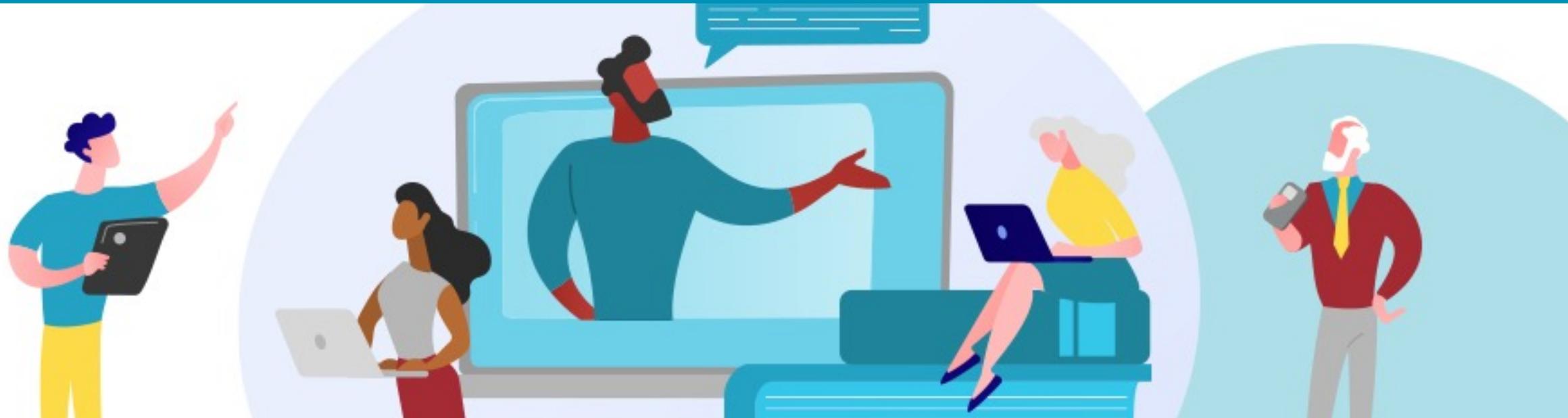




## Let's Build: Create an Implementation Guide with FHIR Shorthand

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Not-for-profit R&D institution working in the public interest and funded by the US government





