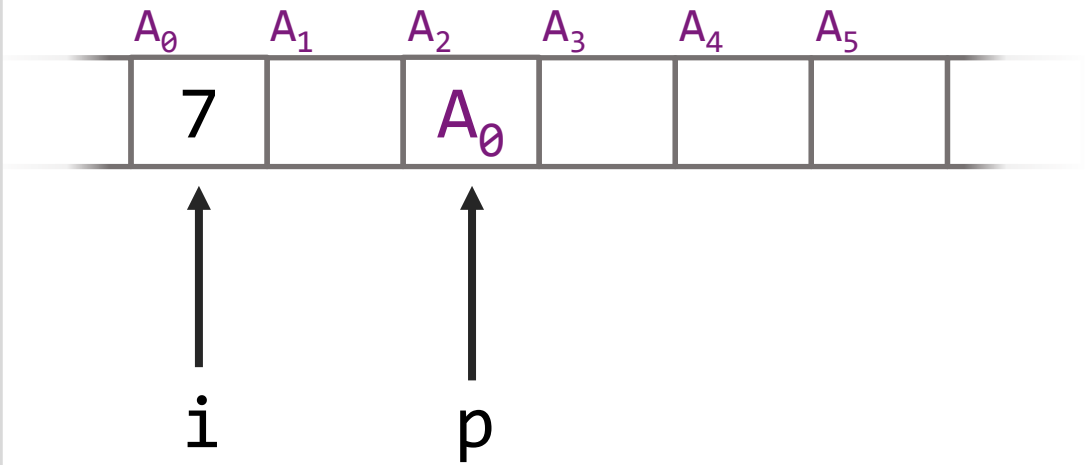
# Step-by-Step Example

```
int i = 5;
int* p;
p = &i;
*p = 7;
```



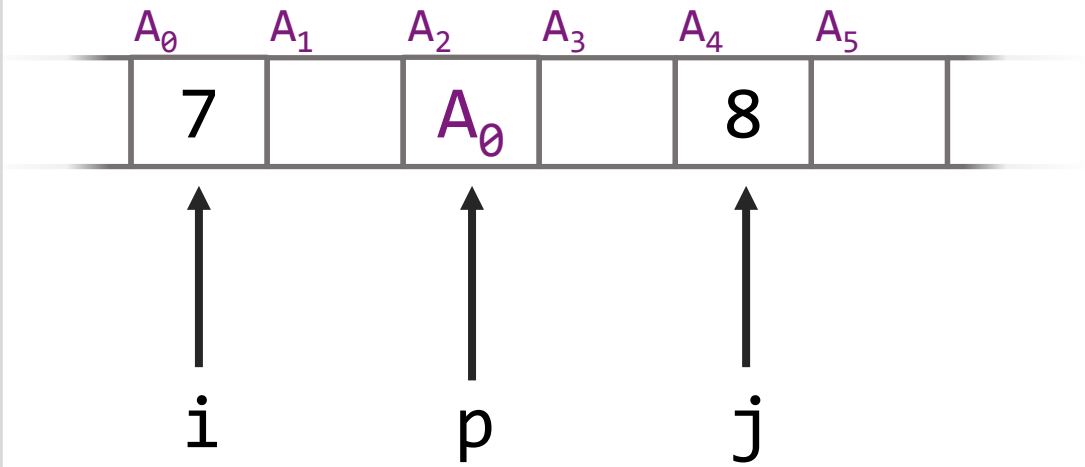
# Step-by-Step Example

```
int i = 5;
int* p;
p = &i;
*p = 7;
cout << i;  // 7
```



