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io.italia.it
Messaggi
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E' disponibile il referto dell'esame effetuato il...
Leggi il referto
Anagrafe Nazionale della Popolazione ...
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La sua Carta d'Identità Elettronica verrà consegnata Mercoledì 31 Marzo fra le 10.00 e...
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Design Secure APIs

Technical specifications and tools from the API Italian Interoperability Framework

EuroPython 2021

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API Ecosystem

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EUROPYTHON
2021 Jul 26 - Aug 1 Online

Agenda

Enforce secure design practices and coherent interfaces for services provided by 20k+ agencies

- Digital Interfaces Challenges
- API Guidelines
- A roundup of useful standards on HTTP headers, content and authentication in REST APIs
- Open source Online Validator

THE CHALLENGE

Standardizing all public sector APIs

Guidelines can uniform APIs produced by thousands of service providers

60M People

+12k Public Agencies

+8k Cities

20 Regions

(∞ cultural heritage)

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Secure and usable by design with API Guidelines

To achieve **reliable, secure** and **consistently designed services** Italy wrote API Guidelines and support tools

Risks

- **over-complexity:** bureaucratic, non-digital processes are mapped to convoluted APIs without a proper redesign
- **time-constrained engineering:** a restricted group of people addressing the above use-cases within a short deadline

Mitigations

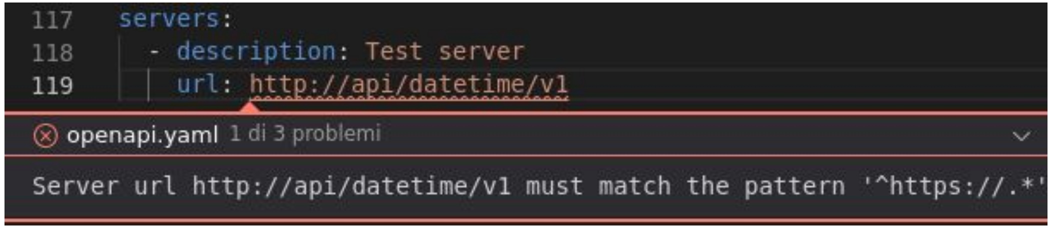
- **Interface Description Languages:** a *formal description of API* interactions, eg: OpenAPI (HTTP) and WSDL (SOAP).

- **API Guidelines:** to uniform the design and security of REST and SOAP services between 12k agencies, together with tools to help agencies and their suppliers in checking their design. *Engage with IETF communities!*

Security basics

Using OpenAPI3 simplifies a broad set of design checks, including some of the OWASP API Security top 10

- **HTTPS** - checks that all URLs in the spec use the https scheme

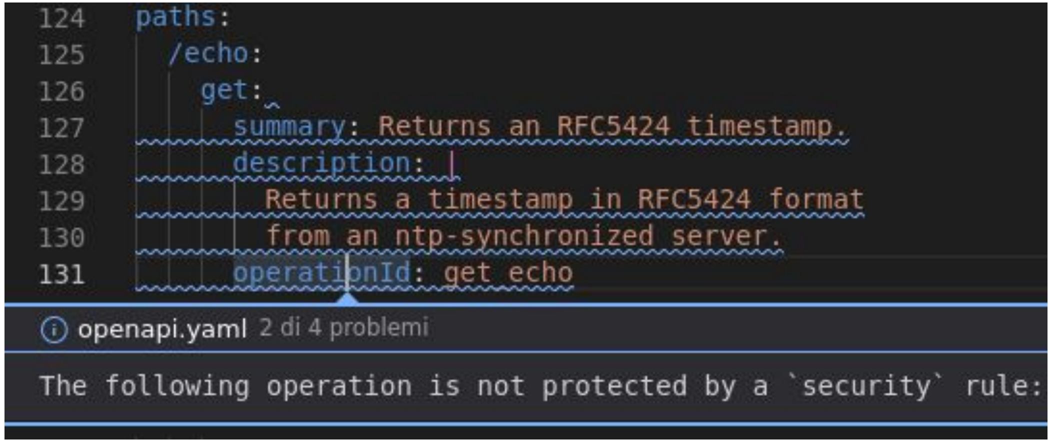


```
servers:
  - description: Test server
    url: http://api/datetime/v1
```

openapi.yaml 1 di 3 problemi

```
Server url http://api/datetime/v1 must match the pattern '^https://.*'
```

