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2023

JavaScript: Objects and Functions

"The" language of the Web

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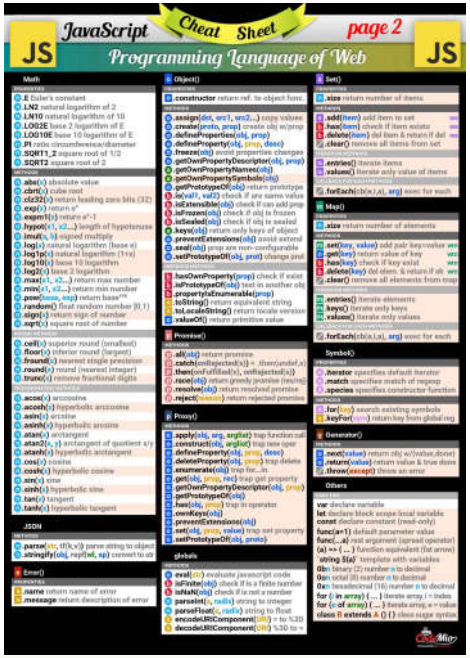


Outline

- Objects
- Functions
  - Closures
- Dates

JavaScript: The Definitive Guide, 7th Edition
Chapter 5. Objects

Mozilla Developer Network

- Learn web development JavaScript » Dynamic client-side scripting » Introducing JavaScript objects
- Web technology for developers » JavaScript » JavaScript reference » Standard built-in objects » Object
- Web technology for developers » JavaScript » JavaScript reference » Expressions and operators » in operator

JavaScript – The language of the Web

OBJECTS

Big Warnings *(a.k.a., forget Java objects)*

- In JavaScript, Objects may exist without Classes
  - Usually, Objects are created directly, without deriving them from a Class definition
- In JavaScript, Objects are dynamic
  - You may add, delete, redefine a *property* at any time
  - You may add, delete, redefine a *method* at any time
- In JavaScript, there are no access control methods
  - Every property and every method is always public (private/protected don't exist)
- There is no real difference between properties and methods (because of how JS functions work)

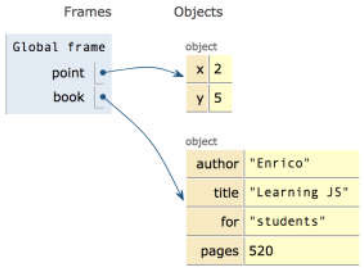
Object

- An object is an unordered collection of properties
  - Each property has a **name** (key), and a **value**
- You store and retrieve *property values*, through the *property names*
- Object creation and initialization:

```
let point = { x: 2, y: 5 };

let book = {
  author : "Enrico",
  title : "Learning JS",
  for: "students",
  pages: 520,
};
```

Object literals syntax:
`{"name": value, "name": value, }`
or:
`{name: value, name: value, }`



Object Properties

Property names are …

- Identified as a string
- Must be unique in each object
- Created at object initialization
- Added after object creation
  - With assignment
- Deleted after object creation
  - With `delete` operator

Property values are …

- Reference to any JS value
- Stored inside the object
- May be primitive types
- May be arrays, other objects, …
  - Beware: the object stores the reference, the value is *outside*
- May also be functions (*methods*)

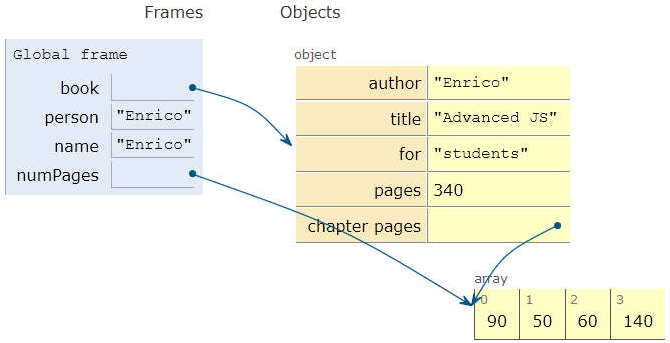
Accessing properties

The . dot notation and omitting the quotes are allowed **when the property name is a valid identifier, only**.
book.title or book['title']
book['my title'] and not ~~book.my title~~