# Track overview: Let's Build a FHIR specification

Monday

Introduction to FHIR  
11:00 – 11:45

Tuesday

Introduction Profiling  
1:00 – 1:45



Profiling with Forge  
2:15 – 3:00

Wednesday

Accelerating your IG production  
1:00 – 1:45



IG with IG Publisher  
2:15 – 3:00

Thursday

FHIR Registry & Packages  
1:00 – 1:45



Publishing with Simplifier.net  
2:15 – 3:00

You are here ➔

Create an IG with  
FHIR Shorthand  
3:15 – 4:00



Create an IG with  
FHIR Shorthand  
4:15 – 5:00



Advanced FHIR Shorthand  
and Tools  
3:15 – 4:00

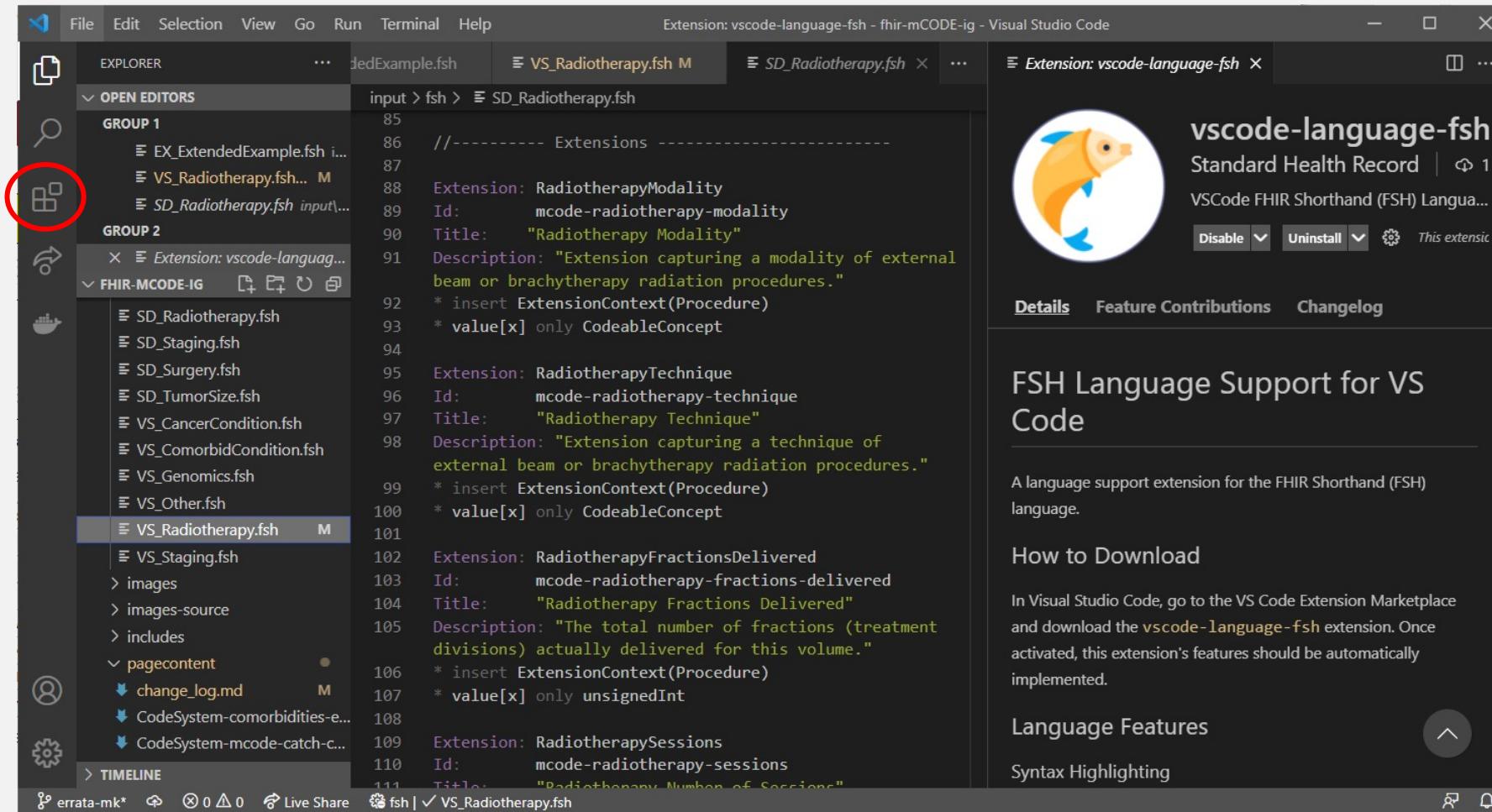


# Prepare for Let's Build

1. Install **Node.js LTS** edition from <https://nodejs.org/>
2. Install **SUSHI** and **GoFSH**
  - Open a terminal and run: `npm install -g fsh-sushi`
  - Open a terminal and run: `npm install -g gofsh`
3. Install **VS Code** (if text editor is needed)
  - <https://code.visualstudio.com/download>
  - Install the VS Code extension for FSH: `vscode:extension/kmahalingam.vscode-language-fsh`

# (Optional) Visual Studio Code: Text Editor for .fsh Files

plug-in  
for .fsh  
files





# Let's Build using FSH



# How to Produce an IG Using FHIR Shorthand

1

Install SUSHI

2

Create a new  
project

3

Author your  
FSH

4

Run SUSHI

5

Download or  
Update IG  
Publisher

6

Run IG  
Publisher

## 1. Install SUSHI

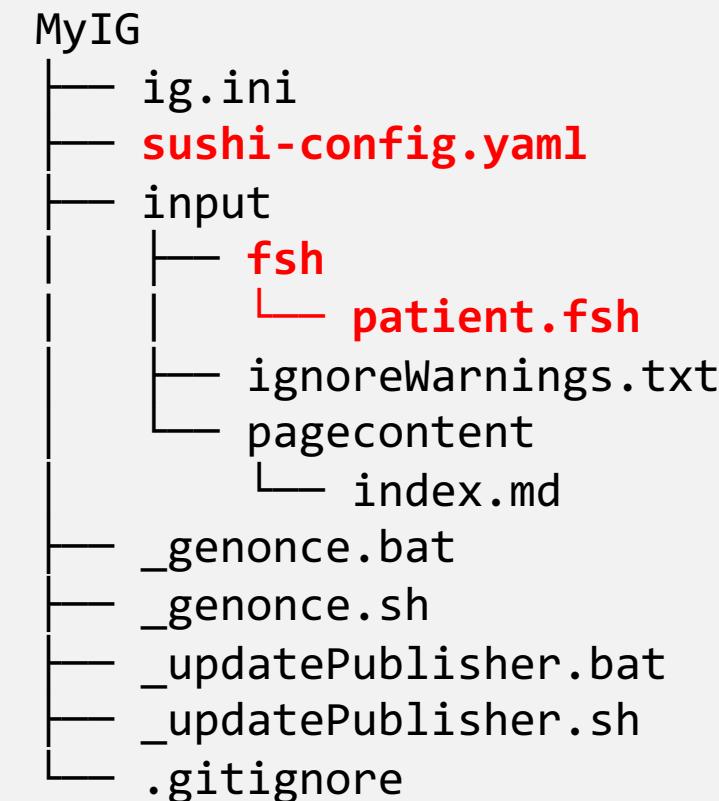
To install SUSHI:

- First install **Node.js LTS** edition from <https://nodejs.org/>
- Open a terminal and run: `npm install -g fsh-sushi`

See <https://fhschool.org/docs/sushi/installation/> for additional details.

