CIS 371 Web Application Programming

TypeScript III

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Based on the original version by Professor Hans Dulimarta.

TypeScript Functions
(& Lambdas)

Important Takeaway Concept

- *Assigned to a variable*
- *Passed as an argument to another function*
- *Returned as a value from other functions*

JS & TS allow variables of type Function

JS & TS variables can hold either data or code

- *JS & TS variables can be assigned typical data values like numbers, strings, and objects,*
- *or they can be assigned functions*

Three variations of Function Declarations

```
function plus2 (a:number, b:number): number {
    return a + b;
}
```

named

```
const plus2 = function (a:number, b:number): number {
    return a + b;
}
```

anonymous func

```
const plus2 = (a:number, b:number) : number => {
    return a + b;
}
```

lambda function

Any of these function declarations can be invoked using ONE syntax:

```
let out:number;
out = plus2(5.0, 2.9);
```

Vars of "function" type

typeless AND 1-line return contraction

```
const plus2 = (a, b) => a + b
```

Fat Arrow fns: single-line return contraction

```
const plusTwo = (a:number, b:number) : number => {
    const sum = a + b;
    return sum;
}
```

no ‘function’ keyword.

```
const plusTwo = (a:number, b:number) : number => {
    return a + b;
}
```

If ‘return’ can be the only statement

omit both the curly braces { } and the ‘return’ keyword.

```
const plusTwo = (a:number, b:number) : number => a + b;
const plusTwo = (a,b) => a + b;    // typeless
```

implicit return

Variables of func type

plus20 and plus22 are variables that hold your DATA

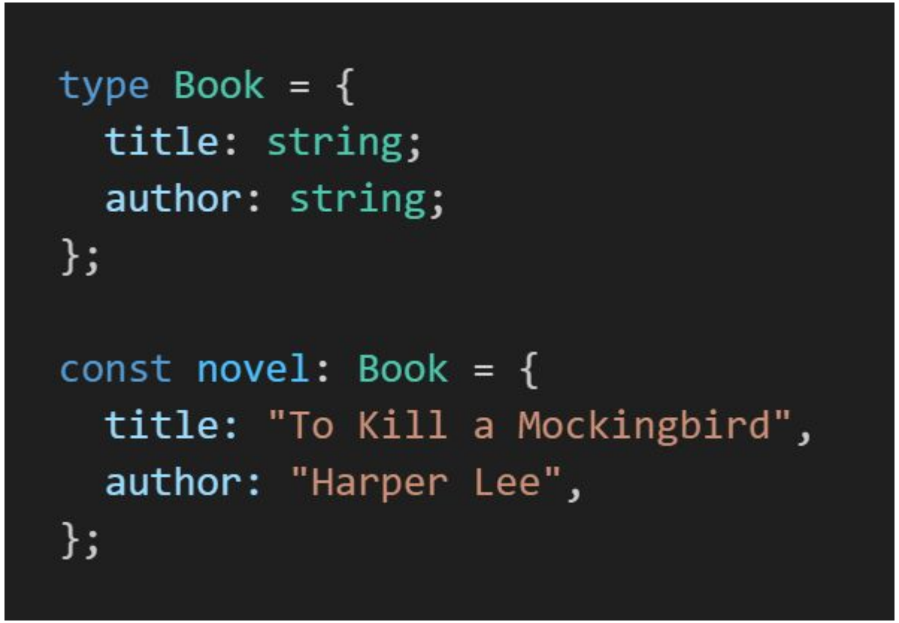
```
const plus20 = "+20";
const plus22 = { positive: true, value: 22 }
```

```
const plus2 = function (a:number, b:number): number {
    return a + b;
}
const plusTwo = (a:number, b:number) : number => {
    return a + b;
}
```

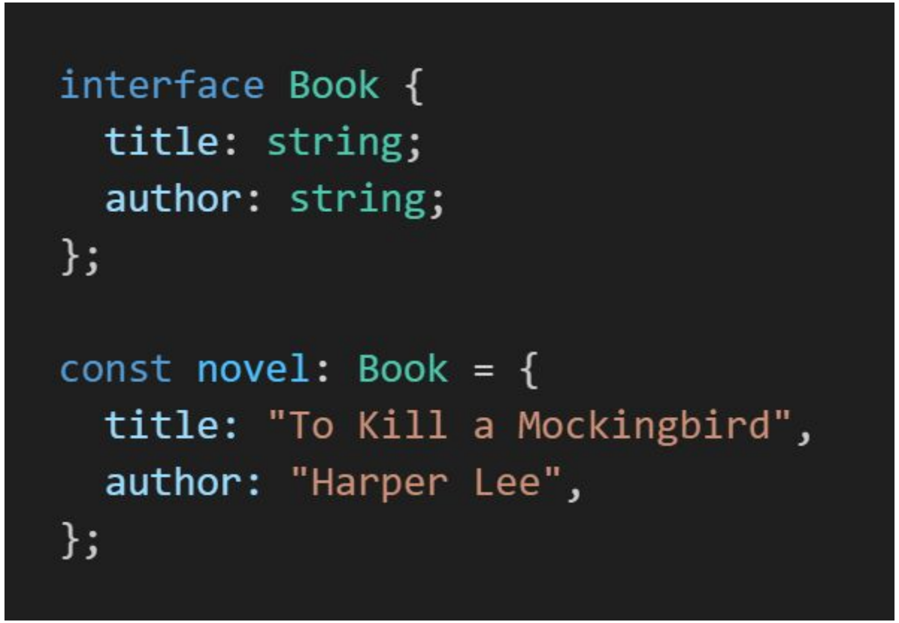
plus2 and plusTwo are variables that hold your ***CODE***

```
console.log(typeof plus20); // string
console.log(typeof plus22); // object
console.log(typeof plus2);   // function
console.log(typeof plusTwo); // function
```