# Step-by-Step Example

```
int i = 5;
int* p;
p = &i;
*p = 7;
cout << i;  // 7
int j = *p + 1;
```



# Step-by-Step Example

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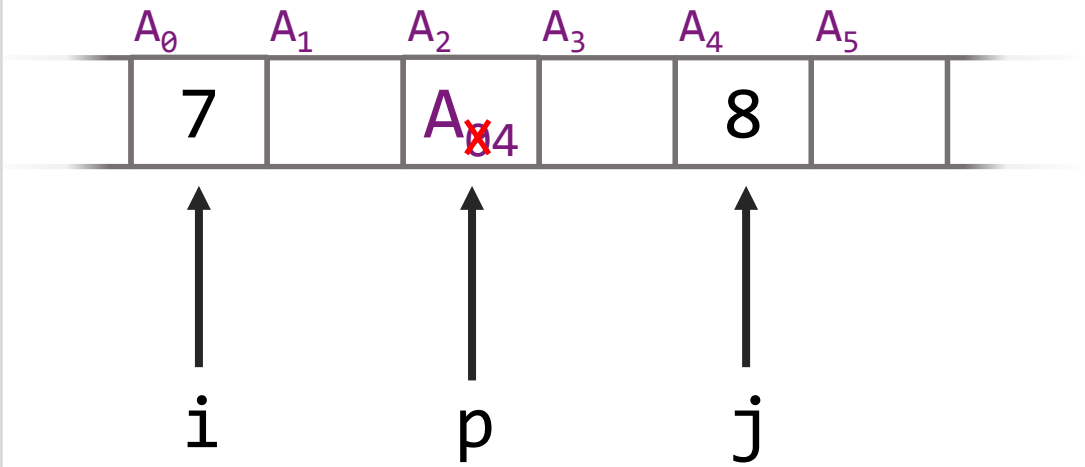
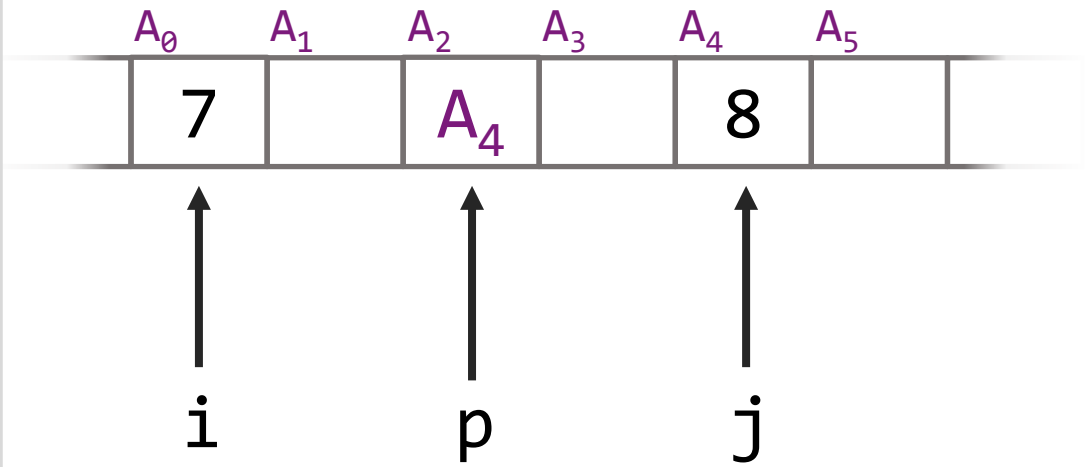
int i = 5;
int* p;
p = &i;
*p = 7;
cout << i;  // 7
int j = *p + 1;
p = &j;
```



# Step-by-Step Example

```
int i = 5;
int* p;
p = &i;
*p = 7;
cout << i;  // 7
int j = *p + 1;
p = &j;
cout << *p; // 8
```



# Step-by-Step Example

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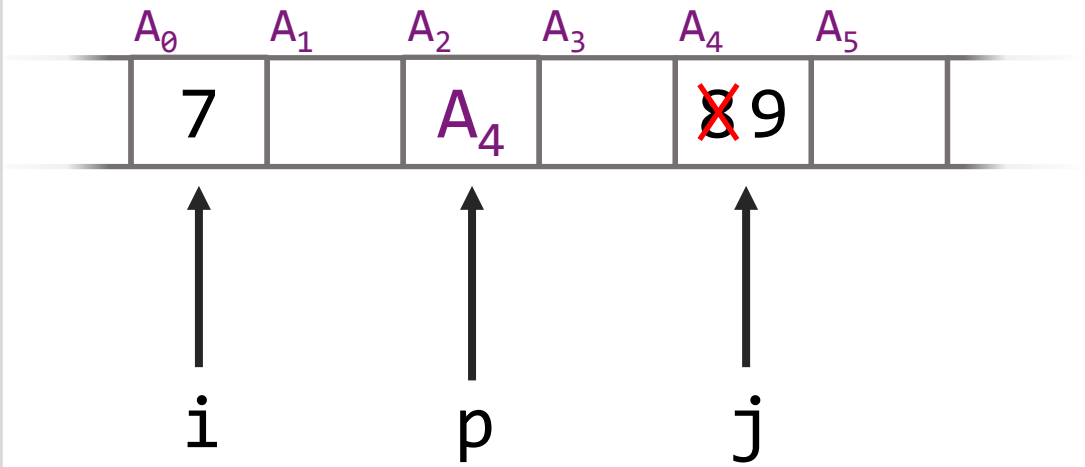
int i = 5;
int* p;
p = &i;
*p = 7;
cout << i;  // 7
int j = *p + 1;
p = &j;
cout << *p; // 8
(*p)++;
```



