Inheritance and Prototypes

Class Inheritance, Prototypes, Prototype Chain, Code Reuse

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Have a Question?

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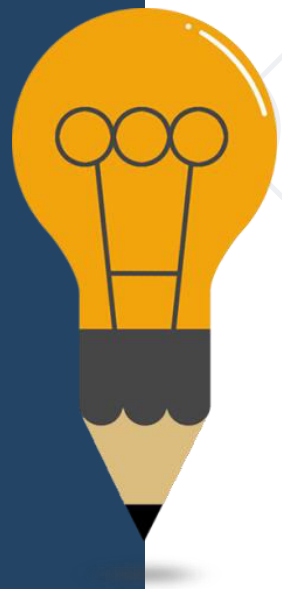
#JSCORE

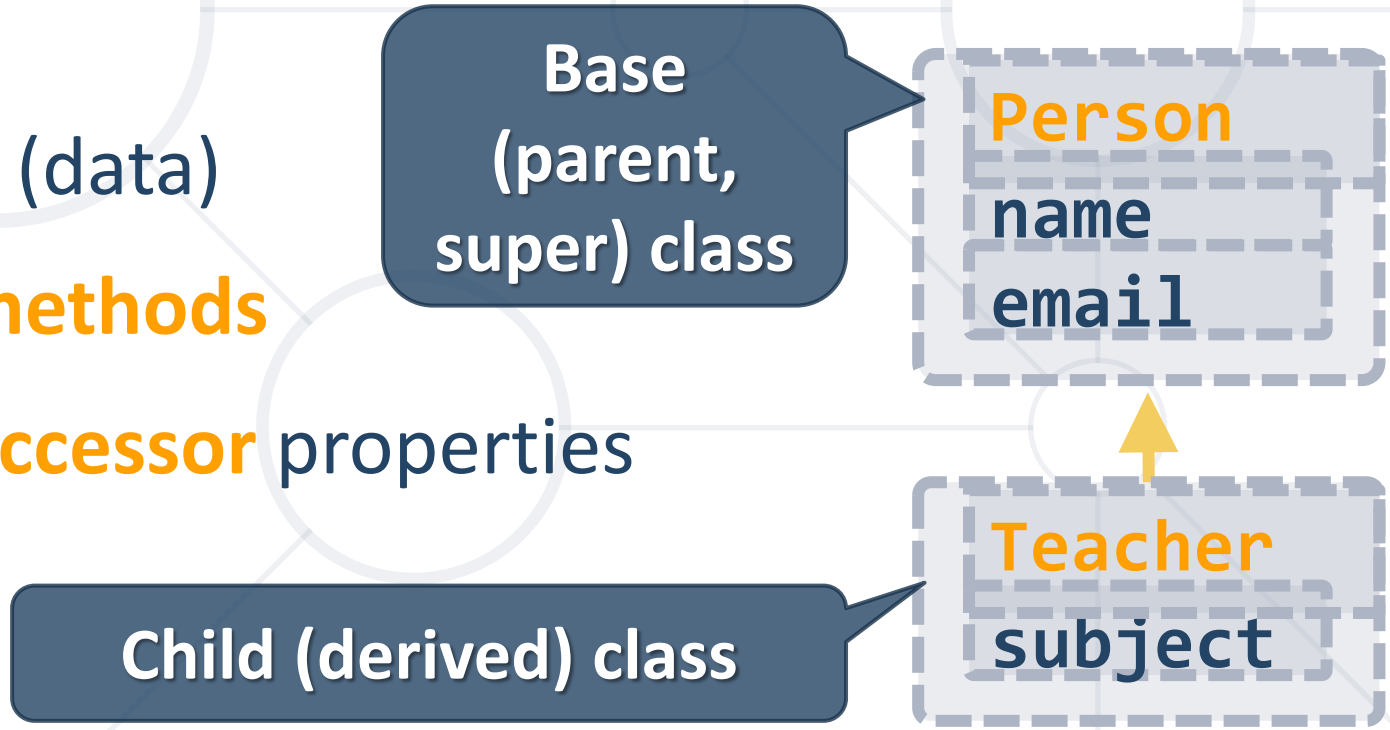
Simple Class Inheritance

Inheriting Data and Methods

Class Inheritance

- Classes can **inherit** (extend) other classes
  - Child class inherits data + methods from its parent
- **Child class** can:
  - Add **properties** (data)
  - Add / replace **methods**
  - Add / replace **accessor** properties





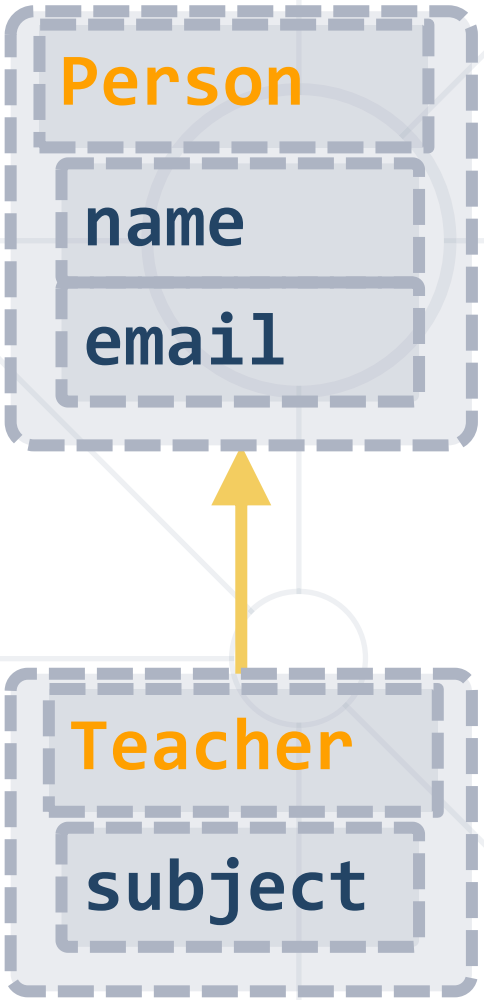
Class Inheritance – Example

```
class Person {
  constructor(name, email) {
    this.name = name; this.email = email;
  }
}
```