Type Alias vs. Interface

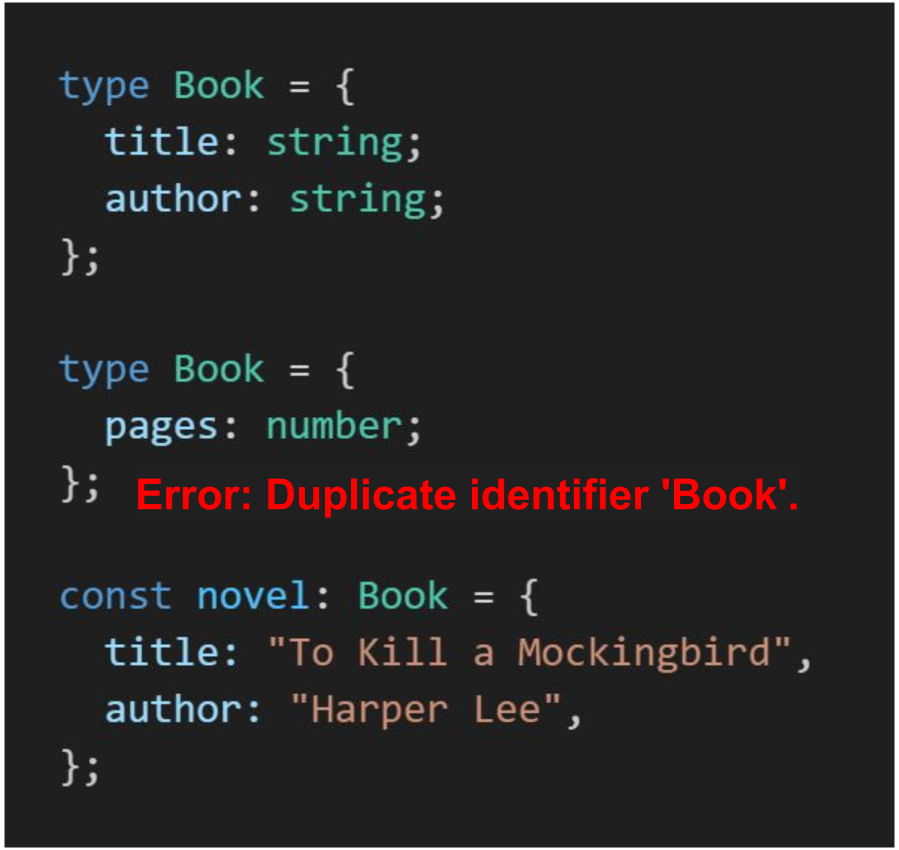


```
type Book = {
  title: string;
  author: string;
};

const novel: Book = {
  title: "To Kill a Mockingbird",
  author: "Harper Lee",
};
```



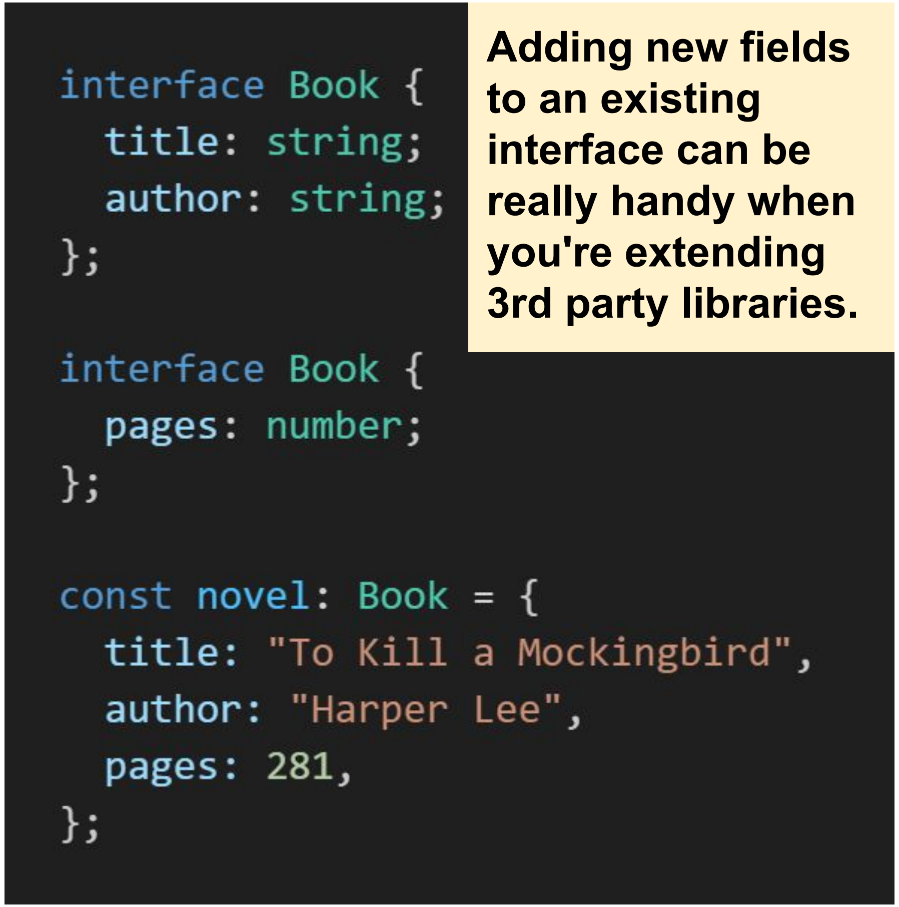
```
interface Book {
  title: string;
  author: string;
};

const novel: Book = {
  title: "To Kill a Mockingbird",
  author: "Harper Lee",
};
```

Type Alias vs. Interface



```
type Book = {
  title: string;
  author: string;
};

type Book = {
  pages: number;
};

const novel: Book = {
  title: "To Kill a Mockingbird",
  author: "Harper Lee",
};
```

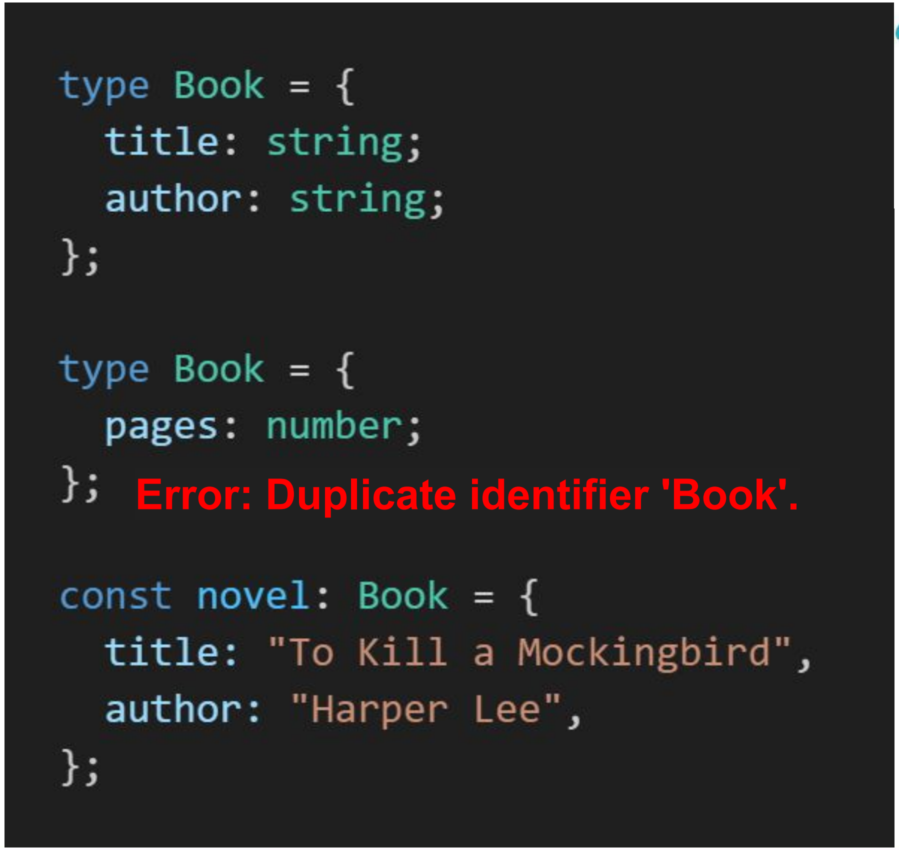
Error: Duplicate identifier 'Book'.