- Dot (.) or square brackets [ ] notation

```
let book = {
  author : "Enrico",
  title : "Learning JS",
  for: "students",
  pages: 340,
  "chapter pages": [90,50,60,140]
};

let person = book.author;
let name = book["author"];
let numPages =
    book["chapter pages"];
book.title = "Advanced JS";
book["pages"] = 340;
```



Objects as associative arrays

- The [ ] syntax looks like array access, but the index is *a string*
  - Generally known as *associative arrays*
- Setting a non-existing property creates it:
  - `person["telephone"] = "0110901234";`
  - `person.telephone = "0110901234";`
- Deleting properties
  - `delete person.telephone;`
  - `delete person["telephone"];`

Computed property names

- Flexibility in creating object properties
  - `{[prop]:value}` -> creates an object with property name equal to *the value of the variable prop*
  - [] can contain more complex expressions: e.g., `i`-th line of an object with multiple "address" properties (address1, address2, …): `person["address"+i]`
    - **Using expressions is not recommended…**
- Beware of quotes:
  - `book["title"]` -> property called `title`
    - Equivalent to `book.title`
  - `book[title]` -> property called with the value of variable `title` (if exists)
    - If `title=="author"`, then equivalent to `book["author"]`
    - No equivalent in dot-notation

Property access errors

- If a property is not defined, the (attempted) access returns `undefined`
- If unsure, must check before accessing
  - Remember: `undefined` is *falsy*, you may use it in Boolean expressions

```
let surname = undefined;
if (book) {
    if (book.author) {
        surname = book.author.surname;
    }
}
```

```
surname = book && book.author && book.author.surname;
```

Iterating over properties

- `for .. in` iterates over the properties

```
for( let a in {x: 0, y:3}) {
     console.log(a) ;
}
```

```
x
y
```

```
let book = {
  author : "Enrico",
  pages: 340,
  chapterPages: [90,50,60,140],
};

for (const prop in book)
  console.log(`${prop} = ${book[prop]}`);
```

```
author = Enrico
pages = 340
chapterPages = 90,50,60,140
```


Iterating over properties

- All the (enumerable) properties names (keys) of an object can be accessed as an array, with:
  - `let keys = Object.keys(my_object) ;`
- All pairs [key, value] are returned as an array with:
  - `let keys_values = Object.entries(my_object)`

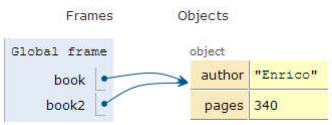
```
[ 'author', 'pages' ]
```

```
[ [ 'author', 'Enrico' ], [ 'pages', 340 ] ]
```

Copying objects

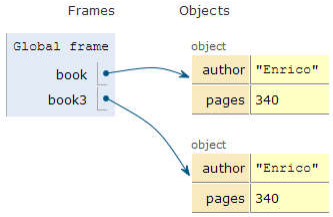
```
let book = {
  author : "Enrico",
  pages: 340,
};

let book2 = book;  // ALIAS
```




```
let book = {
  author : "Enrico",
  pages: 340,
};

let book3 =                // COPY
   Object.assign({}, book);
```



Object.assign

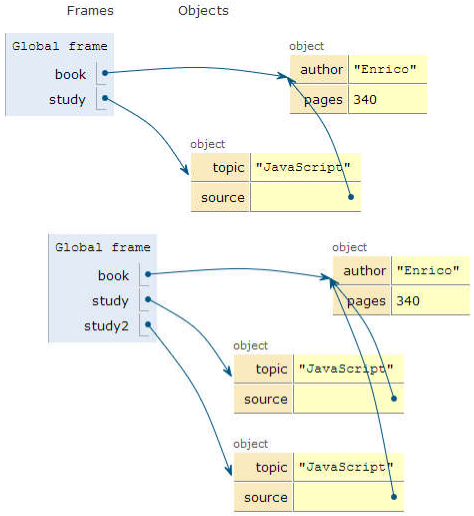
- `let new_object = Object.assign(target, source);`
- Assigns all the properties from the source object to the target one
- The target may be an existing object
- The target may be a new object: {}
- Returns the target object (after modification)

Beware! Shallow copy, only

```
let book = {
  author : "Enrico",
  pages: 340,
};

let study = {
  topic: "JavaScript",
  source: book,
};
```

```
let study2 = Object.assign({},
study);
```