- **Authentication and authorization** - checks that every endpoint is properly protected



```
paths:
  /echo:
    get:
      summary: Returns an RFC5424 timestamp.
      description: |
        Returns a timestamp in RFC5424 format
        from an ntp-synchronized server.
      operationId: get_echo
```

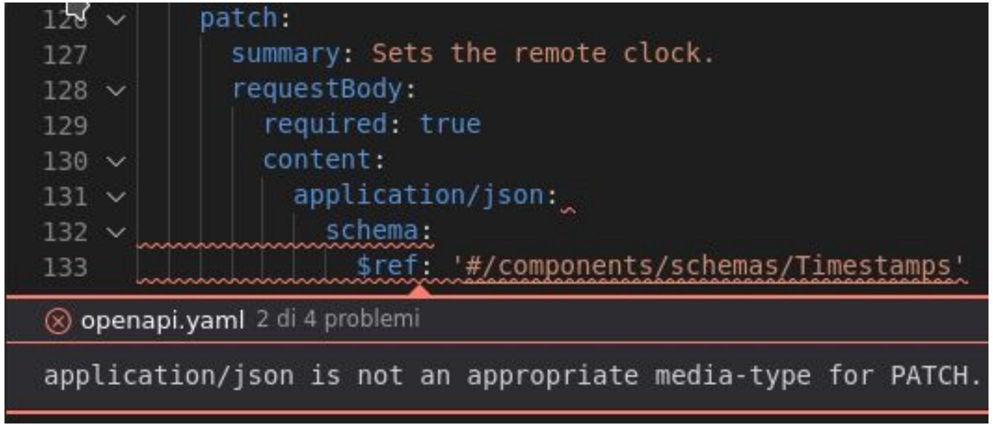
openapi.yaml 2 di 4 problemi

```
The following operation is not protected by a `security` rule:
```

Security basics

Using OpenAPI3 simplifies a broad set of design checks, including some of the OWASP API Security top 10

- **Use HTTP methods correctly** - for example checking that PATCH requests have a suitable media-type, eg. application/merge-patch RFC7386



```
    patch:
      summary: Sets the remote clock.
      requestBody:
        required: true
        content:
          application/json:
            schema:
              $ref: '#/components/schemas/Timestamps'
```

openapi.yaml 2 di 4 problemi

```
application/json is not an appropriate media-type for PATCH.
```

- **RateLimit (OWASP API4:2019)** - define and enforce a coherent ratelimit framework such as draft-ietf-httpapi-ratelimit-headers

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HTTP Headers

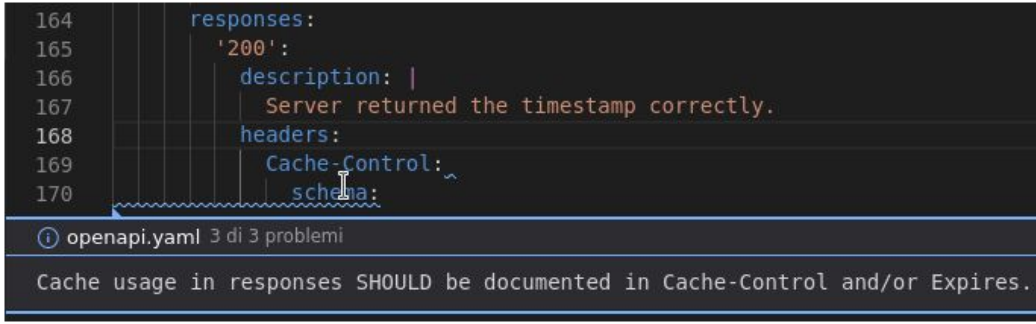
Not just adding or removing headers around!