## 2. Initialize your IG Project

- Open command prompt
- Choose a parent directory
- Run `sushi -i`



If script downloads are blocked by firewall, download them from <https://github.com/HL7/ig-publisher-scripts>

## 3. Create your FSH Sources

- For expedience, copy from the FSH Online example
- Replace the contents of /input/fsh/patient.fsh (the file name does not matter)

<https://bit.ly/3yLJjxY> →

```

Profile: CovidDiagnosis
Parent: Condition
Description: "How to report COVID"
* code = $icd#U07.1
* severity from CovidSeverityVS (required)
* subject only Reference(Patient)
* extension contains ConditionCertainty named certainty 0..1 MS

Alias: $icd = http://hl7.org/fhir/sid/icd-10-cm

ValueSet: CovidSeverityVS
Description: "Values for COVID severity"
* include codes from valueset http://hl7.org/fhir/ValueSet/condition-severity
* include $sct#442452003 "Life threatening severity (qualifier value)"

Alias: $sct = http://snomed.info/sct

Instance: DiagnosisExample
InstanceOf: CovidDiagnosis
* subject.reference = "Patient/JaneDoe"
* code = $icd#U07.1
* severity = $sct#24484000 "Severe"

Instance: JaneDoe
InstanceOf: Patient
* name.family = "Doe"
* name.given = "Jane"

Extension: ConditionCertainty
Description: "The certainty of diagnosis"
* value[x] only CodeableConcept
* value[x] from ConditionCertaintyVS

ValueSet: ConditionCertaintyVS
Description: "Degree of confidence the condition is present"
* $sct#415684004 "Suspected (qualifier value)"
* $sct#410592001 "Probably present (qualifier value)"
* $sct#41060500 "Confirmed present (qualifier value)"

```

## 4. Run SUSHI

- Open command prompt
- Change to your IG directory
- Run **sushi**
- Fix any errors and re-run before the next step

```
info  Converting FSH to FHIR resources...
info  Converted 2 FHIR StructureDefinitions.
info  Converted 2 FHIR ValueSets.
info  Converted 2 FHIR instances.
info  Exporting FHIR resources as JSON...
info  Exported 6 FHIR resources as JSON.
info  Assembling Implementation Guide sources...
info  Generated ImplementationGuide-fhir.example.json
info  Assembled Implementation Guide sources; ready for IG Publisher.
```

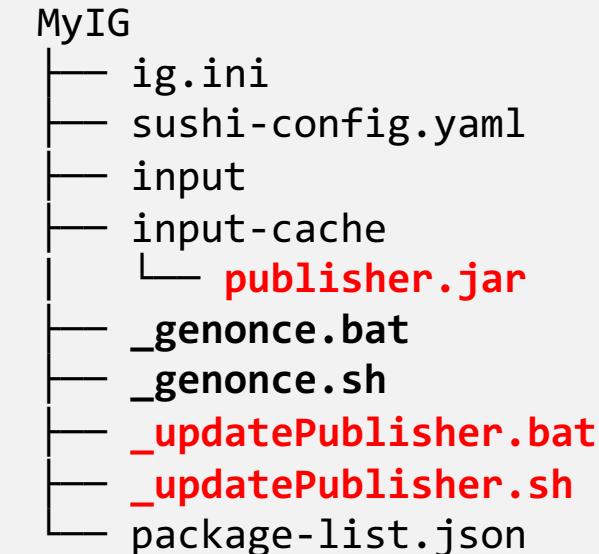
**SUSHI RESULTS**

Profiles	Extensions	ValueSets	CodeSystems	Instances
1	1	2	0	2

Well hooked and landed!      0 Errors      0 Warnings

## 5. Download or Update Publisher

- Open command window
- run `_updatePublisher` script
  - Wait for ~100 MB download



If blocked by firewall, download directly from <https://github.com/HL7/fhir-ig-publisher/releases/latest/download/publisher.jar>

## 6. Run the IG Publisher

- In command window, run  
**\_genonce**
- When run completes,  
open **/output/index.html**

**2 Artifacts Summary**  
 This page provides a list of the FHIR artifacts defined as part of this implementation guide.

**2.0.1 Structures: Resource Profiles**  
 These define constraints on FHIR resources.

<a href="#">CovidDiagnosis</a>	How to report COVID
--------------------------------	---------------------

**2.0.2 Structures: Extensions**  
 These define constraints on FHIR extensions.

<a href="#">ConditionCertainty</a>	The certainty of a condition
------------------------------------	------------------------------

**2.0.3 Terminology: Value Sets**  
 These define sets of codes used in FHIR resources.

<a href="#">ConditionCertaintyVS</a>	Degree of certainty of a condition
<a href="#">CovidSeverityVS</a>	Values

**2.0.4 Example: Examples**  
 These are example instances of the artifacts above.

<a href="#">DiagnosisExample</a>	
<a href="#">JaneDoe</a>	

**2.1.1 Resource Profile: CovidDiagnosis**

Defining URL:	<a href="http://example.org/StructureDefinition/CovidDiagnosis">http://example.org/StructureDefinition/CovidDiagnosis</a>
Version:	0.1.0
Name:	CovidDiagnosis
Status:	Active as of 2021-05-29T09:00:58-04:00
Definition:	How to report COVID
Source Resource:	<a href="#">XML / JSON / Turtle</a>

The official URL for this profile is:  
<http://example.org/StructureDefinition/CovidDiagnosis>

**2.1.1.1 Formal Views of Profile Content**  
 Description of Profiles, Differentials, Snapshots and how the different presentations work.

**Text Summary** **Differential Table** **Snapshot Table** **Snapshot Table (Must Support)** **All**

This structure is derived from [Condition](#).