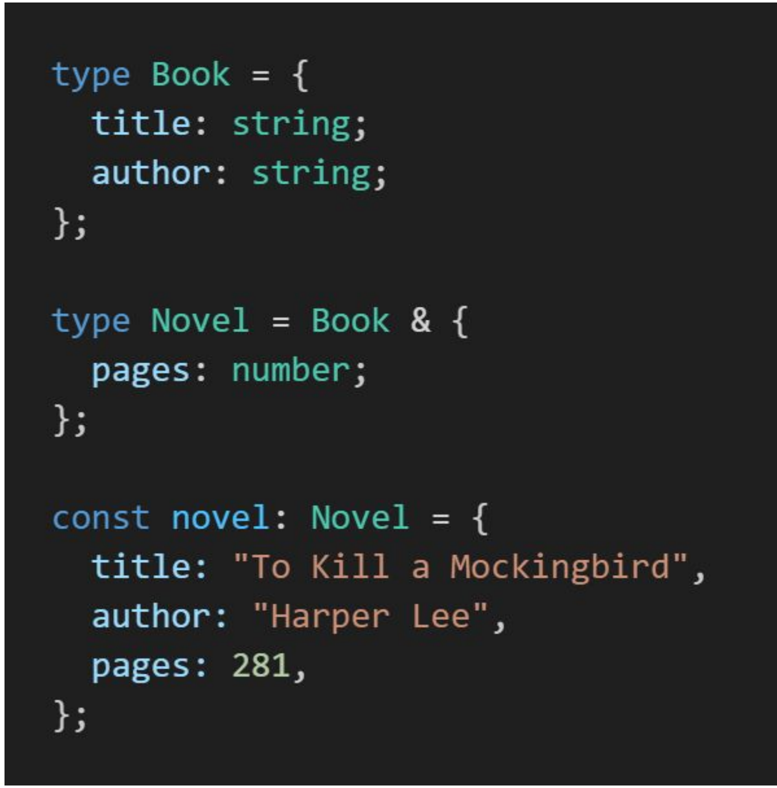
```
interface Book {
  title: string;
  author: string;
};

interface Book {
  pages: number;
};

const novel: Book = {
  title: "To Kill a Mockingbird",
  author: "Harper Lee",
  pages: 281,
};
```

Adding new fields to an existing interface can be really handy when you're extending 3rd party libraries.

Type Alias vs. Interface



```
type Book = {
  title: string;
  author: string;
};

type Book = {
  pages: number;
};  Error: Duplicate identifier 'Book'.

const novel: Book = {
  title: "To Kill a Mockingbird",
  author: "Harper Lee",
};
```



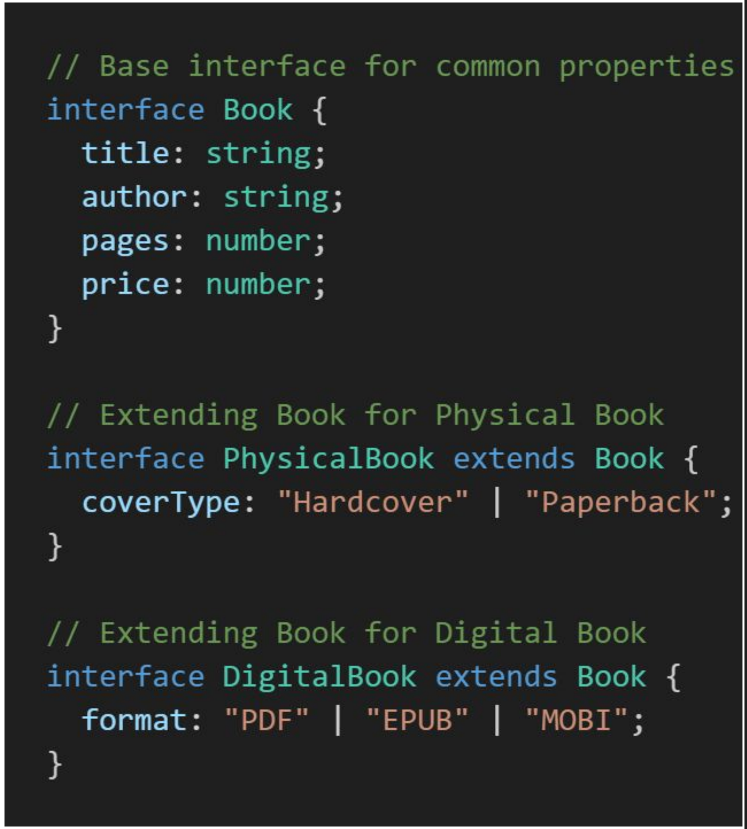
```
type Book = {
  title: string;
  author: string;
};

type Novel = Book & {
  pages: number;
};

const novel: Novel = {
  title: "To Kill a Mockingbird",
  author: "Harper Lee",
  pages: 281,
};
```