class Teacher inherits Person

```
class Teacher extends Person {
  constructor(name, email, subject) {
    super(name, email);
    this.subject = subject;
  }
}
```

Invoke the parent constructor



Class Inheritance – Example (2)

```
let p = new Person("Maria", "maria@gmail.com");
console.log("Person: " +
  p.name + ' (' + p.email + ')');
// Person: Maria (maria@gmail.com)
```

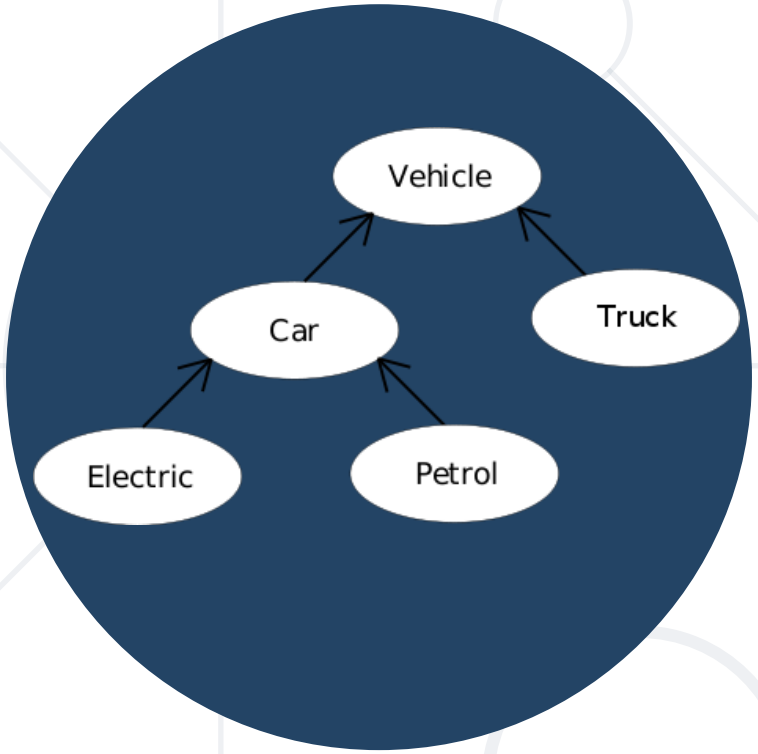
```
let t = new Teacher("Ivan", "iv@yahoo.com", "PHP");
console.log("Teacher: " + t.name +
  ' (' + t.email + '), teaches ' + t.subject);
// Teacher: Ivan (iv@yahoo.com), teaches PHP
```

Submitting Classes in the Judge

- SoftUni Judge (https://judge.softuni.bg) submissions should consist of a single function / arrow function / class definition
- Submit multiple classes as function returning JS object:

```
function personAndTeacherClasses() {
  class Person { … }
  class Teacher extends Person { … }
  return { Person, Teacher };
}
```

Check your solution here: https://judge.softuni.bg/Contests/339



Accessing Parent Members

Invoking Parent Methods

Inheriting and Replacing toString()

```
class Person {
  constructor(name, email) {
    this.name = name;
    this.email = email;
  }
  toString() {
    let className = this.constructor.name;
    return `${className} (name: ${this.name},
email: ${this.email})`;
  }
}
```

Inheriting and Replacing toString() – Teacher

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```
class Teacher extends Person {
  constructor(name, email, subject) {
    super(name, email);
    this.subject = subject;
  }
  toString() {
    let baseStr = super.toString().slice(0, -1);
    return baseStr + `, subject: ${this.subject})`;
  }
}
```

Invoke toString() from the base (parent) class

Inheriting and Replacing toString() – Student

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```
class Student extends Person {
  constructor(name, email, course) {
    super(name, email);
    this.course = course;
  }
  toString() {
    let baseStr = super.toString().slice(0, -1);
    return baseStr + `, course: ${this.course})`;
  }
}
```