- ✓ `Strict-Transport-Security`
- ✓ `X-XSS-Protection`
- ✓ `X-Content-Type-Options`
- ✓ `Content-Security-Policy`
- ✓ `X-Permitted-Cross-Domain-Policies`
- ✓ `Expect-CT`
- ✗ `Server`
- ✗ `X-Powered-By`

HTTP Headers

Document how you use Cache and Authorization requirements

→ **Cache-Control** - clarify in the specification how do you use cache

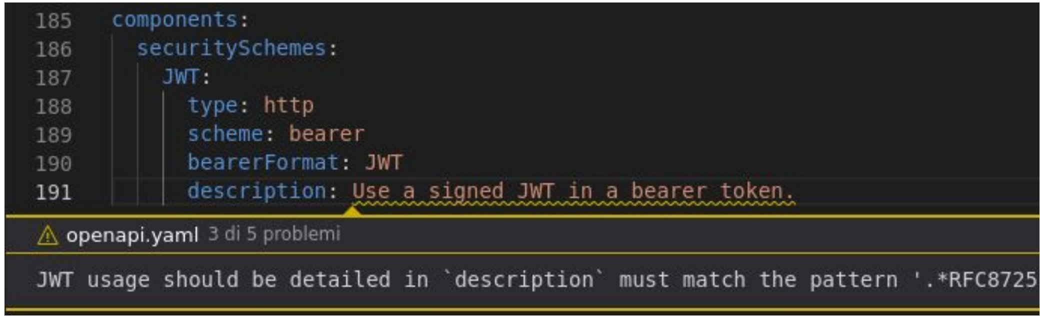


```
          responses:
            '200':
              description: |
                Server returned the timestamp correctly.
              headers:
                Cache-Control:
                  schema:
```

openapi.yaml 3 di 3 problemi

Cache usage in responses SHOULD be documented in Cache-Control and/or Expires.

→ **Authorization** - describe authentication and authorization headers and policies directly into the spec



```
components:
  securitySchemes:
    JWT:
      type: http
      scheme: bearer
      bearerFormat: JWT
      description: Use a signed JWT in a bearer token.
```

openapi.yaml 3 di 5 problemi

JWT usage should be detailed in `description` must match the pattern '.*RFC8725

HTTP Headers

Using secure serializers and parsers to manage headers reduces the attack surface of your APIs.

→ **Limit header parsing complexities** - eg. RFC8941 defines a safe serialization model for header values. There's a python library too!

```
from http_sfv import Dictionary

# Serializing a dictionary structured header
data = {"a": 1, "b": "two", "c": b'\x01\x02\x03'}
dict_header = Dictionary(data)
headers["Foo"] = {
"Foo": str(dict_header)
}

# Foo: a=1, b="two", c=:AQID:

# Parsing
dict_header = Dictionary()  # an empty header object
dict_header.parse(response.headers["Foo"])

assert dict_header["b"].value == "two"
```

Use interoperable subsets of JSON and XML

json-schema and XSD can model complex data-types, support nested structures and implementations have many nuances.

Some JSON hints:

- ➔ utf-8 only - RFC 8259
- ➔ encode floats/bigint as strings - rfc7493#section-2.2

```
>>> json.dumps({"1^1000": 1e1000})
'{"1^1000": Infinity}'
```

- ➔ beware of duplicate names - rfc7493#section-2.3

```
>>> json.loads('{"x": 1, "x": 2}')
{"x": 2}
```

- ➔ use strict parsers and don't truncate characters - consider that client and server will probably use different libraries. Custom parser may be less secure.

```
>>> custom_json_parser.loads('{"u": "ro\ud888ot"}')
{"u": "root"}
```

Read I-JSON specs RFC7493.