Name	Flags	Card.	Type	Description & Constraints
Condition		0..*	Condition	Detailed information about conditions, problems or diagnoses
extension		0..*	Extension	Extension
ConditionCertainty	S	0..1	CodeableConcept	<b>Slice:</b> Unordered, Open by value:url Extension URL: <a href="http://example.org/StructureDefinition/ConditionCertainty">http://example.org/StructureDefinition/ConditionCertainty</a> Binding: ConditionCertaintyVS (required)
severity		0..1	CodeableConcept	Subjective severity of condition Binding: CovidSeverityVS (required)
code		0..1	CodeableConcept	Identification of the condition, problem or diagnosis <b>Required Pattern:</b> At least the following
coding		1..*	Coding	Code defined by a terminology system <b>Fixed Value:</b> (complex)
system		1..1	uri	Identity of the terminology system <b>Fixed Value:</b> <a href="http://hl7.org/fhir/sid/icd-10-cm">http://hl7.org/fhir/sid/icd-10-cm</a>
code		1..1	code	Symbol in syntax defined by the system <b>Fixed Value:</b> U07.1
subject		1..1	Reference(Patient)	Who has the condition?

[Documentation for this format](#)

# Improve your IG

- Add more FSH
  - One or more files
- Add Narrative Content
  - Edit /input/pagecontent/\*.md
- Customize menus
  - sushi-config.yaml
  - <https://fshschool.org/docs/sushi/configuration/>
- Create a github repository and share your work

```
MyIG
├── ig.ini
├── sushi-config.yaml
├── fsh-generated
└── input
    ├── fsh
    │   └── patient.fsh
    ├── ignoreWarnings.txt
    └── pagecontent
        └── index.md
└── output
    ├── _genonce.bat
    ├── _genonce.sh
    ├── _updatePublisher.bat
    └── _updatePublisher.sh
└── .gitignore
```