Invoke toString() from the base (parent) class

Inheriting and Replacing toString() – Usage

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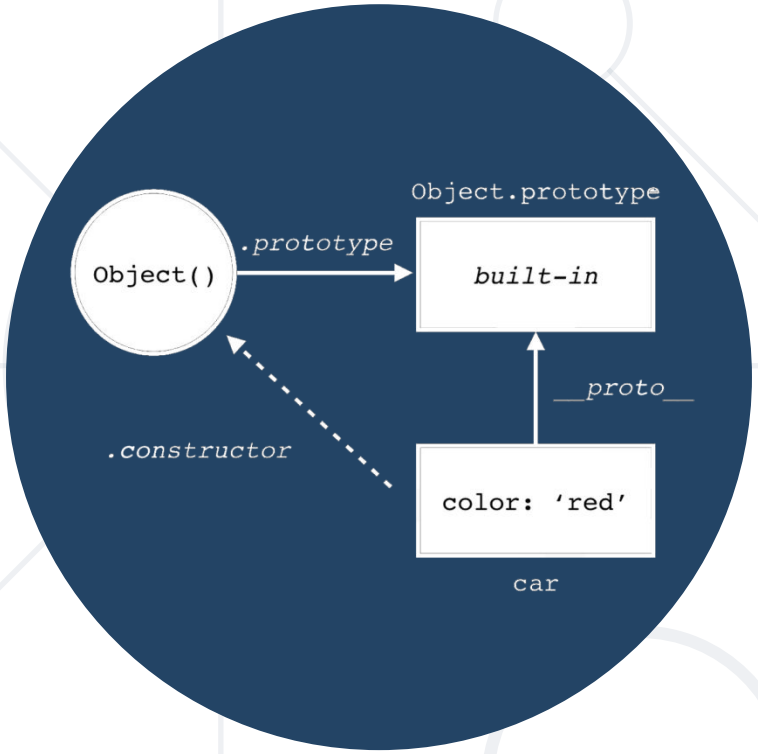
```
let p = new Person("Maria", "maria@gmail.com");
console.log('' + p);
// Person (name: Maria, email: maria@gmail.com)
```

```
let t = new Teacher("Ivan", "iv@yahoo.com", "PHP");
console.log('' + t);
// Teacher (name: Ivan, email: iv@yahoo.com, subject: PHP)
```

```
let s = new Student("Ana", "ana@mail.ru", 3);
console.log('' + s);
// Student (name: Ana, email: ana@mail.ru, course: 3)
```

Check your solution here: https://judge.softuni.bg/Contests/339



The Prototype Chain

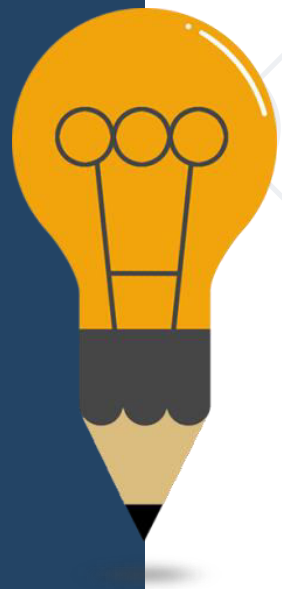
How Does It Work?