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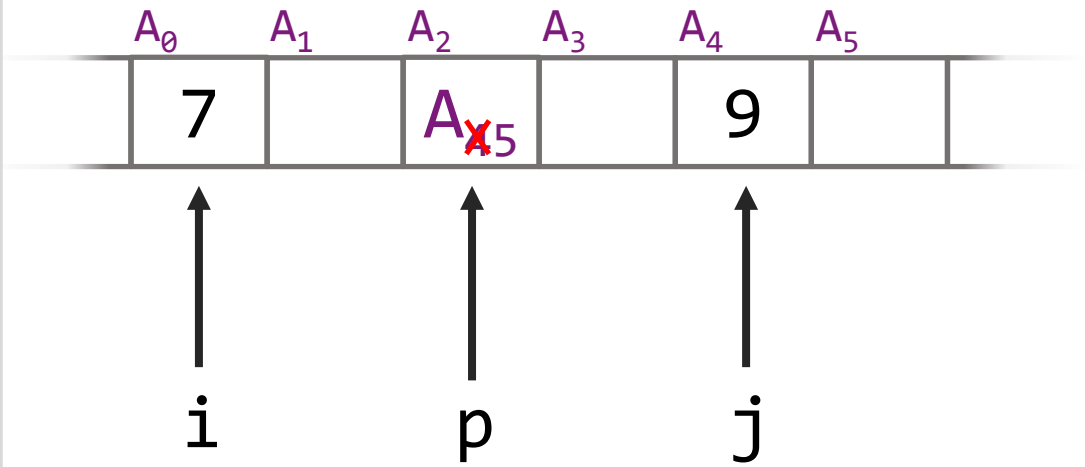
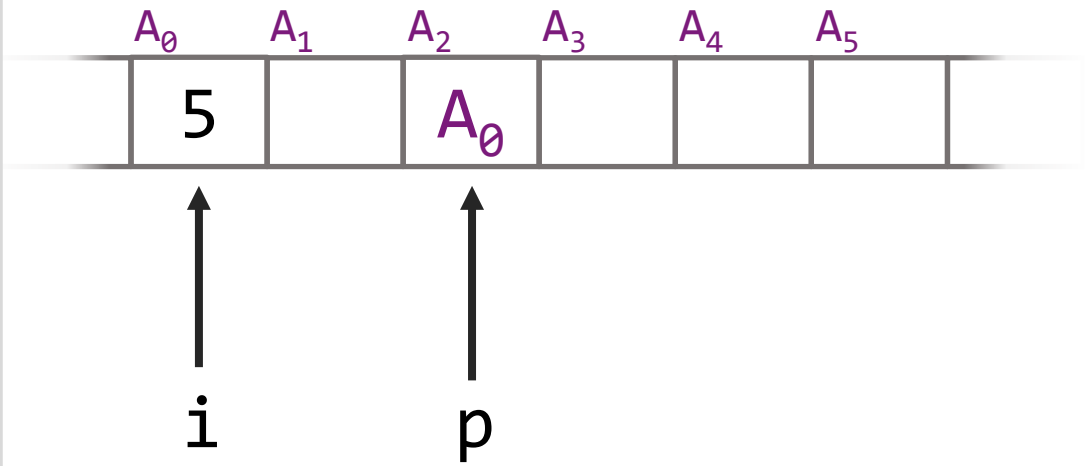
p++;
```



# Step-by-Step Example

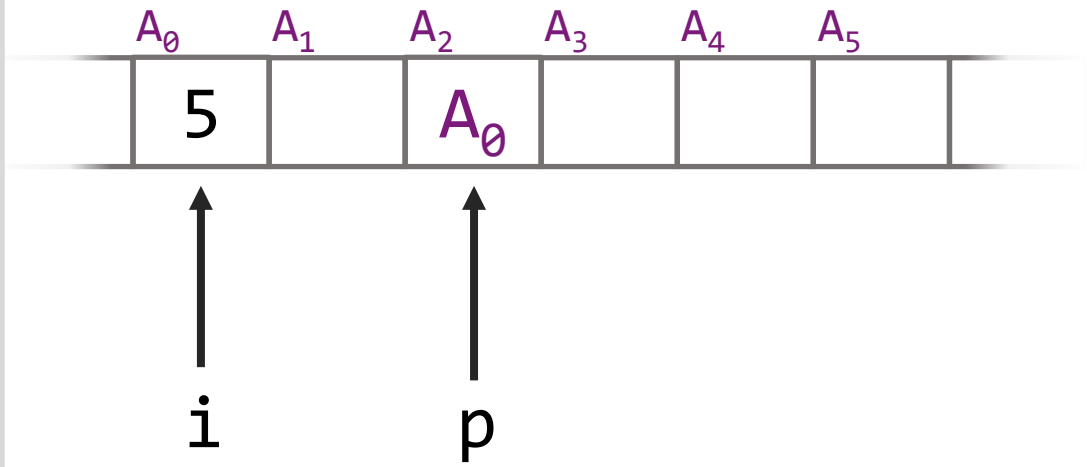
```
int i = 5;