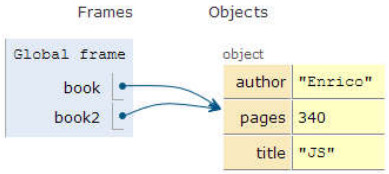


Merge properties (on existing object)

- `Object.assign(target, source, default values, ..);`

```
let book = {
  author : "Enrico",
  pages: 340,
};

let book2 = Object.assign(
 book, {title: "JS"}
);
```

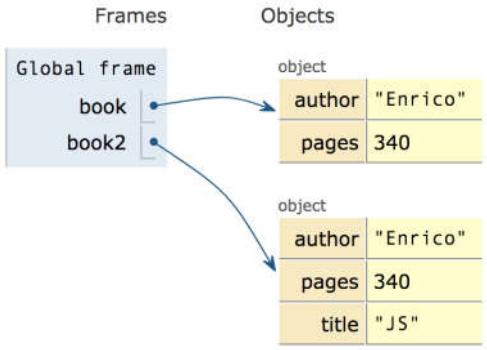


Merge properties (on new object)

- `Object.assign(target, source, default values, ..);`

```
let book = {
  author : "Enrico",
  pages: 340,
};

let book2 = Object.assign(
 {}, book, {title: "JS"}
);
```



Copying with **spread** operator (**ES9** – ES2018)

```
let book = {
  author : "Enrico",
  pages: 340,
};

let book2 = {...book, title: "JS"};
let book3 = { ...book2 } ;
console.log(book2);
```

```
{ author: 'Enrico', pages: 340, title: 'JS' }
```

```
const {a,b,...others} =
   {a:1, b:2, c:3, d:4};

console.log(a);
console.log(b);
console.log(others);
```

```
1
2
{ c: 3, d: 4 }
```

Checking if properties exist

- Operator **`in`**
  - Returns true if property is in the object. Do not use with Array

```
let book = {
  author : "Enrico",
  pages: 340,
};

console.log('author' in book);
delete book.author;
console.log('author' in book);
```

```
true
false
```

```
const v=['a','b','c'];

console.log('b' in v);



console.log('PI' in Math);
```

```
false
true
```


Object creation (equivalent methods)

- By object literal: `const point = {x:2, y:5} ;`
- By object literal (empty object): `const point = {} ;`
- By constructor: `const point = new Object() ;`
- By object static method create:
  `const point = Object.create({x:2,y:5}) ;`
- Using a *constructor function*

Preferred

JavaScript: The Definitive Guide, 7th Edition
Chapter 7. Functions

JavaScript – The language of the Web

FUNCTIONS

Functions

- One of the most important elements in JavaScript
- Delimits a block of code with a private scope
- Can accept parameters and returns one value
  - Can also be an object
- Functions themselves **are objects** in JavaScript
  - They can be assigned to a variable
  - Can be passed as an argument
  - Used as a return value

Declaring functions: 3 ways

1) Classic

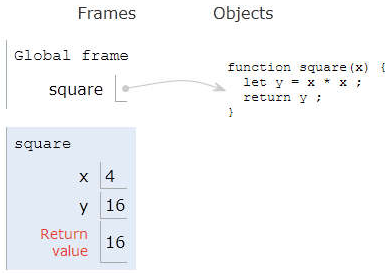
```
function do(params) {
  /* do something */
}
```


Classic functions

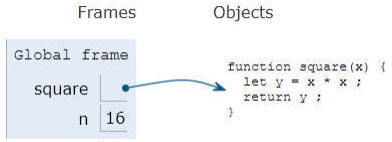
```
function square(x) {
  let y = x * x ;
  return y ;
}

let n = square(4) ;
```

During execution



After execution



Parameters

- Comma-separated list of parameter names
  - May assign a default value, e.g., `function(a, b=1) {}`
- Parameters are passed by-value
  - Copies of the reference to the object
- Parameters that are not passed in the function call get the value 'undefined'
- Check missing/optional parameters with:
  - `if(p===undefined) p = default_value ;`
  - `p = p || default_value ;`

Variable number of parameters

- Syntax for functions with variable number of parameters, using the `...` operator (called "rest")

```
function fun (par1, par2, ...arr) { }
```