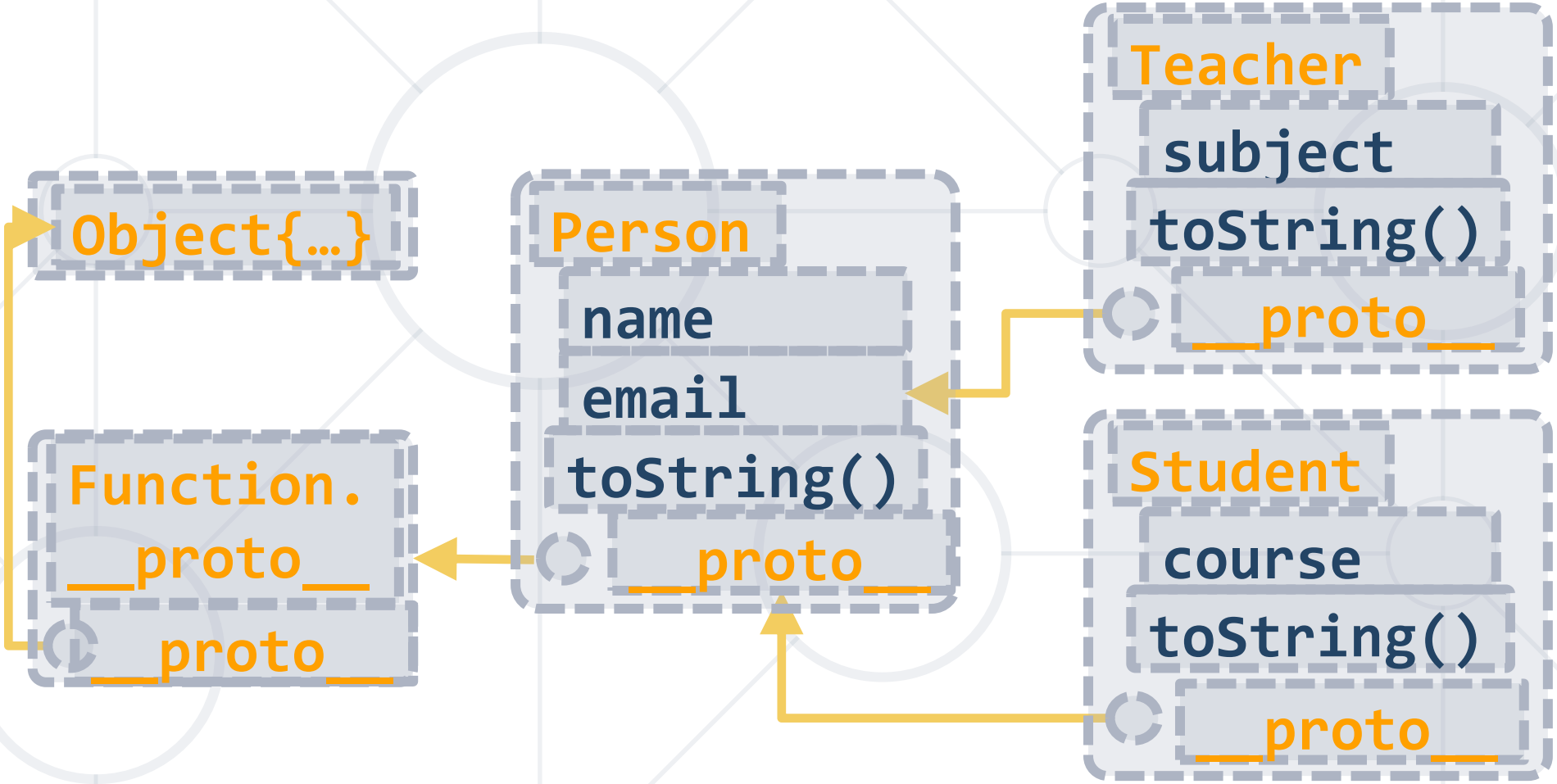
Prototypes in JavaScript

- Every object in JS has a **prototype** (template)
  - Internally called **`__proto__`** in browsers and NodeJS
  - Properties not found in the object are looked up in the prototype

- Can be obtained using **`Object.getPrototypeOf(obj)`**
- Using **`__proto__`** directly is deprecated → should be avoided!

The Prototype Chain for JS Classes





Prototype Chain (for Classes)

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- Classes have a prototype (a parent function)
  - Prototypes form a **prototype chain**

```
Object.getPrototypeOf(Teacher) == Person
// true (class prototype holds the parent class)
```

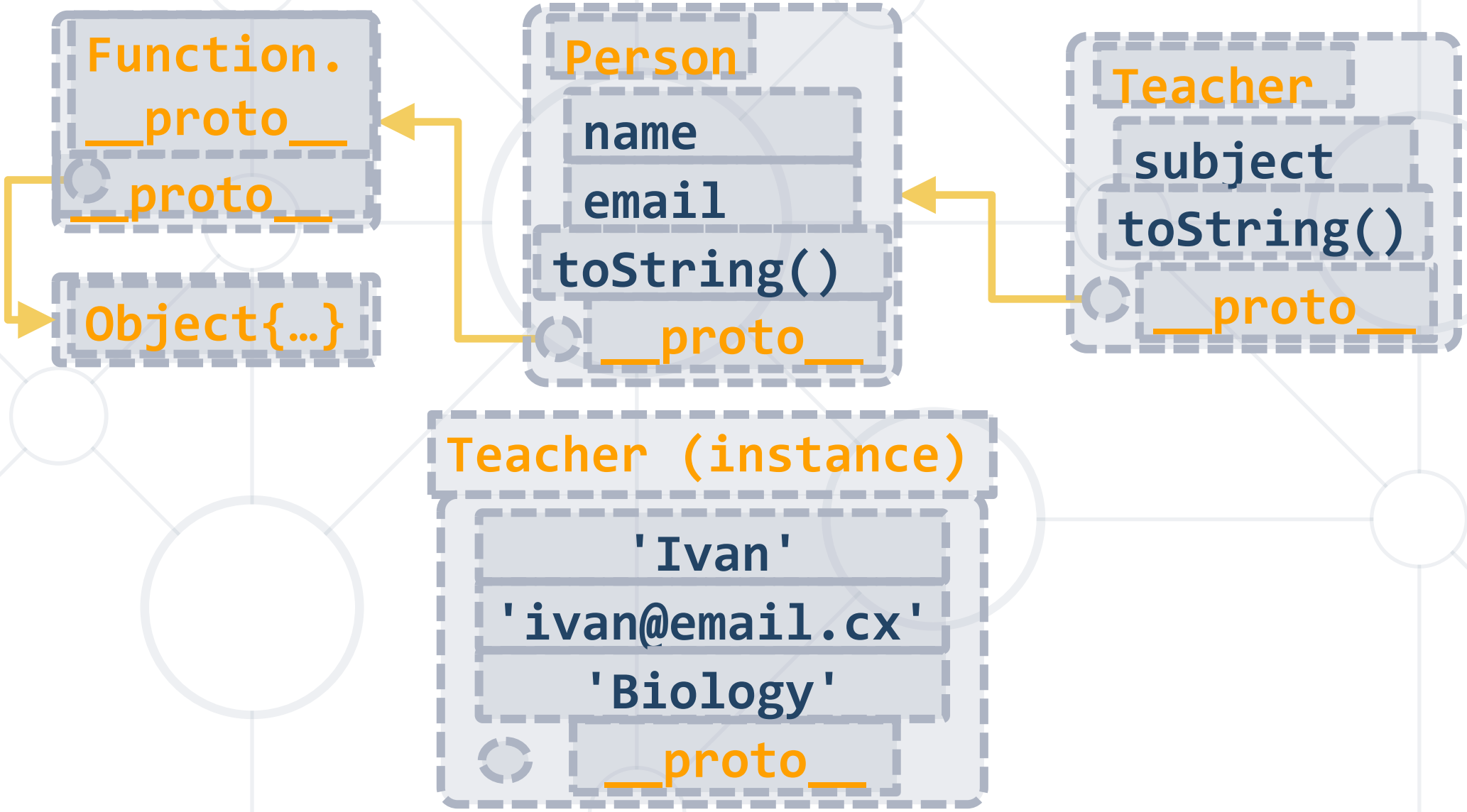
```
Teacher.__proto__ == Person; // true
// The same as the above (unofficial property)
```

```
Object.getPrototypeOf(Person) == Function.prototype; // true
```