For XML, see the comprehensive OWASP XML Security Cheat Sheet

Limit item values and occurrencies.

Limit numbers and strings - in practice, every schema is limited in size. Start with reasonable values, then raise up.

Limit array sizes - arrays should be limited too

```
Uid:
  type: integer
  minimun: 0
  maximum: 1000

Title:
  type: string
  minLength: 5
  maxLength: 128
  pattern: '[a-zA-Z0-9 ]+'

Titles:
  type: array
  minItems: 1
  maxItems: 100
  uniqueItems: true
  items: {$ref: '#/Title'}
```

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Constrain json-schema objects

Object validation is very tolerant

```
Account:                                ✓{"user": 123}
  type: object                          ✓{}
  properties:                           ✓{"name": ""}
    user: {$ref: "#/Uid"}
```

Specify required properties - or objects will always validate.

```
Account:
  type: object                         ✓{"user": 12}
  required: [user]                     ✓{
  properties:                             "user: 1
    user: {$ref: "#/Uid"}                 "infinite_list": [..]
                                         }
```

Disable additional properties - if you don't want unexpected fields

```
Account:
  type: object                           ✓{"user": 12}
  additionalProperties : false
  required: [user]                       ✓{
  properties:                               "user": 12,
    user:                                   "titles": []
      $ref: "#/Uid"                        }
    titles:
      $ref: "#/Title"
```

JWT and OAuth2

RFC8725 defines security best practices for JSON Web Tokens, and OAuth2 deprecated insecure flows.

JSON and XML flexibility increases their attack surface

JWT Best Current Practices (RFC8725) :

- use and verify appropriate algorithms, avoid substitution attacks
- use / validate the **aud**ience, **iss**uer and **sub**ject claims
- don't trust received claims

More JWT hints:

- limit temporal validity with **nbf** and **exp** claims
- add a token identifier (**jti** claim) to mitigate replay attacks
- don't use private keys associated to TLS certs to sign JWT to avoid cross-protocol attacks

OAuth2 hints:

- don't use "implicit" and "resource owner password" flows
- use "authorization code with PKCE" and "client credentials" with a jwt-bearer client_assertion_type (RFC7523)
- limit access token requests to specific resources using RFC8707