- The "rest" parameter must be the last, and will deposit all extra arguments into an array

```
function sumAll(initVal, ...arr) {
  let sum = initVal;
  for (let a of arr) sum += a;
  return sum;
}
sumAll(0, 2, 4, 5); // 11
```

Declaring functions: 3 ways

1) Classic

```
function do(params) {
  /* do something */
}
```

2a) Function expression

```
const fn = function(params) {
  /* do something */
}
```

2b) Named function expression

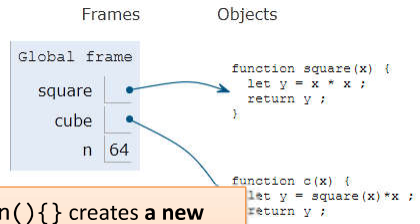
```
const fn = function do(params) {
  /* do something */
}
```


Function expression: indistinguishable

```
function square(x) {
  let y = x * x ;
  return y ;
}

let cube = function c(x) {
  let y = square(x)*x ;
  return y ;
}

let n = cube(4) ;
```



The *expression* `function(){}` creates **a new object of type 'function'** and returns the result.

Any variable may "refer" to the function and call it. You can also store that reference into an array, an object property, pass it as a parameter to a function, redefine it, …

method

callback

Declaring functions: 3 ways

1) Classic

```
function do(params) {
  /* do something */
}
```

2a) Function expression

```
const fn = function(params) {
  /* do something */
}
```

3) Arrow function

```
const fn = (params) => {
  /* do something */
}
```

2b) Named function expression

```
const fn = function do(params) {
  /* do something */
}
```

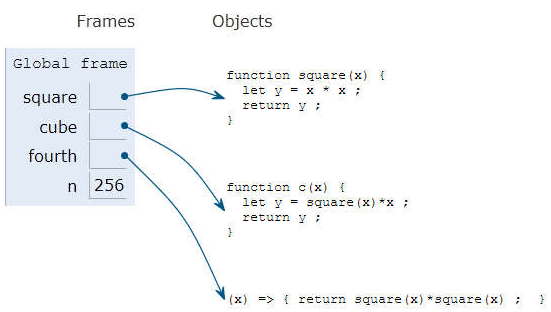

Arrow Function: just a shortcut

```
function square(x) {
  let y = x * x ;
  return y ;
}

let cube = function c(x) {
  let y = square(x)*x ;
  return y ;
}

let fourth = (x) => { return
square(x)*square(x) ;  }

let n = fourth(4) ;
```



Parameters in arrow functions

```
const fun = () => {  /* do something */ }          // no params

const fun = param => {  /* do something */ }       // 1 param

const fun = (param) => {  /* do something */ }     // 1 param

const fun = (par1, par2) => {  /* smtg */ } // 2 params

const fun = (par1 = 1, par2 = 'abc') => {  /* smtg */ }   // default values
```


Return value

- Default: `undefined`
- Use `return` to return a value
- Only one value can be returned
- However, objects (or arrays) can be returned

```
const fun = () => {  return ['hello', 5] ; }
const [ str, num ] = fun() ;
console.log(str) ;
```

- Arrow functions have implicit return if there is only one value

```
let fourth = (x) => { return square(x)*square(x) ;  }
let fourth = x => square(x)*square(x) ;
```

Nested functions

- Function can be nested, i.e., defined within another function

```
function hypotenuse(a, b) {
    const square = x => x*x ;
    return Math.sqrt(square(a) + square(b));
}
```

=> Preferred in nested functions

```
function hypotenuse(a, b) {
    function square(x) { return x*x; }
    return Math.sqrt(square(a) + square(b));
}
```

- The inner function is *scoped within* the external function and cannot be called outside
- The inner function might *access variables declared* in the *outside* function

Closure: definition (somewhat cryptic)

A **closure** is a name given to a feature in the language by which a **nested** function executed **after** the execution of the outer function can still access **outer function's scope**.