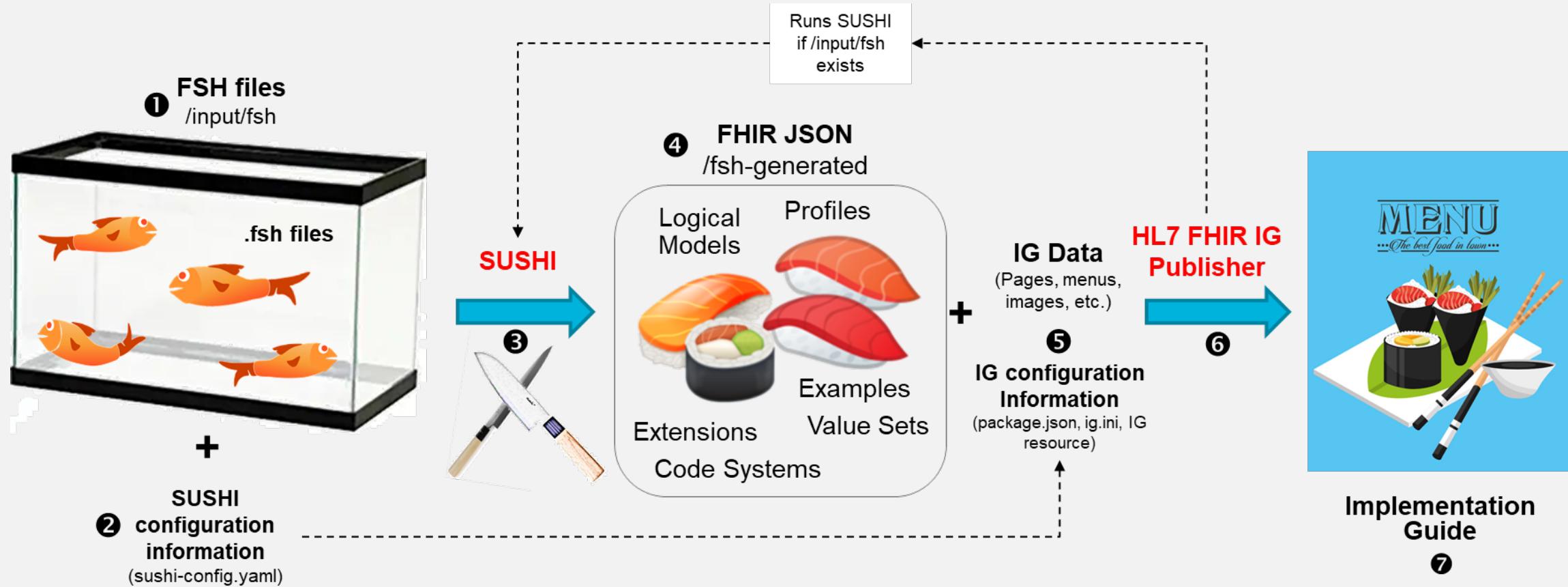
# Configuration File: sushi-config.yaml

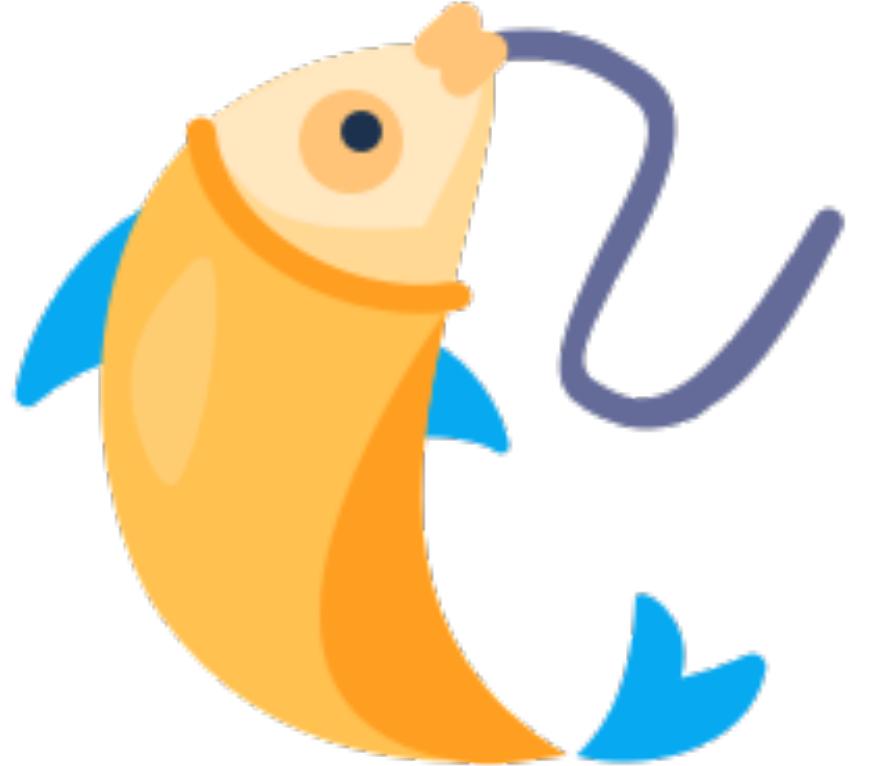
Include in top level project directory:

```
id: fhir.example
canonical: http://hl7.org/fhir/example
name: ExampleIG
title: "Example IG Version 0.1.0"
description: "An example IG that demonstrates FSH grammar"
status: draft
license: CC0-1.0
version: 0.1.0
fhirVersion: 4.0.1
copyrightYear: 2020+
releaseLabel: ci-build
dependencies:
    hl7.fhir.us.core: 3.1.0
```

See <https://fshschool.org/docs/sushi/configuration/>

# Overview: Creating an IG with FSH





Convert an  
Existing IG to  
FSH using  
GoFSH

## General Tips:

- Conversion to FSH works best on a clean IG (few errors on QA report)
  - Use the JSON IG package downloaded from the published IG
  - Use the artifacts in the **/output** folder after running the IG Publisher
  - Use the sources in Github
- GoFSH and SUSHI will often find latent problems
- GoFSH may not be 100% perfect in all cases (but it is getting there)

# Convert an Existing IG using GoFSH

1

Install GoFSH

2

Create a local  
copy of the  
IG

3

Run GoFSH  
and correct  
any problems

4

Run SUSHI  
and correct  
any problems

5

Replace IG  
sources with  
FSH files

6

Run IG  
Publisher

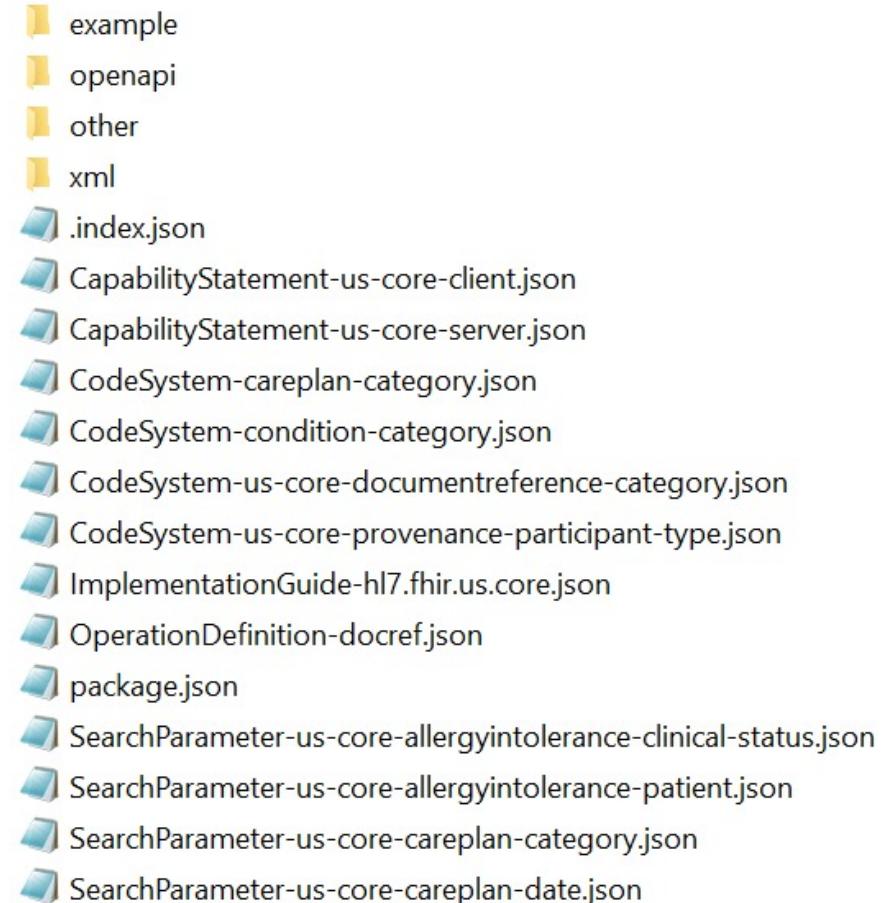
## 1. Install GoFSh

- Open a terminal window and run: `npm install -g gofsh`

(If you haven't, first install **Node.js LTS** edition from <https://nodejs.org/>)

