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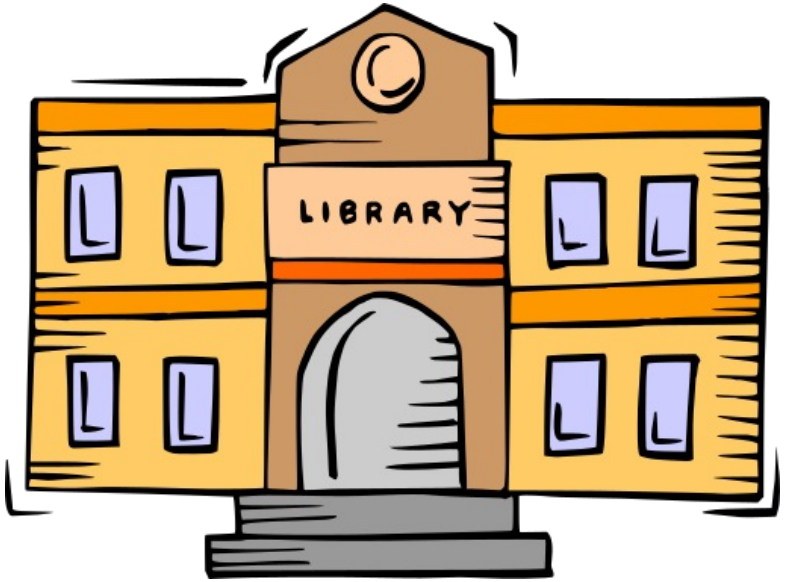
2024

JavaScript: Libraries and Packages



“The” language of the Web

Enrico Masala
Antonio Servetti

Outline

- Modules, libraries, packages
- Package manager
- Package example: handling dates
- Issues and security concerns

Definition

- **Module**: a Javascript file, having its own scope isolated from the rest
  - Will be described later in the course
- **Library**: a group of modules and/or scripts that implements a desired function (e.g., handling dates/times)
  - Similarly to other programming languages
- **Package**: one or more libraries organized so that they can be easily integrated into projects

Handling Packages

- **Registry:** a database of software packages that facilitates searching, download, and dependency management
- In the Javascript community: *NPM Registry* is the largest (2M+ packages)
  - https://www.npmjs.com

- **Package manager**: software tools to automate managing packages in a standardized manner
  - An assistant to the developer to install the packages required by the developer while automatically managing package versions and their dependencies
  - **Dependencies**: other packages (software and libraries) needed to run a package

Javascript Package Managers

- **`npm:`** the default for the node.js environment
  - npm is the “node package manager”
  - npm is also a “repo platform” now maintained by GitHub (owned by Microsoft)

In the rest of the course: we focus on **`npm`**

- **`yarn:`** alternative to npm developed by Facebook
  - faster, can work offline in certain cases, but some drawbacks: not compatible with older node versions, issues with native code packages
- **`pnpm:`** npm improvement (“performant npm”)
  - Not so popular, compatibility issues with some packages

https://romanglushach.medium.com/comparing-npm-yarn-and-pnpm-package-managers-which-one-is-right-for-your-distributed-project-to-4d7de2f0db8e

How does a package manager work?

Example 1: Developer tells the package manager to import a new package in the project. The package manager **automatically**:

1. Queries a software registry to find the package
2. If found, obtains the information about to download it
3. Downloads it
4. Includes it in the project
   - Typically in a standardized form, e.g. in `package.json` for the case of `npm`
5. Checks dependencies, and restart from 2 until all dependencies are met

How does a package manager work?

Example 2: Developer tells the package manager to install all packages that are required by a project

1. The package manager reads the list of packages required by the project
   - From `package.json` for the case of `npm`
2. Then it proceeds to include them in the project as in previous example

The developer:

- share only the application code
- does not need to care about other code (packages) that will be managed automatically

Example: Day.js Package

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

- Install (from command line)

```
# initialize the package manager files in the project
# if not already done (choose a name and default for the rest)
npm init

# download from registry, add to project package list
# make it available to the scripts in the project
npm install dayjs
```

package.json

```
{
  "name": "my-project",
  "version": "1.0.0",
  "main": "index.js",
  . . .
  "dependencies": {
    "dayjs": "^1.11.10"
  }
}
```

Folder Structure after running npm

```
my-project
├── node_modules
├── package.json
├── package-lock.json
└── index.js
```

- `my-project` is the project root
- `node_modules` is the folder where packages are installed. This is automatically managed/reconstructed by npm, do not touch!
- `package.json` contains (also) the list of packages needed by the project, with their minimum version
- `package-lock.json` contains the list of packages actually installed in the project, with more details (version, package hash)
- `index.js` is the code of the project
  - **Develop here!**
  - Insert the `require()` statement here to use the package

Example: Day.js Package usage in node

- In the Javascript file, after the package has been installed

index.js

```
// import (using name of my choice)
const dayjs = require ('dayjs');

// use (depends on the specific package)
let now = dayjs();
console.log(now.format());
```

Day.js main goals

- Compatible with moment.js (most used date library until a few years ago)
  - But very small (2kB) compared to moment.js
- 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 support
- Plugin system for extending functionality

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
  - (in this case, they come with dayjs package, no need to install them)
- 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

Security and Critical Issues with External Code

Security: The package code is:

- running in your project
- with the **same privileges as your code**
- same possibility to access data
- how can it be trusted?