int* p = &i;
```



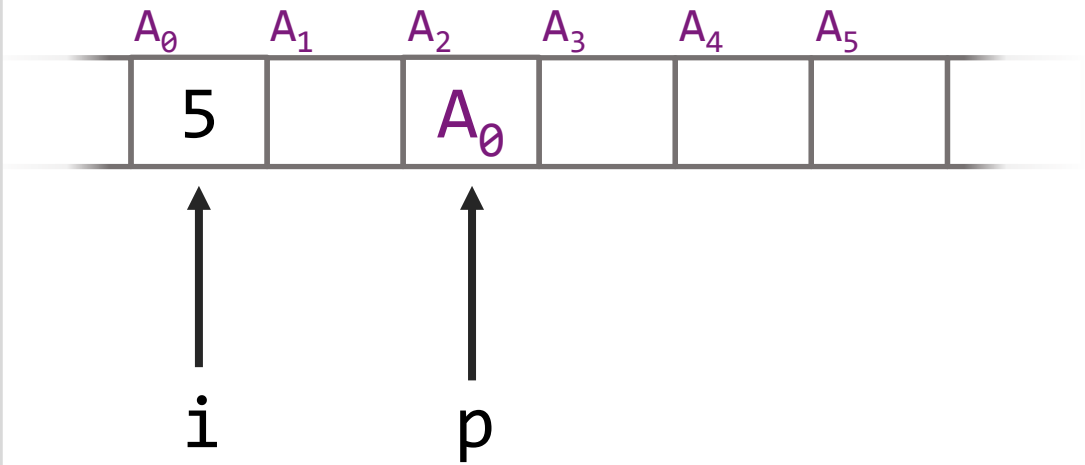
# Step-by-Step Example

```
int i = 5;
int* p = &i;
cout << p; // A0
```



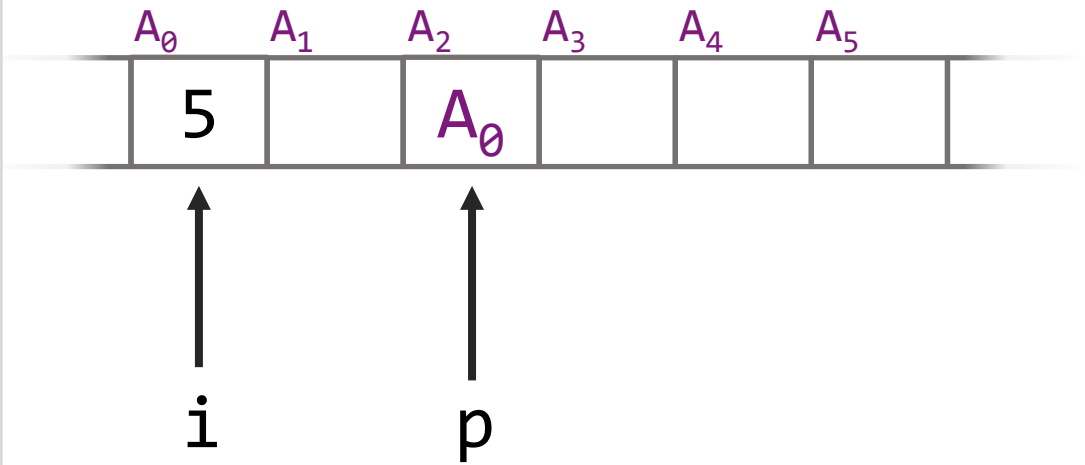
# Step-by-Step Example