Type Alias vs. Interface

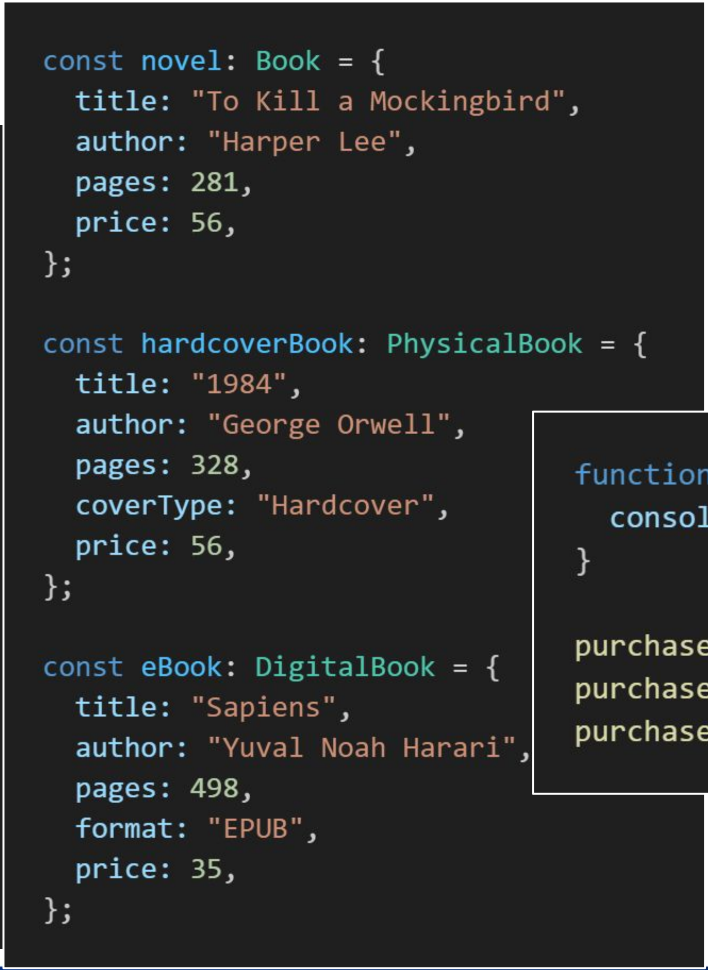
- A type cannot be re-opened to add new properties
- An interface which is always extendable.

Online Doc

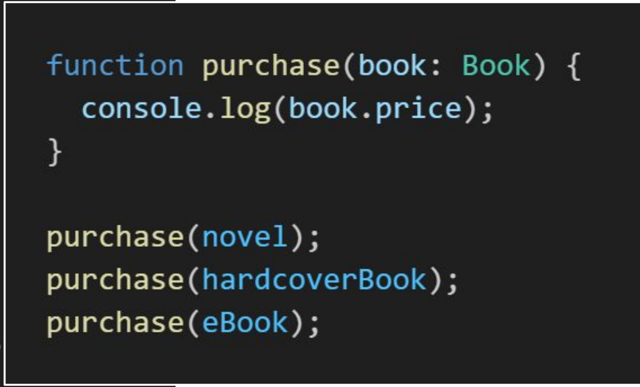
Interface



```
// Base interface for common properties
interface Book {
  title: string;
  author: string;
  pages: number;
  price: number;
}

// Extending Book for Physical Book
interface PhysicalBook extends Book {
  coverType: "Hardcover" | "Paperback";
}

// Extending Book for Digital Book
interface DigitalBook extends Book {
  format: "PDF" | "EPUB" | "MOBI";
}
```

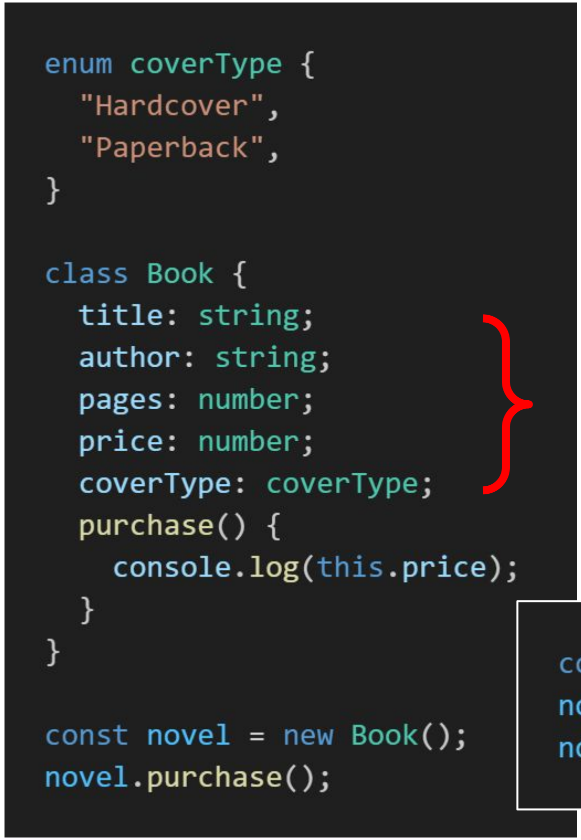


```
const novel: Book = {
  title: "To Kill a Mockingbird",
  author: "Harper Lee",
  pages: 281,
  price: 56,
};

const hardcoverBook: PhysicalBook = {
  title: "1984",
  author: "George Orwell",
  pages: 328,
  coverType: "Hardcover",
  price: 56,
};

const eBook: DigitalBook = {
  title: "Sapiens",
  author: "Yuval Noah Harari",
  pages: 498,
  format: "EPUB",
  price: 35,
};
```

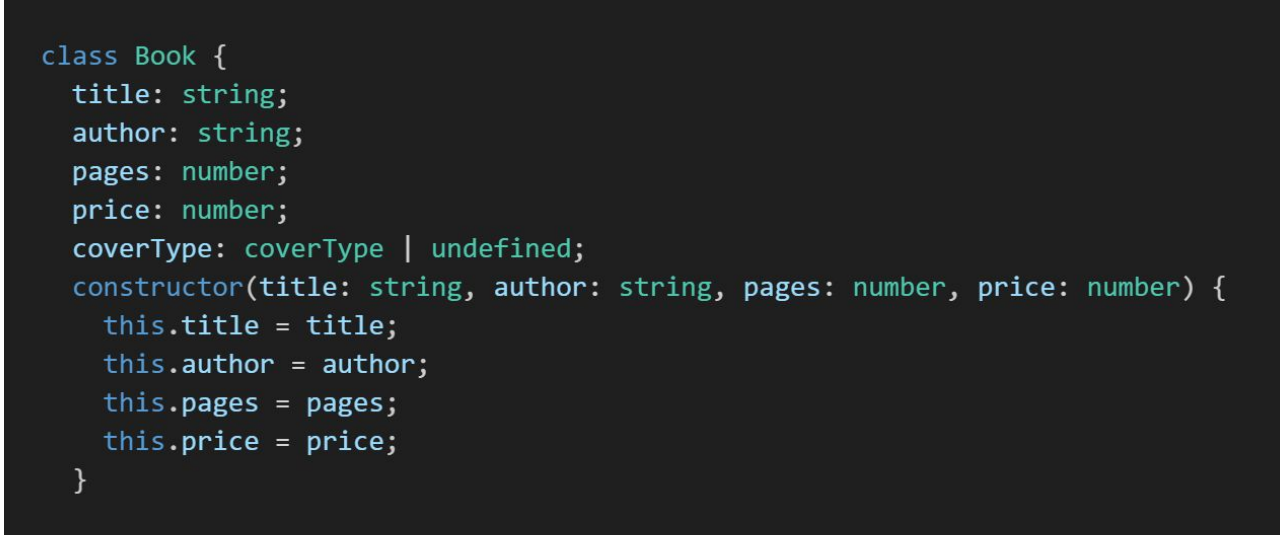


```
function purchase(book: Book) {
  console.log(book.price);
}

purchase(novel);
purchase(hardcoverBook);
purchase(eBook);
```