Availability: If the package and/or a specific package version is not available anymore:

- how can the project be run?

Checking for Bugs/Vulnerabilities

- **First**: do not forget to check for known bugs/vulnerabilities!

  `npm audit`

  NB: `npm audit fix` ONLY updates the package version(s)! https://docs.npmjs.com/cli/v10/commands/npm-audit

```
@babel/traverse  <7.23.2
Severity: critical
Babel vulnerable to arbitrary code execution when compiling specifically crafted malicious code - https://github.com/advisories/GHSA-67hx-x53-jw92
fix available via `npm audit fix`
node_modules/@babel/traverse
```

...

```
vite  4.2.0 - 4.2.2
Severity: high
Vite Server Options (server.fs.deny) can be bypassed using double forward-slash (//) - https://github.com/advisories/GHSA-353f-5xf4-qw67
fix available via `npm audit fix`
node_modules/vite

4 vulnerabilities (2 moderate, 1 high, 1 critical)

To address all issues, run:
  npm audit fix
```

Security

How to trust packages written by others?

- By reading and checking it yourself or by some trusted entity (e.g. your organization / company)
- And by using formal verification tools
- And …
- Do not rely only on unknown / untrusted entities, and/or reputation

Result

- An *approved* package that can be securely used in your projects / organization / company

Secure distribution of packages

How to force package managers use only approved packages?

- Search/install only from a private registry containing only approved packages (serious companies always have one)
  - The private registry/database solves also the availability issue because:
    - the package is stored in computers systems you control thus it cannot disappear
    - the package cannot change its content due to malicious attacks
- A cryptographically secure hash applied to the package helps in checking if the content of the package changed (even if name and version are the same!)
  - `package-lock.json` contains both the hash and the version of the package

Forcing specific packages

- Always use `package-lock.json`, distribute it with your code
  - npm will always check hash, will always try to install dependencies whose version matches the ones listed in the `package-lock.json` file.
- Note the subtle differences in npm install commands

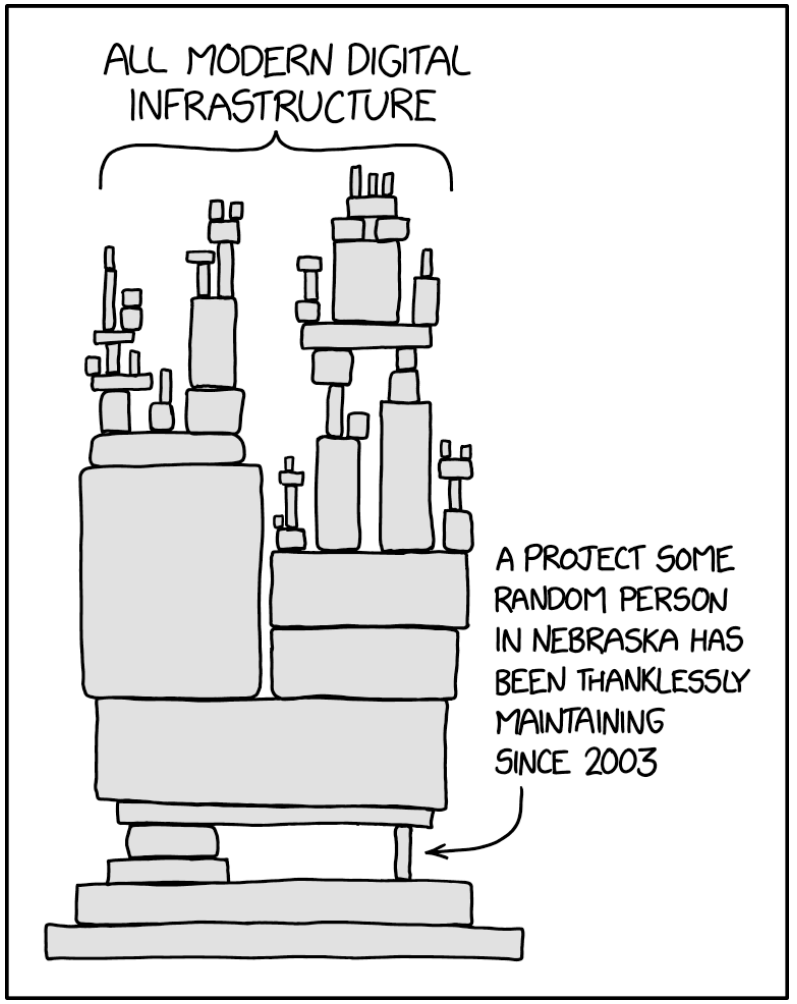
```
npm install
# if dependencies already exist
in node_modules, use them;
it creates package-lock.json if it
doesn't exist, no hash/version check!

npm ci
# ci = continuous integration,
for reproducible builds in automated
environments: delete node_modules
then start from scratch
```

`package-lock.json`

```
{ "name": "my-project",
  . . .
  "packages": {
    . . .
    "node_modules/dayjs": {
      "version": "1.11.10",
      "resolved": "https://registry.npmjs.org/dayjs/-
                                          /dayjs-1.11.10.tgz",
      "integrity": "sha512-vjAczensTgRcqDERK0SR2XMwsF/ … "
    }
} }
```

Choosing libraries/packages

- Beware: before choosing libraries, packages, etc. consider:
  - Licensing
  - Community / long term support
  - Security
  - Documentation and code quality



https://xkcd.com/2347/

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