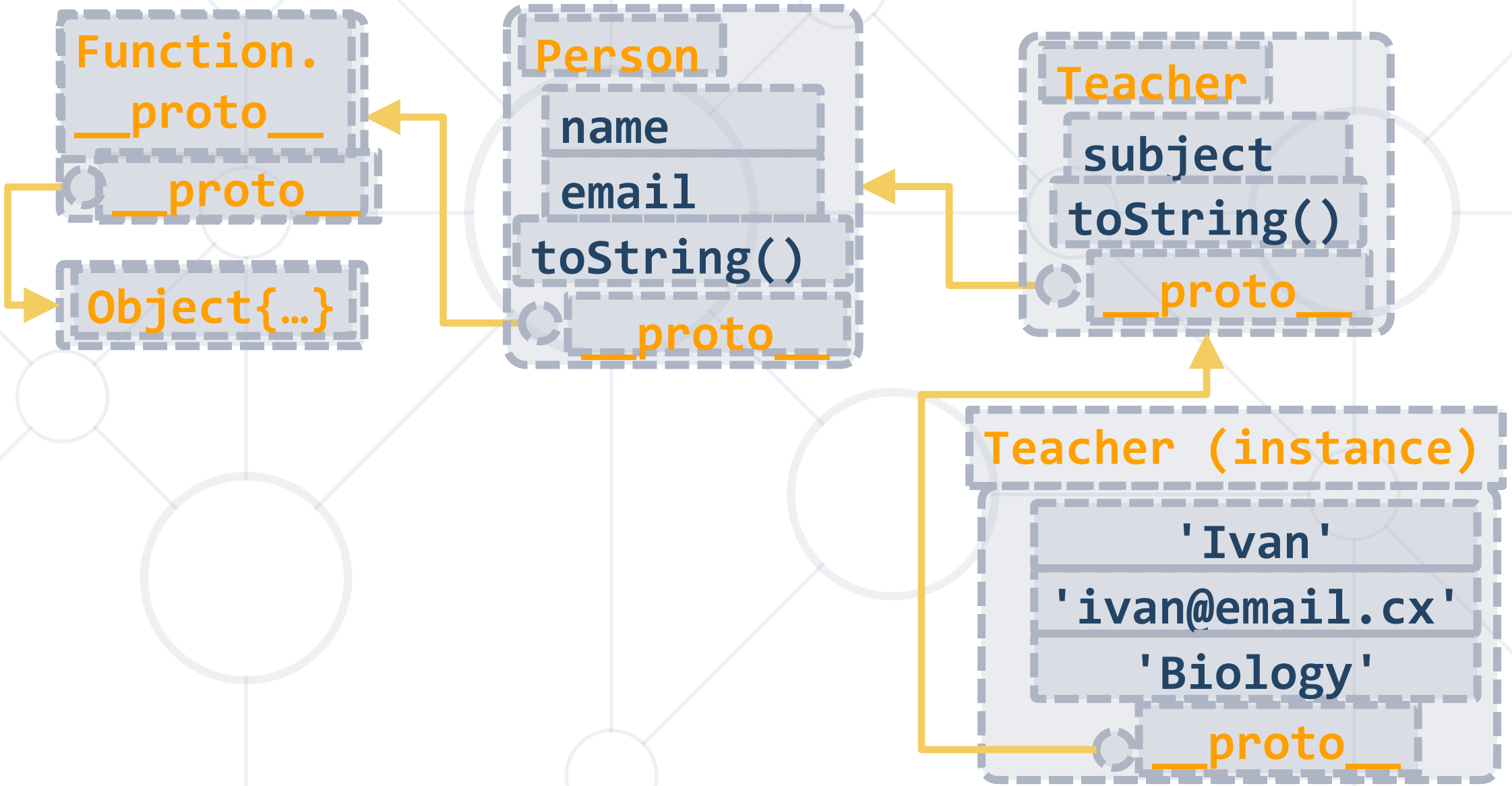
Prototypes in Classes and Objects

- Prototypes in **classes** / functions
  - Classes use their **__proto__** to resolve methods / properties
    - **__proto__** holds the parent class / function
  - Classes have also **prototype** object used to create new objects
    - Assigned to **__proto__** of each new object
- Prototypes in **objects**
  - Objects use their **__proto__** to resolve methods / properties
  - Objects do not have **prototype** object