```
int i = 5;
int* p = &i;
cout << p; // A0
cout << *p;// 5
```



# Step-by-Step Example

```
int i = 5;
int* p = &i;
cout << p; // A0
cout << *p;// 5
cout << &p;// A2
```



# Recap:
# Pointers vs. References

# Pointers vs. References

```
int i = 5;
```

```
int* p = &i;
```

```
int& r = i;
```

Declaration and initialisation

# Pointers vs. References

```
int i = 5;
```

```
int* p = &i;
```

```
*p = 0; // i = 0
```

```
int& r = i;
```

```
r = 0; // i = 0
```

Declaration and initialisation

Writing to underlying variable

# Pointers vs. References

```
int i = 5;
```

| | | |
|---|---|---|
| `int* p = &i;` | `int& r = i;` | Declaration and initialisation |
| `*p = 0; // i = 0` | `r = 0; // i = 0` | Writing to underlying variable |
| `cout << *p; // 0` | `cout << r; // 0` | Reading underlying variable |

# Pointers vs. References

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int i = 5;
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| `int* p = &i;` | `int& r = i;` | Declaration and initialisation |
| `*p = 0; // i = 0` | `r = 0; // i = 0` | Writing to underlying variable |
| `cout << *p; // 0` | `cout << r; // 0` | Reading underlying variable |
| `int* p;`<br>`p = &i;` | ~~`int& r;`~~<br>~~`r = i;`~~ | References must be initialised immediately |

# Pointers vs. References

```
int i = 5;
```

| | | |
|---|---|---|
| `int* p = &i;` | `int& r = i;` | Declaration and initialisation |
| `*p = 0; // i = 0` | `r = 0; // i = 0` | Writing to underlying variable |
| `cout << *p; // 0` | `cout << r; // 0` | Reading underlying variable |
| `int* p;`<br>`p = &i;` | ~~`int& r;`~~<br>~~`r = i;`~~ | References must be initialised immediately |
| `int* p = &i;`<br>`p = &j;` | `int& r = i;`<br>~~`r = j;`~~ | References *themselves* cannot be changed (“redirected”) |

# Pointers vs. References

```
int i = 5;
```

| | | |
|---|---|---|
| `int* p = &i;` | `int& r = i;` | Declaration and initialisation |
| `*p = 0; // i = 0` | `r = 0; // i = 0` | Writing to underlying variable |
| `cout << *p; // 0` | `cout << r; // 0` | Reading underlying variable |
| `int* p;`<br>`p = &i;` | ~~`int& r;`~~<br>~~`r = i;`~~ | References must be initialised immediately |
| `int* p = &i;`<br>`p = &j;` | `int& r = i;`<br>~~`r = j;`~~ | References *themselves* cannot be changed (are always `const`) |
| `int* p = &i;`<br>`cout << &p;` | `int& r = i;`<br>~~`cout << &r;`~~ | References don't have addresses (they are just aliases of sth. else) |

# Why Pointers and References?

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## Historical language development:

- C: 1969; has pointers
- C++: 1983
  - Inherited pointers from C
    (backwards compatibility)
  - Added references to support *operator overloading*
    (i.e. << from streams; later in the course)

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    (i.e. << from streams; later in the course)

## Rule of thumb: prefer references over pointers

- References are more restricted → harder to make mistakes
- Reference syntax is nicer (`r` vs `*p`) → easier to read

# Why Pointers *and* References?

## When do we *need* pointers?

- Fast(er) *iteration over data*: e.g. arrays (last week) and containers (today)

# Why Pointers *and* References?

## When do we *need* pointers?

- Fast(er) *iteration over data*: e.g. arrays (last week) and containers (today)
- *Complex data structures* that *change* over time (later in the course): e.g. graphs