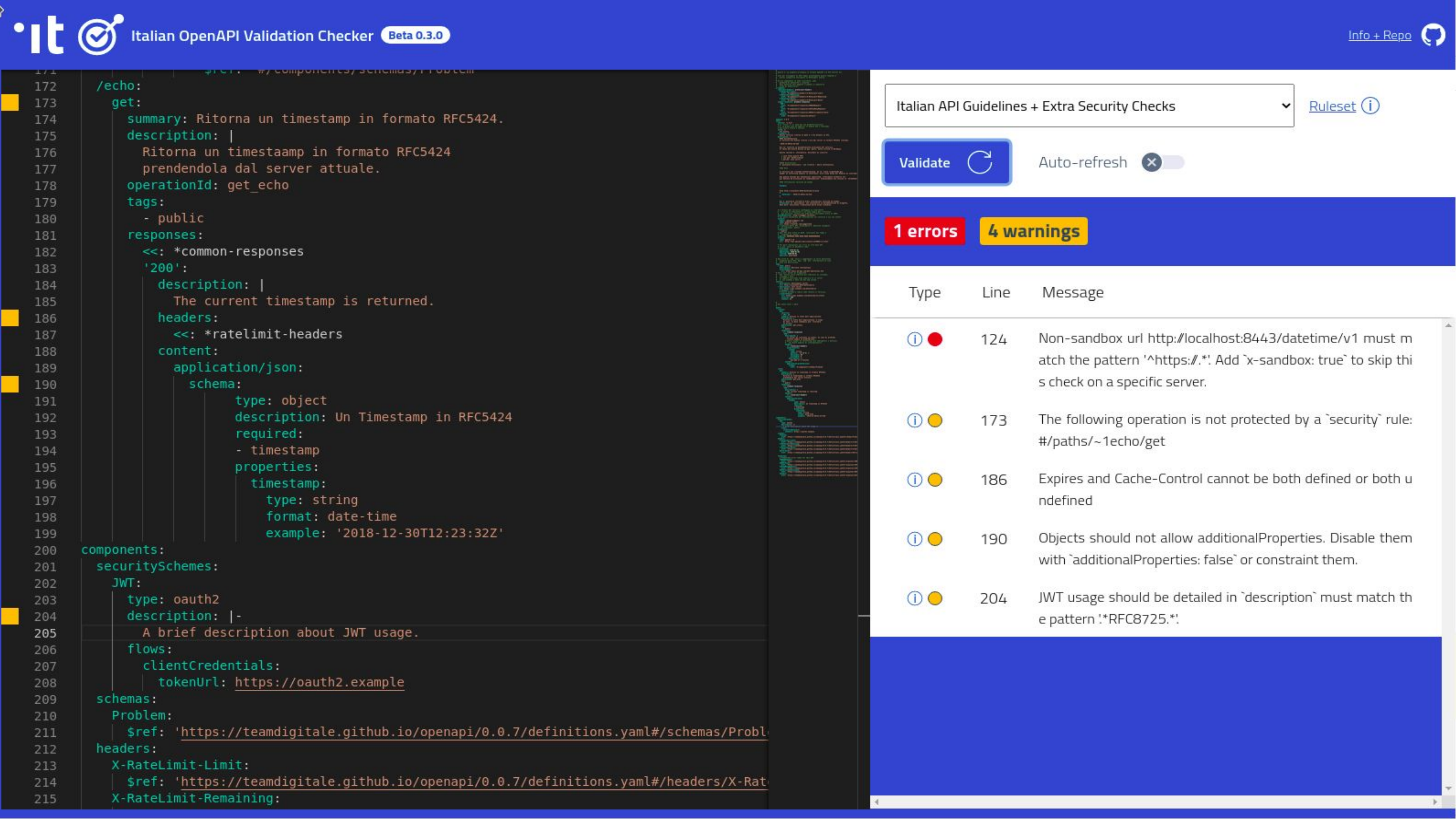
OpenAPI Checker

Guide implementers in checking the quality and security of APIs via the conformance with given rulesets, based on the *Spectral* open source tool.

APIs interactions and data schemas must be formally defined in "specification files" using an Interface Description Language. We can validate those files using automatic tools like italia/api-oas-checker!

- ➔ **security:** avoid common errors in API design (under-defined schemas, insecure methods, ...)
- ➔ **standards:** verify that Internet Standards are used correctly
- ➔ **usability:** the design is consistent with respect to the API domain and other usability rules (eg. field names, methods, ...)

[1] Spectral: https://github.com/stoplightio/spectral



```
171          $ref: '#/components/schemas/Problem
172  /echo:
173   get:
174    summary: Ritorna un timestamp in formato RFC5424.
175    description: |
176     Ritorna un timestaamp in formato RFC5424
177     prendendola dal server attuale.
178    operationId: get_echo
179    tags:
180     - public
181    responses:
182     <<: *common-responses
183     '200':
184      description: |
185       The current timestamp is returned.
186      headers:
187       <<: *ratelimit-headers
188      content:
189       application/json:
190        schema:
191           type: object
192           description: Un Timestamp in RFC5424
193           required:
194           - timestamp
195           properties:
196            timestamp:
197             type: string
198             format: date-time
199             example: '2018-12-30T12:23:32Z'
200 components:
201  securitySchemes:
202   JWT:
203    type: oauth2
204    description: |-
205     A brief description about JWT usage.
206    flows:
207     clientCredentials:
208      tokenUrl: https://oauth2.example
209  schemas:
210   Problem:
211    $ref: 'https://teamdigitale.github.io/openapi/0.0.7/definitions.yaml#/schemas/Probl
212  headers:
213   X-RateLimit-Limit:
214    $ref: 'https://teamdigitale.github.io/openapi/0.0.7/definitions.yaml#/headers/X-Rat
215   X-RateLimit-Remaining:
```