## 2. Create a Local Copy of the IG

- Let's convert the US Core IG
- Download the US Core version  
3.2 Package:  
<http://hl7.org/fhir/us/core/2021Jan/downloads.html>
- Unzip to a new directory



## 3. Run GoFSH and Correct Any Errors

- Review optional arguments: `gofish -h`
- Run (for example): `gofsh -s file-per-definition`
- A `/gofsh` directory will be created:
  - `/input` contains all generated definitions and examples
  - `sushi-config.yaml` -- needed for running sushi

### 3. Run GoFSH and Correct Any Errors

**error** Encountered profile with a duplicate name, **USCoreRespiratoryRateProfile**, which GoFSH cannot make unique. Fix the source file to resolve this error or update the resulting FSH definition.

```
Profile: USCoreRespiratoryRateProfile  
Parent: USCoreVitalSignsProfile  
Id: us-core-bmi  
Title: "US Core BMI Profile"
```



```
Profile: USCoreBMIPROFILE  
Parent: USCoreVitalSignsProfile  
Id: us-core-bmi  
Title: "US Core BMI Profile"
```

# Typical Generated FSH File

## USCore Condition in FSH

```
1 Profile: USCoreCondition
2 Parent: Condition
3 Id: us-core-condition
4 Title: "US Core Condition Profile"
5 Description: "Defines constraints and extensions on the Condition resource for the minimal set of data to query and retrieve concerns information."
6 * ^version = "3.2.0"
7 * ^status = #active
8 * ^experimental = false
9 * ^date = "2020-06-27"
10 * ^publisher = "HL7 International - US Realm Steering Committee"
11 * ^contact.name = "HL7 International - US Realm Steering Committee"
12 * ^contact.telecom.system = #url
13 * ^contact.telecom.value = "http://www.hl7.org/Special/committees/usrealm/index.cfm"
14 * ^jurisdiction = urn:iso:std:iso:3166#US
15 * ^copyright = "Used by permission of HL7 International, all rights reserved Creative Commons License"
16 * obeys us-core-1
17 * . ^definition = "The US Core Condition Profile is based upon the core FHIR Condition Resource and created to meet the 2015 Data Set 'Problems' and 'Health Concerns' requirements."
18 * . ^constraint[8].extension.url = "http://hl7.org/fhir/StructureDefinition/elementdefinition-bestpractice"
19 * . ^constraint[=].extension.valueBoolean = true
20 * . ^mustSupport = false
21 * clinicalStatus 0..1 MS
22 * clinicalStatus only CodeableConcept
23 * clinicalStatus from ConditionClinicalStatusCodes (required)
24 * verificationStatus 0..1 MS
25 * verificationStatus only CodeableConcept
26 * verificationStatus from ConditionVerificationStatus (required)
27 * category 1..* MS
28 * category only CodeableConcept
29 * category from $us-core-condition-category (extensible)
30 * category ^short = "problem-list-item | encounter-diagnosis | health-concern"
31 * category ^condition = "us-core-1"
32 * code 1..1 MS
33 * code only CodeableConcept
34 * code from USCoreConditionCode (required)
35 * code ^binding.description = "Valueset to describe the actual problem experienced by the patient"
36 * subject 1..1 MS
37 * subject only Reference(USCorePatientProfile)
```

# (Optional) Check Translation with FSHing Trip

- FSHing Trip is a round-trip analysis, JSON → FSH → JSON, to validate the correctness of the generated FSH
- Use the GoFSH -f option

## FSHing Trip Comparison

### Files changed (40) hide

➡ ImplementationGuide-hl7.fhir.us.core.json → gofsh/ImplementationGuide-hl7.fhir.us.core.json	+0	-3770
➡ StructureDefinition-head-occipital-frontal-circumference-percentile.json → gofsh/fsh-generated/resources/StructureDefinition-head-occipital-frontal-circumference-percentile.json	+16	-37
➡ StructureDefinition-pediatric-bmi-for-age.json → gofsh/fsh-generated/resources/StructureDefinition-pediatric-bmi-for-age.json	+16	-37
➡ StructureDefinition-pediatric-weight-for-height.json → gofsh/fsh-generated/resources/StructureDefinition-pediatric-weight-for-height.json	+16	-39
➡ StructureDefinition-us-core-allergyintolerance.json → gofsh/fsh-generated/resources/StructureDefinition-us-core-allergyintolerance.json	+15	-15
➡ StructureDefinition-us-core-birthsex.json → gofsh/fsh-generated/resources/StructureDefinition-us-core-birthsex.json	+31	-12
➡ StructureDefinition-us-core-blood-pressure.json → gofsh/fsh-generated/resources/StructureDefinition-us-core-blood-pressure.json	+30	-78
➡ StructureDefinition-us-core-bmi.json → gofsh/fsh-generated/resources/StructureDefinition-us-core-bmi.json	+16	-37
➡ StructureDefinition-us-core-body-height.json → gofsh/fsh-generated/resources/StructureDefinition-us-core-body-height.json	+16	-37

