Recall Arrays

- Arrays: sequences of elements from the same base type
  - \( \text{int}[] \) a; // array of ints
  - \( \text{Date}[] \) d; // array of references to Dates
- Base type may be:
  - Primitive (i.e. int)
  - Reference (i.e. Date, other objects)
- Arrays are also objects.
- Notice the similarities:
  - Arrays created using \text{new}
  - Array elements stored on heap
  - Array variables store references to space on the heap
Allocation of Space

- Syntax for allocating space for the 1st level array:
  ```java
c char[][] a; // Array of char arrays
  a = new char[3][]; // Create array of 3 arrays
  ```

- Syntax for allocating space for the 2nd level of arrays:
  ```java
  a[0] = new char[4]; // Create array of 4 char
  a[1] = new char[6]; // Create array of 6 char
  a[2] = new char[3]; // Create array of 3 char
  ```

Example

```java
c char[][] a;
a = new char[3][];
a[0] = new char[4];
a[1] = new char[6];
a[2] = new char[3];
a[1][3] = 'a';
```

- This array has two dimensions: rows, columns
- This kind of array is called **ragged** because the rows are of unequal length
Questions

```java
char[][] a;
a = new char[3][];
a[0] = new char[4];
a[1] = new char[6];
a[2] = new char[3];
```

- What does `a[1][2] = 'x';` do?
  - Set element in row 2, column 3 to 'x'
- What does `a.length` return?
  - 3
- What does `a[1].length` return?
  - 6
- What type is `a`?
  - a reference to an array of array references
- What Type is `a[0]`?
  - a reference to an array of characters
- What type is `a[0][0]`?
  - a character

Initializers

- **In one dimension:**

  ```java
  char[][] a;
a = new char[3][];
a[0] = {'a','b','c','d'};
a[1] = {'x','y','z'};
a[2] = {'m','n'};
  ```

- **In two dimensions:**

  ```java
  char[][] a = {{'a','b','c','d'},
               {'x','y','z'},
               {'m','n'}};
  ```
Rectangular Arrays

- Often we want 2-dimensional arrays in which rows have the same length
  - Tables
  - Matrices
- Java has a special short-hand syntax for creating rectangular arrays
  ```java
  int[][] a = new int[2][4];  // 2 rows, 4 cols
  ```
  Equivalent to:
  ```java
  int[][] a = new int[2][];
  a[0] = new int[4];
  a[1] = new int[4];
  ```
- The short-hand takes care of allocating each row, initializing each cell in each row

Example

```java
int[][] a = new int[2][4];
```

- Note each cell is initialized to default value (0)
- Each row is a 1-dim array
2-D Arrays of Objects

- The array name when indexed with two indexes is of that indicated type
- Of Strings:
  ```java
  String[][] s = new String[4][2];
  s[0][0] = "Fred";
  s[1][1] = "Jane";
  ```
- Of Cats:
  ```java
  Cat[][] c = new Cat[4][2];
  c[0][0] = new Cat("Fred");
  c[1][1] = new Cat("Jane");
  ```