Class

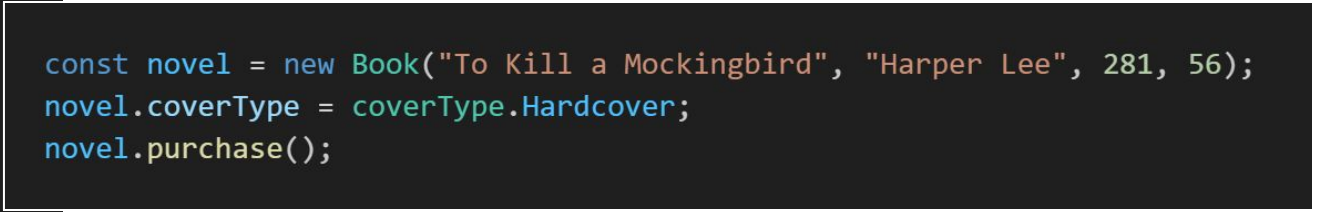


```
enum coverType {
  "Hardcover",
  "Paperback",
}

class Book {
  title: string;
  author: string;
  pages: number;
  price: number;
  coverType: coverType;
  purchase() {
    console.log(this.price);
  }
}

const novel = new Book();
novel.purchase();
```



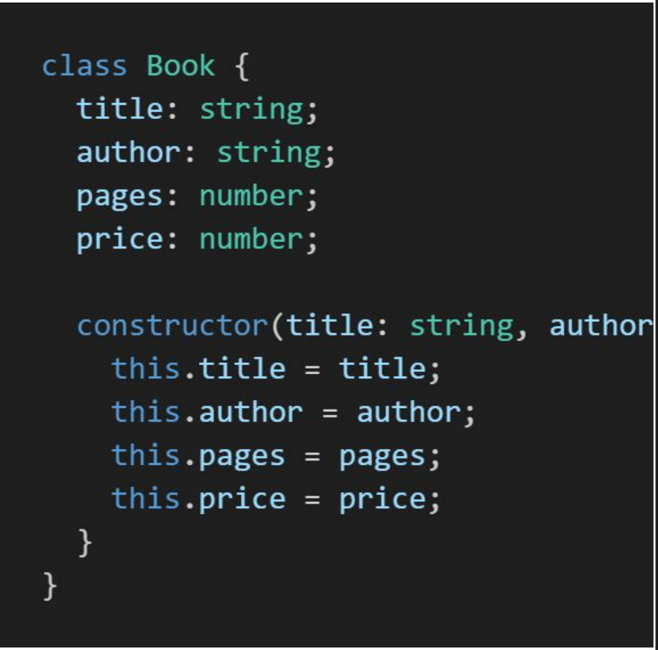
```
class Book {
  title: string;
  author: string;
  pages: number;
  price: number;
  coverType: coverType | undefined;
  constructor(title: string, author: string, pages: number, price: number) {
    this.title = title;
    this.author = author;
    this.pages = pages;
    this.price = price;
  }
```

Error: Property '...' has no initializer and is not definitely assigned in the constructor..

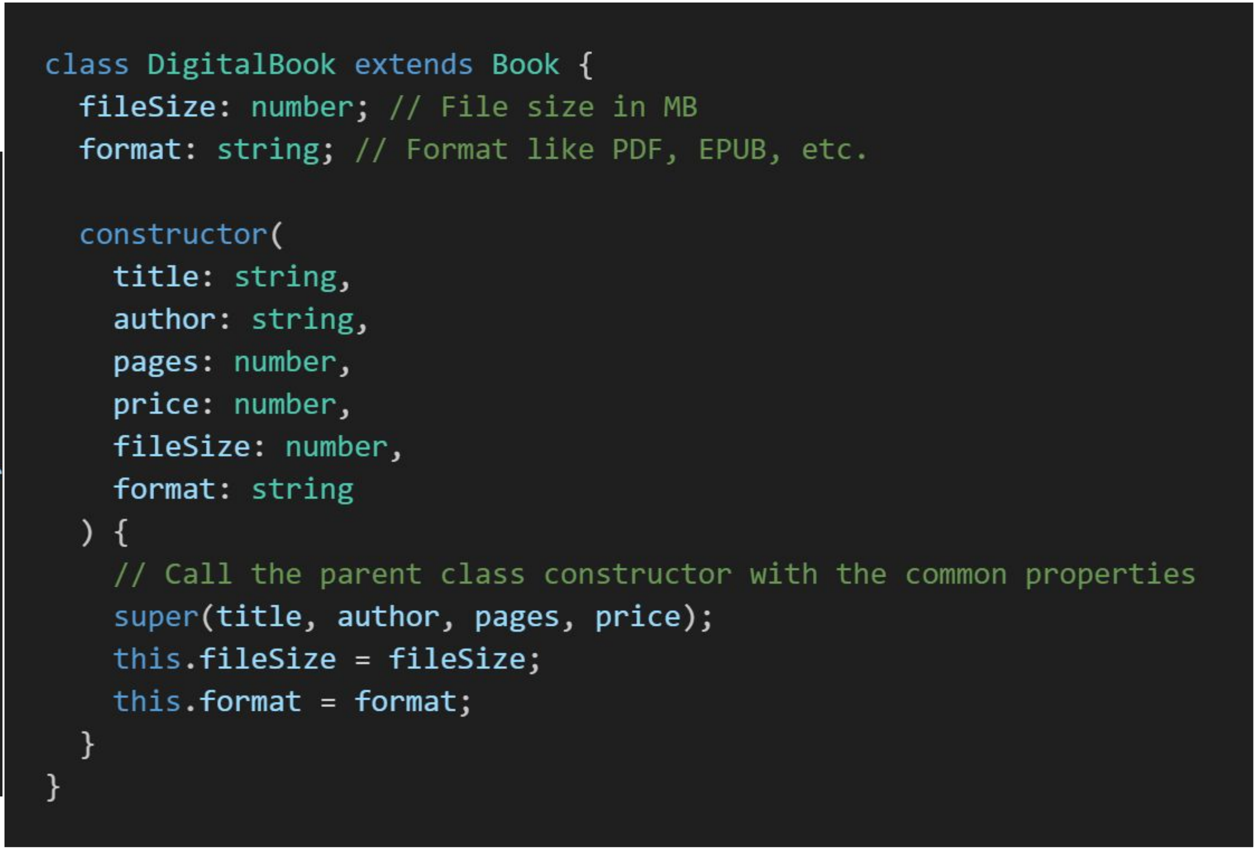


```
const novel = new Book("To Kill a Mockingbird", "Harper Lee", 281, 56);
novel.coverType = coverType.Hardcover;
novel.purchase();
```