Really: one of the most important concepts in JS

https://medium.com/@vvkchandra/learn-javascript-closures-through-the-laws-of-karma-49d32d35b3f7

Closures

- JS uses *lexical scoping*
  - Each new functions defines a *scope* for the variables declared inside
  - Nested functions may access the scope of *all enclosing* functions
- Every function object remembers the scope where it is defined, even after the external function is no longer active → Closure

```
"use strict" ;

function greeter(name) {
    const myname = name ;

    const hello = function () {
        return "Hello " + myname ;
    }

    return hello ;
}

const helloTom = greeter("Tom") ;
const helloJerry = greeter("Jerry") ;

console.log(helloTom()) ;
console.log(helloJerry()) ;
```

Warning: not `return hello() ;`

Closures

- `hello` accesses the variable `myname`, defined in the outer scope
- The function is returned (as `helloTom` or `helloJerry`)
- Each of the functions "remembers" the reference to `myname`, when it was defined
- The variable `myname` goes out of scope, but is not destroyed
  - Still accessible (referred) by the `hello` functions.

```
"use strict" ;

function greeter(name) {
    const myname = name ;

    const hello = function () {
        return "Hello " + myname ;
    }

    return hello ;
}

const helloTom = greeter("Tom") ;
const helloJerry = greeter("Jerry") ;

console.log(helloTom()) ;
console.log(helloJerry()) ;
```

greeter scope

hello scope

Using closures to emulate objects

```
"use strict" ;

function counter() {
    let value = 0 ;

    const getNext = () => {
        value++;
        return value;
    }

    return getNext ;
}
```

```
const count1 = counter() ;
console.log(count1()) ;
console.log(count1()) ;
console.log(count1()) ;

const count2 = counter() ;
console.log(count2()) ;
console.log(count2()) ;
console.log(count2()) ;
```

```
1
2
3
1
2
3
```


Using closures to emulate objects (with methods)

```
"use strict";

function counter() {
    let n = 0;

    // return an object,
    // containing two function-valued
    // properties
    return {
        count: function() {
            return n++; },
        reset: function() { n = 0; }
    };
}
```

```
let c = counter(), d = counter();
        // Create two counters

c.count()
        // => 0

d.count()
        // => 0: they count independently

c.reset()
        // reset() and count() methods

c.count()
        // => 0: because we reset c

d.count()
        // => 1: d was not reset
```

Immediately Invoked Function Expressions (IIFE)

- Functions may protect the *scope* of variables and inner functions
- May declare a function
  - With internal variables
  - With inner functions
  - Call it only once, and discard everything

```
( function() {
    let a = 3 ;
    console.log(a) ;
} ) () ;
```

```
let num = ( function() {
    let a = 3 ;
    return a ;
} ) () ;
```

https://flaviocopes.com/javascript-iife/

https://medium.com/@vvkchandra/essential-javascript-mastering-immediately-invoked-function-expressions-67791338ddc6

Using IIFE to emulate objects (with methods)

```
"use strict";

const c = (
    function () {
        let n = 0;

        return {
            count: function () {
                return n++; },
            reset: function () {
                n = 0; }
        };
    })();
```

```
console.log(c.count());
console.log(c.count());
c.reset();
console.log(c.count());
console.log(c.count());
```

```
0
1
0
1
```

Construction functions

- Define the object type
  - Use a capital initial letter
  - Set the properties with the keyword **this**
- Create an instance of the object with **new**

```
function Car(make, model, year) {
  this.make = make;
  this.model = model;
  this.year = year;
  this.isNew = ()=>(year>2000);
}
```

```
let mycar = new Car('Eagle',
'Talon TSi', 1993);
```


JavaScript: The Definitive Guide, 7th Edition
Chapter 9.4 Dates and Times

Mozilla Developer Network
Web technology for developers » JavaScript »
JavaScript reference »
Standard built-in objects » Date

Day.js
https://day.js.org/en/

JavaScript – The language of the Web

DATES

Date object

- Store a time instant with *millisecond* precision, counted from Jan 1, 1970 UTC (Unix Epoch)
- Careful with time zones
  - Most methods work in local time (not UTC) the computer is set to

```
let now = new Date();
```

```
let newYearMorning = new Date(
2021, // Year 2021
0, // January (from 0)
1, // 1st
18, 15, 10, 743);
// 18:15:10.743, local time
```

UTC vs Local time zone are confusing.