Italian API Guidelines + Extra Security Checks

Ruleset

Validate

Auto-refresh

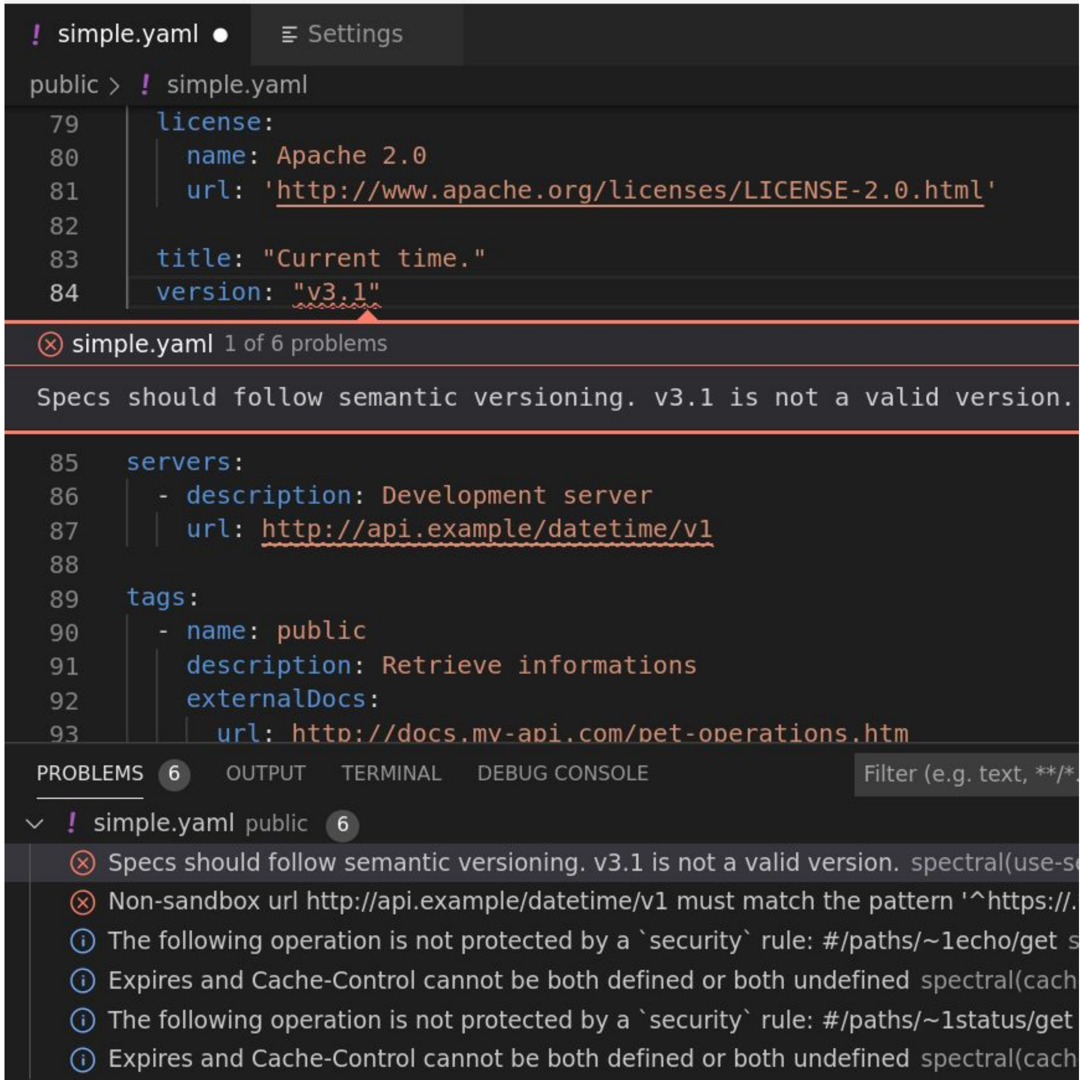
1 errors 4 warnings

Type	Line	Message
●	124	Non-sandbox url http://localhost:8443/datetime/v1 must match the pattern '^https://.*'. Add `x-sandbox: true` to skip this check on a specific server.
●	173	The following operation is not protected by a `security` rule: #/paths/~1echo/get
●	186	Expires and Cache-Control cannot be both defined or both undefined
●	190	Objects should not allow additionalProperties. Disable them with `additionalProperties: false` or constraint them.
●	204	JWT usage should be detailed in `description` must match the pattern '.*RFC8725.*'.

italia/api-oas-checker

Guideline support tools

Coherent and secure by design,
integrating checks in your IDE.



```
license:
  name: Apache 2.0
  url: 'http://www.apache.org/licenses/LICENSE-2.0.html'

title: "Current time."
version: "v3.1"
```

simple.yaml 1 of 6 problems

Specs should follow semantic versioning. v3.1 is not a valid version.

```
servers:
  - description: Development server
    url: http://api.example/datetime/v1

tags:
  - name: public
    description: Retrieve informations
    externalDocs:
      url: http://docs.my-api.com/pet-operations.htm
```

Specs should follow semantic versioning. v3.1 is not a valid version. spectral(use-s