Inheritance



```
class Book {
  title: string;
  author: string;
  pages: number;
  price: number;

  constructor(title: string, author
    this.title = title;
    this.author = author;
    this.pages = pages;
    this.price = price;
  }
}
```



```
class DigitalBook extends Book {
  fileSize: number; // File size in MB
  format: string; // Format like PDF, EPUB, etc.

  constructor(
    title: string,
    author: string,
    pages: number,
    price: number,
    fileSize: number,
    format: string
  ) {
    // Call the parent class constructor with the common properties
    super(title, author, pages, price);
    this.fileSize = fileSize;
    this.format = format;
  }
}
```

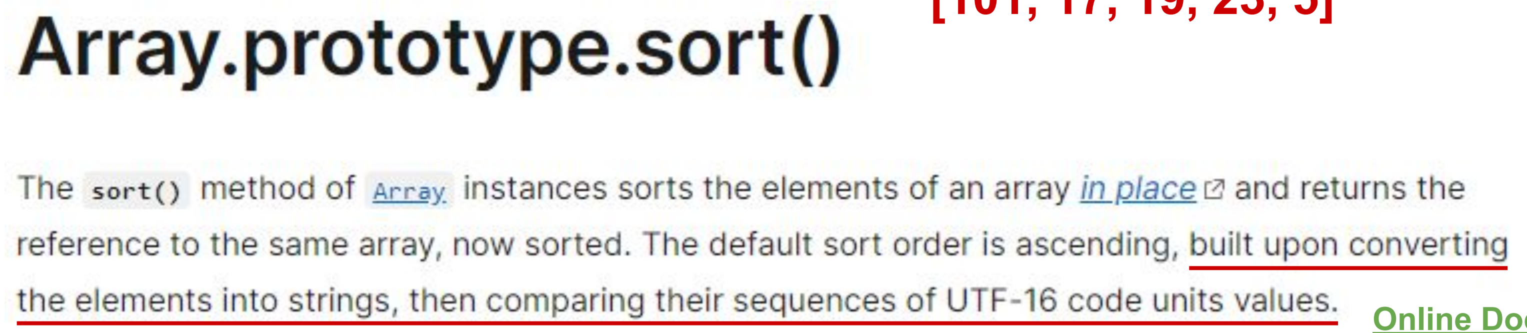
Functions as Arguments (to another Fn)

Array.sort()

```
const atoms = ["Neon", "Iron", "Calcium", "Hydrogen"]
console.log(atoms.sort())
// ["Calcium", "Hydrogen", "Iron", "Neon"]
```

```
const primes = [23, 17, 5, 101, 19]
const sorted_nums = primes.sort()
console.log(sorted_nums)
```

[101, 17, 19, 23, 5]

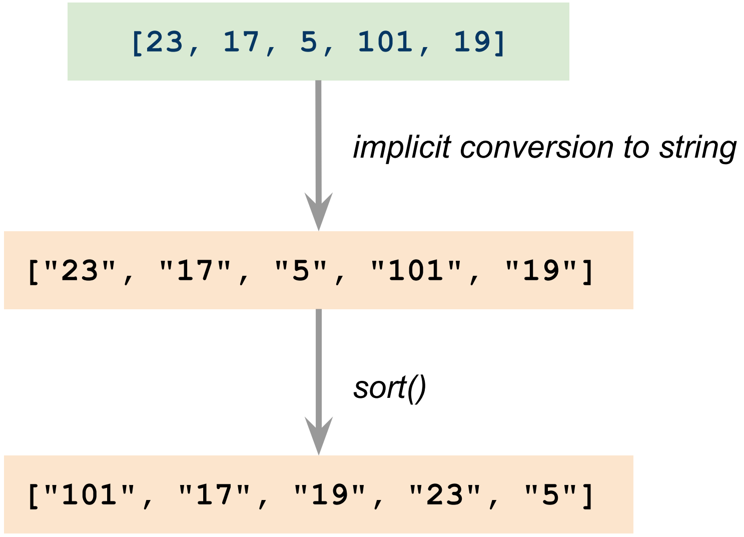


Array.prototype.sort()

The `sort()` method of `Array` instances sorts the elements of an array *in place* and returns the reference to the same array, now sorted. The default sort order is ascending, built upon converting the elements into strings, then comparing their sequences of UTF-16 code units values.

Online Doc

Array.sort() builtin behavior



```
[23, 17, 5, 101, 19]
["23", "17", "5", "101", "19"]
["101", "17", "19", "23", "5"]
```

To fix this ***“bug”***, we have to tell sort() the **collating order between two data items**

Array.sort() with collating order

```
function numericOrder(a:number, b:number): number {
    if (a < b) return -1;              // any negative number
    else if (a > b) return +1;         // any positive number
    else return 0;
}
```

```
const primes = [23, 17, 5, 101, 19]
const sorted_nums = primes.sort(numericOrder)
console.log(sorted_nums) // [5, 17, 19, 23, 101] Ok
```

The collating function must return a ***number***

- *Negative when the "first" item should be placed BEFORE the "second" item*
- *Positive when the "first" item should be placed AFTER the "second" item*
- *Zero when the order of the two items is irrelevant*

Array.sort() on objects

```
type Language = {
    name: string;  yearCreated: number
}
const langs: Language[] = [
    { name: "C", yearCreated: 1970},
    { name: "JavaScript", yearCreated: 1995},
    { name: "Fortran", yearCreated: 1954}
]
function orderByName(a:Language, b:Language): number {
    return a.name.localeCompare(b.name)
}
function orderByYear(a:Language, b:Language): number {
    return a.yearCreated - b.yearCreated
}
langs.sort(orderByName)
```

The collating function takes two parameters of type Language but must ***return a number***