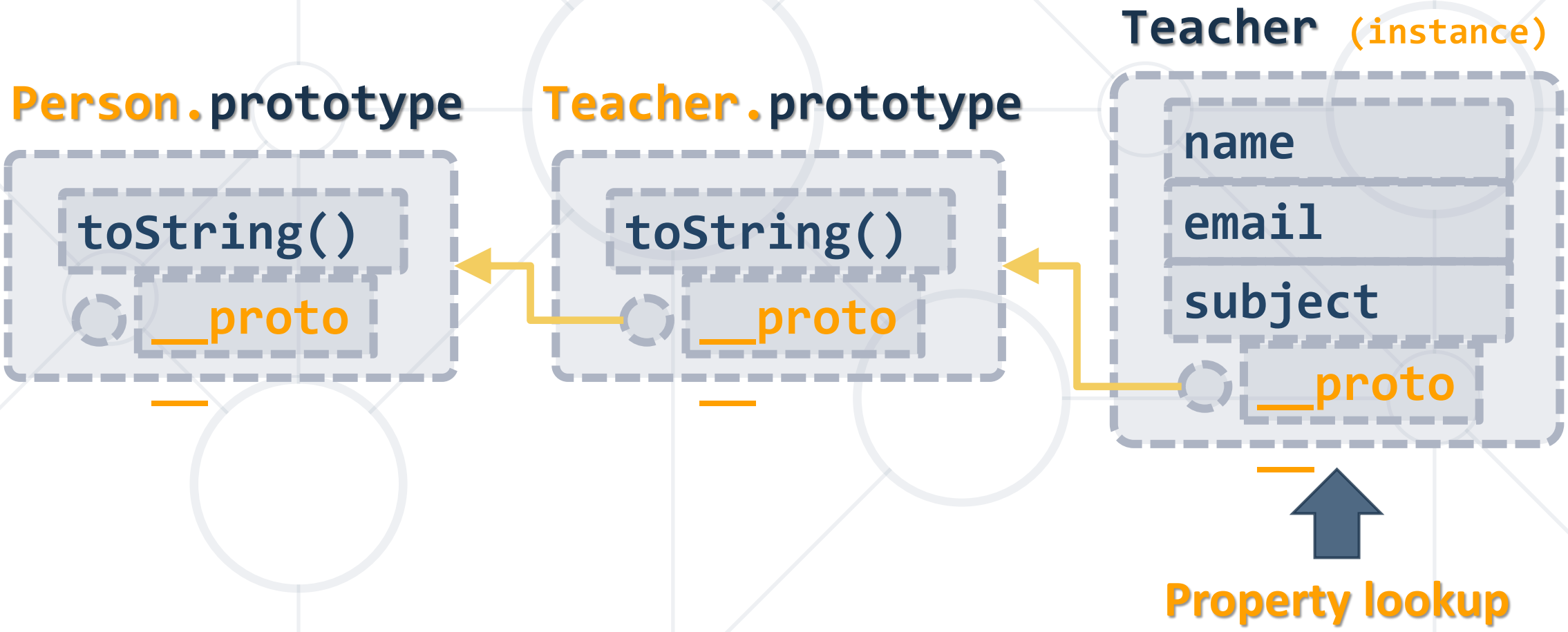
Object Instantiation (Create New Object)



Object Instantiation (Create New Object)



Prototype Chain for JS Objects



Problem: Extending Prototype

- Extend a passed class's **prototype** with a property **species** and m ethod **toSpeciesString()**:
  - **Person.prototype.species** – holds a string value "*Human*"
  - **Person.prototype.toSpeciesString()** – returns "I am a **{species}. {class.toString()}**"

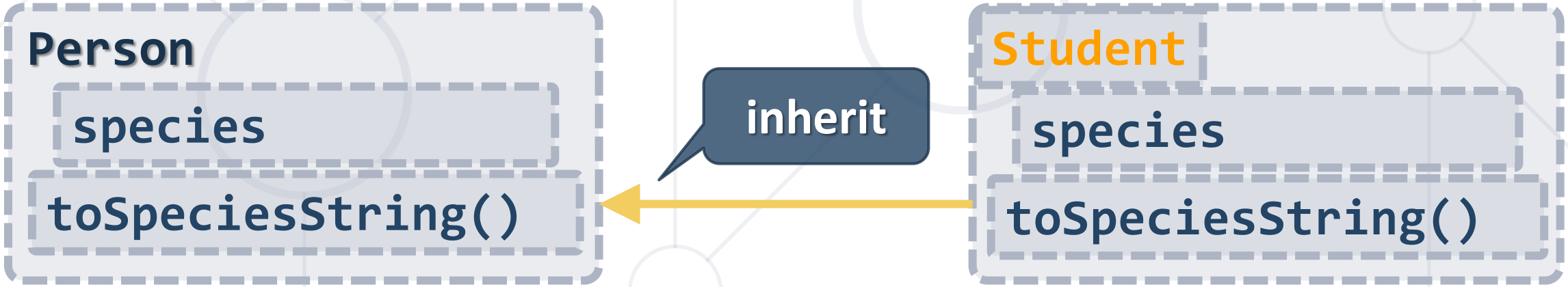
```
new Person("Maria", "maria@gmail.com").toSpeciesString()
// "I am a Human. Person (name: Maria, email: maria@gmail.com)"
```

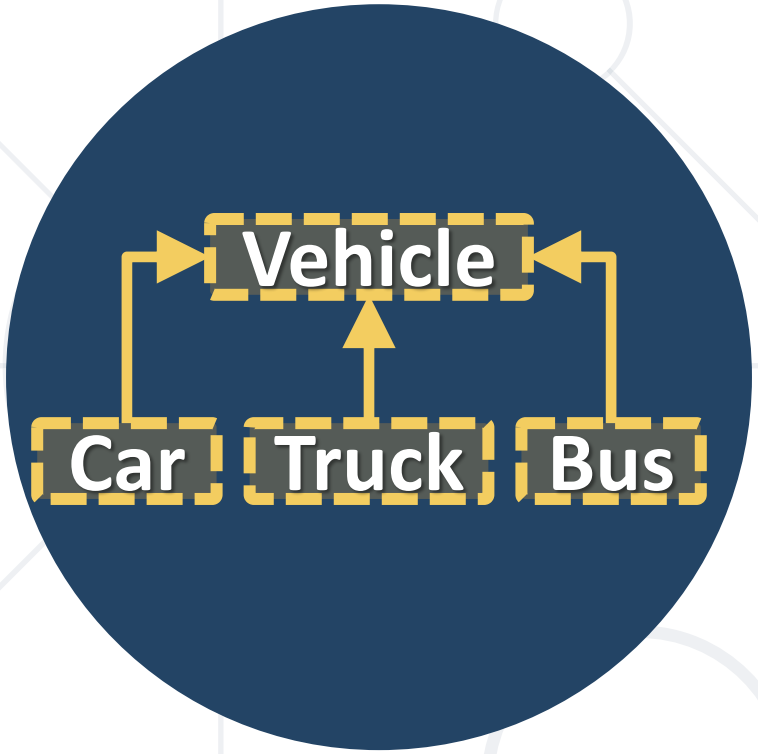
```
new Student("Ana", "ana@mail.ru", 3).toSpeciesString()
// "I am a Human. Student (name: Ana, email: ana@mail.ru, course: 3)"
```