# FSHing Trip JSON Comparison

<pre> &gt;differential": {   "element": [     {       "id": "Condition",       "path": "Condition",       "definition": "The US Core Condition Profile is based upon the core FHIR Condition Resource and crea"       "constraint": [         {           "extension": [             {               "url": "http://hl7.org/fhir/StructureDefinition/elementdefinition-bestpractice",               "valueBoolean": true             }           ],           "key": "us-core-1",           "severity": "warning",           "human": "A code in Condition.category SHOULD be from US Core Condition Category Codes value set"           "expression": "where(category.memberOf('http://hl7.org/fhir/us/core/ValueSet/us-core-condition-c"))           "xpath": "(no xpath equivalent)"          }       ],       "mustSupport": false,       "mapping": [         {           "id": "Condition.clinicalStatus",           "path": "Condition.clinicalStatus",           "min": 0,           "max": "1",           "type": [             {               "code": "CodeableConcept"             }           ],           "mustSupport": true,           "mapping": [             {               "id": "Condition.clinicalStatus"             }           ]         }       ]     }   ] } </pre> <p>-103,15 +115,8 @@</p>		<pre>   "differential": {     "element": [       {         "id": "Condition",         "path": "Condition",         "definition": "The US Core Condition Profile is based upon the core FHIR Condition Resource and crea"         "constraint": [           {             "key": "us-core-1",             "severity": "warning",             "human": "A code in Condition.category SHOULD be from US Core Condition Category Codes value set"             "expression": "where(category.memberOf('http://hl7.org/fhir/us/core/ValueSet/us-core-condition-c"))             "xpath": "(no xpath equivalent)"            }         ],         "mustSupport": false,         "mapping": [           {             "id": "Condition.clinicalStatus",             "path": "Condition.clinicalStatus",             "min": 0,             "max": "1",             "type": [               {                 "code": "CodeableConcept"               }             ],             "mustSupport": true,             "mapping": [               {                 "id": "Condition.clinicalStatus"               }             ]           }         ]       }     ]   } </pre>
		<p style="text-align: center;">re-ordered statements</p> <p style="text-align: right;">new statement</p> <p style="text-align: center;"> unnecessary statements</p>

## 4. Run SUSHI and Correct Any Problems

- In terminal window, run **sushi**
- SUSHI will flag data type and other errors
- The file name and line number will be reported

```
error Cannot bind value set to XHTML; must be coded (code, Coding, CodeableConcept, Quantity, CodeableReference),  
or the data types (string, uri).  
File: C:\Users\mkramer\Documents\GitHub\us-core-3.2-package\gofsh\input\fsh\USCoreCarePlanProfile-Profile.fsh  
Line: 22
```

22    `*·text.div·from·NarrativeStatus·(required)`

it is illegal to bind a value  
set to an XHTML element

element definition  
invariants:

eld-11	Rule	(base)	Binding can only be present for coded elements, string, and uri

## 5. Move FSH files into IG

- Clone a copy of the US Core github sources
  - <https://github.com/HL7/US-Core.git>
  - Use git clone command or Github desktop
- Remove the current definition sources: **/input/examples** and **/input/resources**
- Copy your **/fsh** folder into the **/input** folder of the IG

## 6. Run the IG Publisher

- Get the publisher scripts and publisher.jar are present (using instructions on previous slide)
- Run **\_genonce**
- When complete, open **/output/index.html**

**Result:  
US Core IG  
produced from  
FSH sources**



**US Core Implementation Guide**  
3.2.0 - CI build

Table of Contents > Artifacts Summary > **US Core Condition Profile**

US Core Implementation Guide - Local Development build (v3.2.0). See the [Directory of published versions](#).

**Content** Detailed Descriptions Examples XML JSON

### 18.86.1 Resource Profile: US Core Condition Profile

Defining URL:	<a href="http://hl7.org/fhir/us/core/StructureDefinition/us-core-condition">http://hl7.org/fhir/us/core/StructureDefinition/us-core-condition</a>
Version:	3.2.0
Name:	USCoreCondition

### 18.86.1.3 Formal Views of Profile Content

Description of Profiles, Differentials, Snapshots and how the different presentations work.

**Text Summary** **Differential Table** **Snapshot Table** **Snapshot Table (Must Support)** **All**

This structure is derived from [Condition](#).

Name	Flags	Card.	Type	Description & Constraints
Condition	I	0..*	Condition	Detailed information about conditions, problems or diagnoses <b>us-core-1:</b> A code in Condition.category SHOULD be from US Core Condition Category Codes value set. <b>Binding:</b> ConditionClinicalStatusCodes (required)
clinicalStatus	S	0..1	CodeableConcept	active   recurrence   relapse   inactive   remission   resolved <b>Binding:</b> ConditionVerificationStatus (required)
verificationStatus	S	0..1	CodeableConcept	unconfirmed   provisional   differential   confirmed   refuted   entered-in-error <b>Binding:</b> US Core Condition Category Codes (extensible)
category	S I	1..*	CodeableConcept	problem-list-item   encounter-diagnosis   health-concern <b>Binding:</b> US Core Condition Code (required): Valueset to describe the actual problem experienced by the patient
code	S	1..1	CodeableConcept	Identification of the condition, problem or diagnosis <b>Binding:</b> US Core Condition Code (required): Valueset to describe the actual problem experienced by the patient
subject	S	1..1	Reference(US Core Patient Profile)	Who has the condition?