Array.sort() on objects

```
type Language = {
    name: string;  yearCreated: number
}
const langs: Language[] = [
    { name: "C", yearCreated: 1970},
    { name: "JavaScript", yearCreated: 1995},
    { name: "Fortran", yearCreated: 1954}
]
function orderByName(a:string, b:string): number {
    return a.localeCompare(b)
}
function orderByYear(a:number, b:number): number {
     return a - b
}
langs.sort(orderByName)
```

The collating function must take two parameters of type Language

Array.sort() on objects

```
type Language = {
    name: string;  yearCreated: number
}
const langs: Language[] = [
    { name: "C", yearCreated: 1970},
    { name: "JavaScript", yearCreated: 1995},
    { name: "Fortran", yearCreated: 1954}
]
```

```
function orderByName(a:Language, b:Language): number {
    return a.name.localeCompare(b.name)
}
langs.sort(orderByName)
```

Option 1: named function

```
langs.sort(
    function (a:Language, b:Language): number {
        return a.name.localeCompare(b.name)
    }
)
```

Option 2: unnamed function

```
langs.sort(
    (a:Language, b:Language): number => {
        return a.name.localeCompare(b.name)
    }
)
```

Option 3: lambda function

```
langs.sort(
    (a, b) => a.name.localeCompare(b.name)
)
```

Opt 4: typeless lambda & 1-line return contraction

Function Optional Parameters/Arguments

```
// whoAmI can be called with 2, 3, or 4 args
const whoAmI = (name: string, age: number,  occupation?: string, spouse?: string): void => {
    console.log("Work as", occupation);
    console.log("Spouse name:", spouse ?? "N/A")
}
```

```
whoAmI("Andy", 22);                         // Work as undefined
                                            // Spouse name: N/A
whoAmI("Bob", 43, "banker");                // Work as banker
                                            // Spouse name: N/A
whoAmI("Chuck", 31, undefined, "Cindy");    // Work as undefined
                                            // Spouse name Cindy
whoAmI("Chuck", 31, null, "Cindy");         // Work as null
                                            // Spouse name Cindy
```

Function Parameter Default Value

```
const whoAmI = (name: string, age: number, occupation: string = "Student", spouse?: string):
void => {
    console.log("Work as", occupation);
    console.log("Spouse name:", spouse ?? "N/A")
}
```

```
whoAmI("Andy", 22);                          // Work as undefined
                                             // Spouse name: N/A
whoAmI("Bob", 43, "banker");                 // Work as banker
                                             // Spouse name: N/A
whoAmI("Chuck", 31, undefined, "Cindy");     // Work as Student
                                             // Spouse name Cindy
whoAmI("Chuck", 31, null, "Cindy");          // Work as null
                                             // Spouse name Cindy
```

Array Operations

Array high-order functions

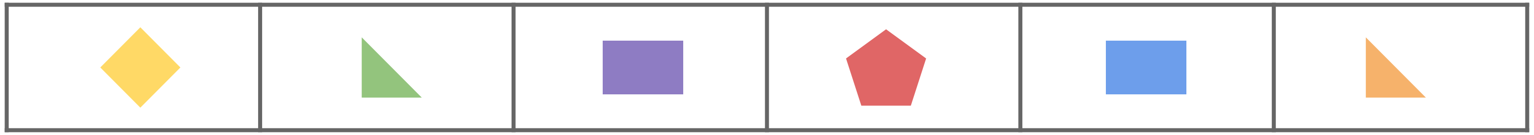
- Array.every(), Array.some()
- Array.find(), findIndex()
- Array.filter(), Array.map(), Array.flatmap()
- Array.forEach()
- Array.reduce()
- … and many others
- flatMap() is available in ES2019

```
// tsconfig.json {
  "compilerOptions": {
    "target": "ES2019",
    // other options go here
  }
  ...
}
```

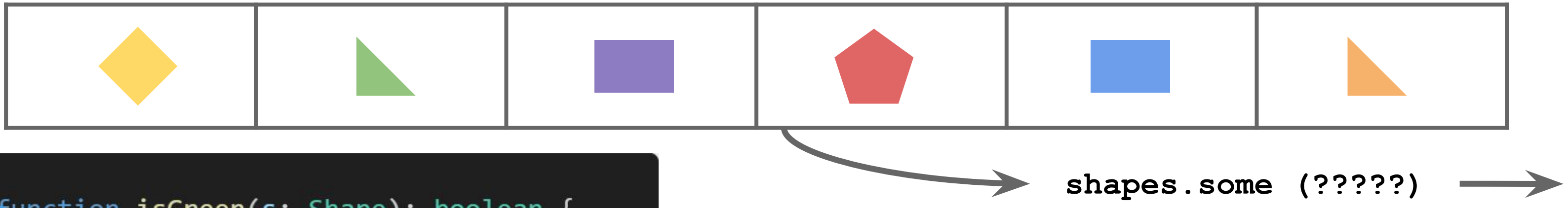
Array high-order functions

```
type Shape = {
  color: string;
  numSides: number;
  sideDims: Array<number>; // the length of each side
};
```

```
let shapes: Array<Shape> = [_____]
```



Array.some(): do we have any green shape?

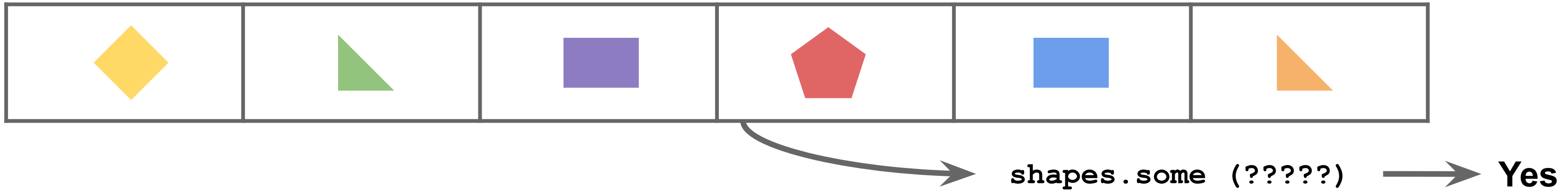


```
function isGreen(s: Shape): boolean {
    return s.color === "green"
}

const someGreen = shapes.some(isGreen);
console.log(someGreen);   // true
```