Solution: Extending Prototype

```
function extendPrototype(Class) {
  Class.prototype.species = "Human";
  Class.prototype.toSpeciesString = function () {
    return `I am a ${this.species}. ${this.toString()}`;
  }
}
```

```
extendPrototype(Person);
```





Abstract Classes and Mixins

Inheriting Pieces of Functionality

What is Abstract Class?

- **Abstract classes** are abstractions → cannot be instantiated
  - Check **new.target** in the constructor

```
class Abstract {
  constructor() {
    if (new.target === Abstract)
      throw new TypeError("Cannot
construct Abstract instances directly");
  }
}
```

What is a Mixin?

- **Mixins** are bits of functionality that can be added to objects of **different** classes
  - Allow extending existing classes without modifying t hem directly
  - The code becomes more portable

```
function Mixin() {
  this.extensionFunc = function() { // New functionality …};
  return this;
}
```

What is a Mixin?

```
function asCircle() {
  this.area = function() {
    return Math.PI * this.radius * this.radius;
  };return this;
}
class Circle {constructor(r) { this.radius = r; } }
asCircle.call(Circle.prototype);
let circle = new Circle(5);
circle.area();
```

asCircle

area()

Circle

radius

Checking the Object Type

- Checking object type using `constructor.name`

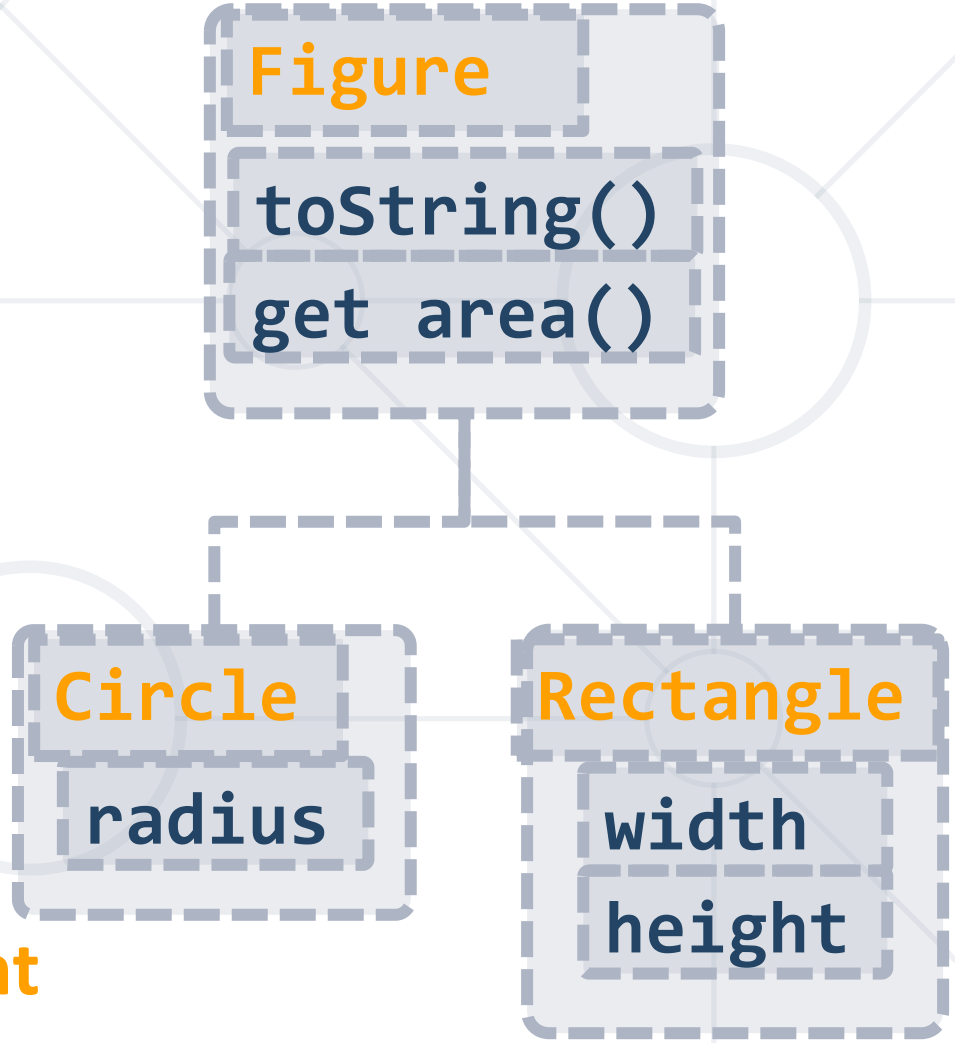
```
let p = new Person("Pesho","pesho@hit.bg");
console.log(p.constructor.name);
// Person
```