[Documentation for this format](#)

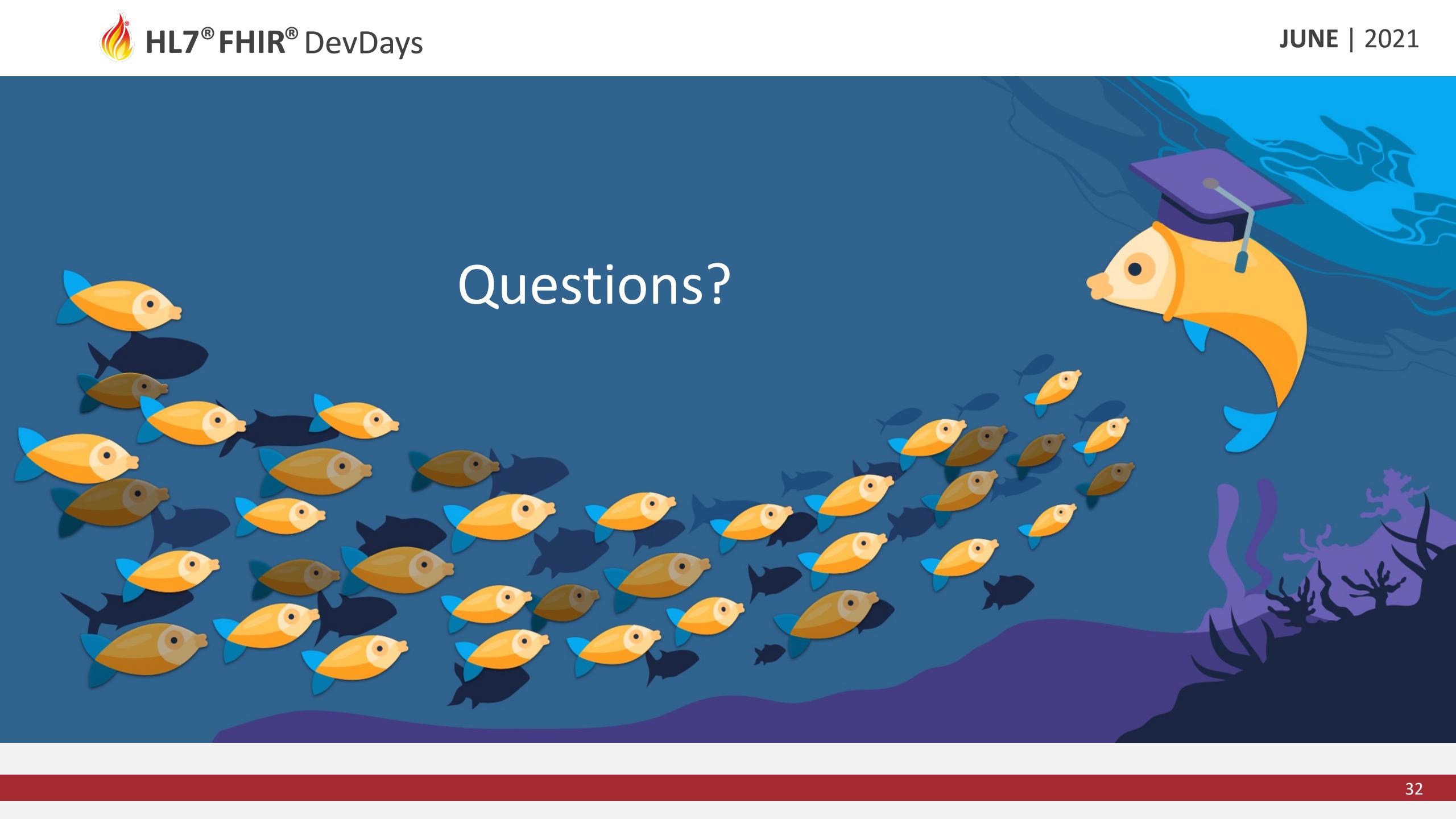
Bonus points: See any differences?

# Advantages of FHIR Shorthand Profiling Language

- Concise, readable, understandable
- Rapid changes via text operations: copy, paste, search, and replace
- Perfect for source code control (branching, merging, diffs)
- Error checking and incorporation of best practices
- Complete: FSH does everything you can do by manually editing
  - Profiles, extensions, value sets, code systems, invariants, mappings
  - Resources and logical models (NEW!)
- HL7 Standard and integrated with HL7 FHIR IG Publisher

## FSH Resources and Tools

- [FSH Language Specification](#) -- HL7 FHIR Standard
- [SUSHI](#) -- compile FSH into FHIR Artifacts
- [FSH School](#) -- web site with documentation, tools, examples
- [FSH Online](#) -- interactive FHIR Shorthand with examples
- [GoFSH](#) -- convert existing implementation guides into FSH (beta)
- [FSH Finder](#) -- web crawler to find FSH projects
- [VS Code extension](#) -- code highlighter for VS Code editor



# Questions?

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