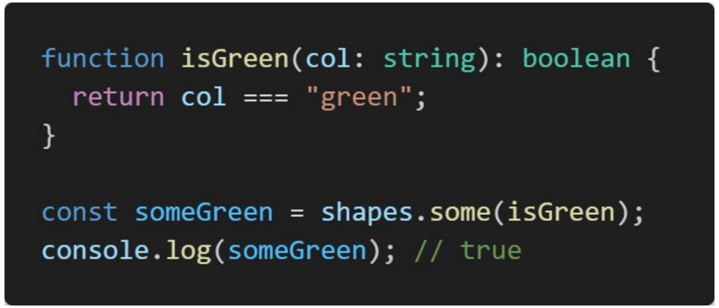
```
const someGreen = shapes.some(function (s: Shape): boolean {
  return s.color === "green";                              // Anonymous function
});

const someGreen = shapes.some((s: Shape): boolean => {
  return s.color === "green";                              // Anonymous fat arrow
});

const someGreen = shapes.some((s: Shape): boolean => s.color === "green");
                                                           // 1 line return elimination
const someGreen = shapes.some((s) => s.color === "green");
                                                           // No explicit type
```

- *Purpose: Test if at least one element in the array passes the test implemented by the provided function.*
- *Return value: **A Boolean** (true if at least one passes the test, otherwise false).*

Array.some(): do we have any green shape?



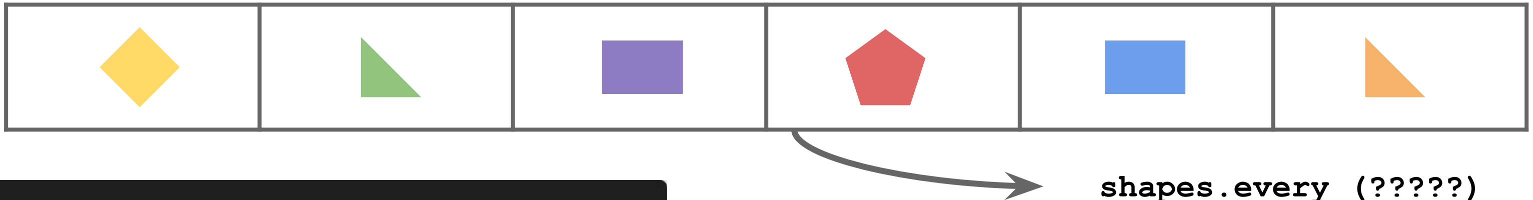
Incorrect!!!



```
function isGreen(col: string): boolean {
  return col === "green";
}

const someGreen = shapes.some(isGreen);
console.log(someGreen); // true
```

// isGreen must take a Shape as its input parameter
// NOT a string!!!

Array.every(): are all shapes triangle?

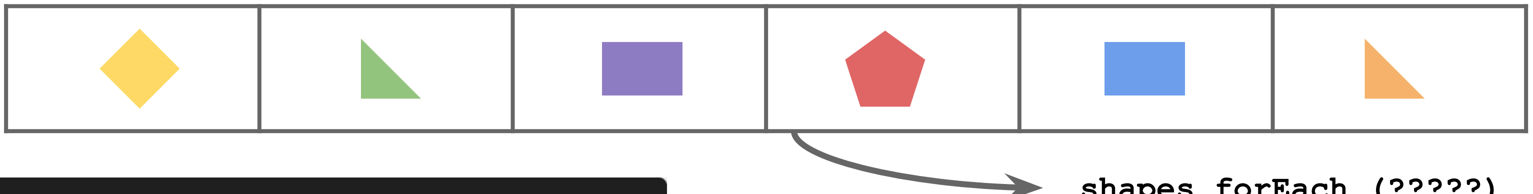


```
function isTriangle(s: Shape): boolean {
  return s.numSides === 3;
}

const allTriangle = shapes.every(isTriangle);
console.log(allTriangle); // false
```

```
const allTriangle = shapes.every(function (s: Shape): boolean {
  return s.numSides === 3;                                 // Anonymous function
});

const allTriangle = shapes.every((s: Shape): boolean => {
  return s.numSides === 3;                                 // Anonymous fat arrow
});

const allTriangle = shapes.every((s: Shape): boolean => s.numSides === 3);
                                                           // 1 line return elimination

const allTriangle = shapes.every((s) => s.numSides === 3);
                                                           // No explicit type
```

- *Purpose: Tests whether all elements in the array pass the test implemented by the provided function.*
- *Return value:* ***A Boolean*** *(true if every element passes the test, otherwise false).*

Array.forEach(): inspect all shapes

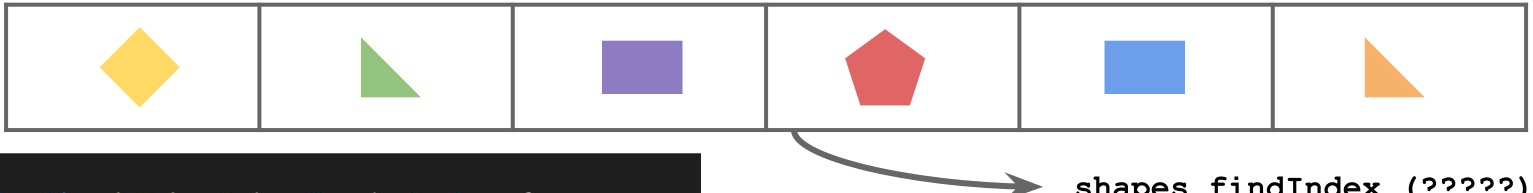


```
function printShape(s: Shape): void {
  console.log("# of sides", s.numSides);
}

shapes.forEach(printShape);
```

```
shapes.forEach(function (s: Shape): void {
  console.log("# of sides", s.numSides);
});                         // Anonymous function

shapes.forEach((s: Shape): void => {
  console.log("# of sides", s.numSides);
});                         // Anonymous fat arrow

shapes.forEach((s) => {
  console.log("# of sides", s.numSides);
});                         // No explicit type
```

- *Purpose: Executes a provided function once for each array element.*
- *Return value:* ***undefined.***

Array.findIndex(): where is ...?



```
function isTriangle(s: Shape): boolean {
  return s.numSides === 3;
}

const idxTriangle = shapes.findIndex(isTriangle);
console.log(idxTriangle); // 1
```

- *Purpose: To find the index of the **first element** in the array that satisfies a provided testing function.*
- *Return value: the index of the **first element** in the array that passes the test. If **no elements** pass the test, it returns **-1**.*

```
const idxTriangle = shapes.findIndex(function (s: Shape): boolean {
  return s.numSides === 3;
});

const idxTriangle = shapes.findIndex((s: Shape): boolean => {
  return s.numSides === 3;
});

const idxTriangle = shapes.findIndex((s: Shape): boolean => s.numSides === 3);

const idxTriangle = shapes.findIndex((s) => s.numSides === 3);
```