Non-sandbox url http://api.example/datetime/v1 must match the pattern '^https://.
The following operation is not protected by a `security` rule: #/paths/~1echo/get s
Expires and Cache-Control cannot be both defined or both undefined spectral(cach
The following operation is not protected by a `security` rule: #/paths/~1status/get
Expires and Cache-Control cannot be both defined or both undefined spectral(cach

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Next Steps

Involve communities, countries and API experts in the project

- **Usability:** improve the web interface, which is the showcase of the API Guidelines
- **Security:** create a community around the identification and implementation of more security rules
- **Coherence:** improve the coverage of the Italian API Guidelines and evolve the project together with the framework
- **Community**: synergies and contributions to related and underlying projects

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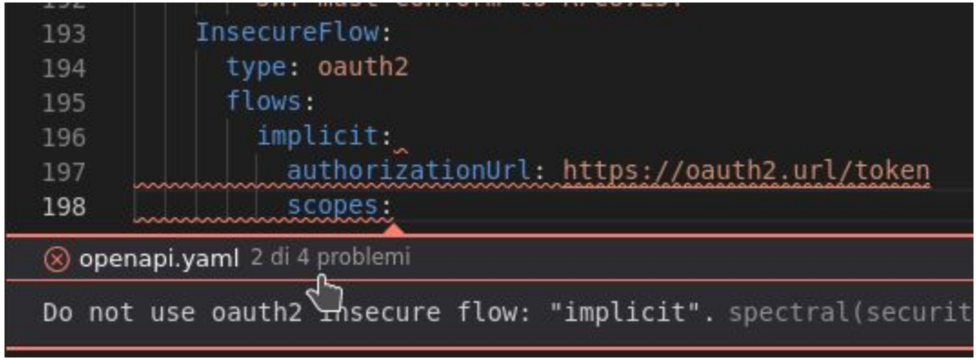

```
    InsecureFlow:
      type: oauth2
      flows:
        implicit:
          authorizationUrl: https://oauth2.url/token
          scopes:
```

openapi.yaml 2 di 4 problemi

```
Do not use oauth2 insecure flow: "implicit". spectral(securit
```