- Check if object belongs to a certain class (or its descendant):

```
let t = new Teacher("Pesho","pp@hit.bg","PHP");
console.log(t instanceof Person)
// true
```

Problem: Class Hierarchy

- Define the following class hierarchy:
  - **Figure**
    - **Abstract** class, defines **toString()** and **get area()**
  - **Circle**
    - Extends **Figure**, adds **radius**
  - **Rectangle**
    - Extends **Figure**, adds **width** + **height**



Solution: Class Hierarchy

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```
function classHierarchy() {
  class Figure {
    constructor() {
      if (new.target === Figure)
        throw new Error("Cannot instantiate an abstract class.");
    }
    get area() { return undefined; }
    toString() { let type = this.constructor.name; return type;
    }
  }
```

abstract method → will be implemented in child classes

Solution: Class Hierarchy (2)

```
class Circle extends Figure {
  constructor(radius) {
    super();
    this.radius = radius;
  }
  get area() { return Math.PI * this.radius * this.radius; }
  toString() {
    return super.toString() + ` - radius: ${this.radius}`;
  }
}
```

Solution: Class Hierarchy (3)

```
  class Rectangle extends Figure {
    constructor(width, height) {
      super(); [this.width, this.height] = [width, height];
    }
    get area() { return this.width * this.height; }
    toString() {
      return super.toString() + ` - width: ${this.width}, height
: ${this.height}`;
    }
  } return { Figure, Circle, Rectangle };
}
```

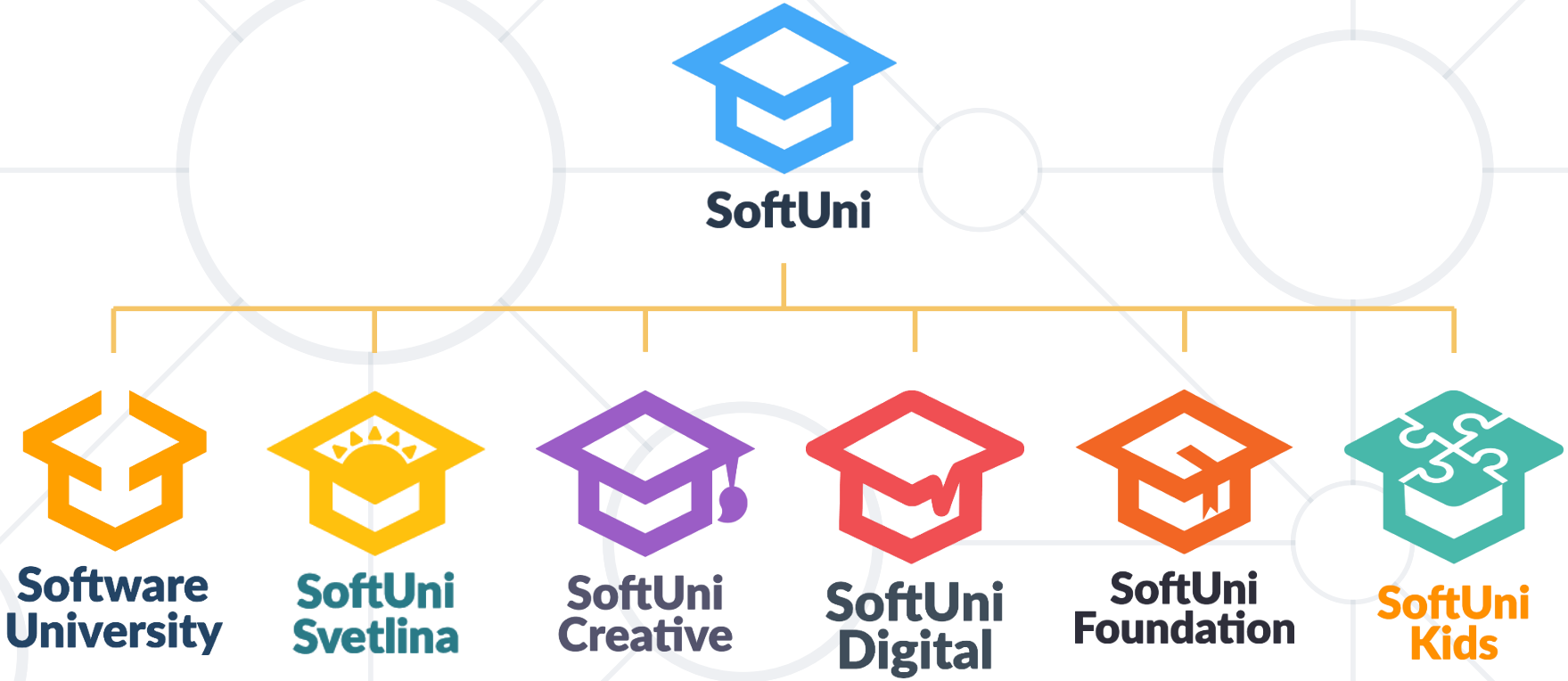
Check your solution here: https://judge.softuni.bg/Contests/339

Live Exercises

Summary

- Inheritance allows **extending** existing classes
- Objects in JS have **prototypes**
  - Objects look for **properties** in their prototype chains
  - Prototypes form a **hierarchical chain**

Questions?



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