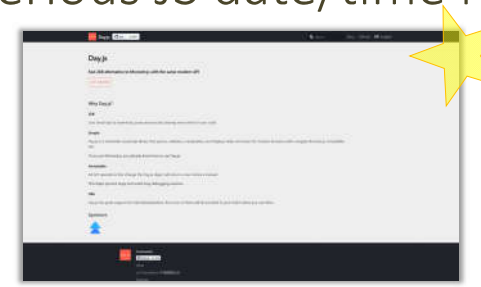
```
> new Date('2020-03-18')
2020-03-18T00:00:00.000Z
> new Date('18 March 2020')
2020-03-17T23:00:00.000Z
```

😱

Formatting is locale and implementation dependent 😱😱

Comparisons are difficult (no way to specify which fields you want, must set them to zero explicitly) 😱😱😱

Serious JS date/time handling libraries



https://day.js.org/

https://moment.github.io/luxon/

https://momentjs.com/

https://date-fns.org/

https://js-joda.github.io/js-joda/

Day.js Library

DAY.JS https://day.js.org/

- Goals
  - Compatible with moment.js
    - But very small (2kB)
  - Works in nodejs and in the browser
  - All objects are *immutable*
    - All API functions that modify a date, will always return a new object instance
  - Localization
  - Plugin system for extending functionality
- Install

```
npm init  # if not already done
npm install dayjs
```

- Import

```
const dayjs = require('dayjs')
```

- Use

```
let now = dayjs()
console.log(now.format())
```


Basic operations with Day.js

Creating date objects – `dayjs()` constructor

```
let now = dayjs()  // today
let date1 = dayjs('2019-12-27T16:00');
        // from ISO 8601 format
let date2 = dayjs('20191227');
        // from 8-digit format
let date3 = dayjs(new Date(2019, 11, 27));
        // from JS Date object
let date5 = dayjs.unix(1530471537);
    // from Unix timestamp

By default, Day.js parses in local time
```

https://day.js.org/docs/en/parse/parse

Displaying date objects – format()

```
console.log(now.format());
        2021-03-02T16:38:38+01:00

console.log(now.format('YYYY-MM [on the] DD'));
        2021-03 on the 02

console.log(now.toString());
        Tue, 02 Mar 2021 15:43:46 GMT

By default, Day.js displays in local time
```

Get/Set date/time components

```
# obj.unit() -> get
# obj.unit(new_val) -> set

let now2 = now.date(15);
let now2 = now.set('date', 15);
        2021-03-15T16:50:26+01:00

let now3 = now.minute(45);
let now3 = now.set('minute',45);
        2021-03-02T16:45:26+01:00

let today_day = now.day();
let today_day = now.get('day');
        2
```

Unit	Shorthand	Description
`date`	`D`	Date of Month
`day`	`d`	Day of Week (Sunday as 0, Saturday as 6)
`month`	`M`	Month (January as 0, December as 11)
`year`	`y`	Year
`hour`	`h`	Hour
`minute`	`m`	Minute
`second`	`s`	Second
`millisecond`	`ms`	Millisecond

https://day.js.org/docs/en/get-set/get-set

Date Manipulation and Comparison

```
let wow = dayjs('2019-01-25').add(1, 'day').subtract(1, 'year').year(2009).toString() ;
// "Sun, 25 Jan 2009 23:00:00 GMT"
```

- Methods to "modify" a date (and return a modified one)
- `.add` / `.subtract`
- `.startOf` / `.endOf`
- `d1.diff(d2, 'unit')`
- Specify the unit to be added/subtracted/rounded
- Can be easily *chained*

- Day.js objects can be compared
- `.isBefore` / `.isSame` / `.isAfter`
- `.isBetween`
- `.isLeapYear` / `.daysInMonth`

Day.js Plugins

- To keep install size minimal, several functions are only available in *plugins*
- Plugins must be
  - Loaded
  - Registered into the libraries
- Then, functions may be freely used

```
const isLeapYear =
   require('dayjs/plugin/isLeapYear') ;
        // load plugin

dayjs.extend(isLeapYear) ;
        // register plugin

console.log(now.isLeapYear()) ;
        // use function
```


Advanced Day.js Topics

- Localization / Internationalization
  - Language-aware and locale-aware parsing and formatting
  - Various formatting patterns for different locales/languages
- Durations
  - Measuring time intervals (the difference between two time instants)
  - Interval arithmetic
- Time Zones
  - Conversion between time zones

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