

Advanced HL7 FHIR Shorthand

Ninja Tricks for Nerds

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Introducing Your Captain

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 - Co-creator of FHIR Shorthand w/ Mark Kramer
 - Development lead for FSH Tools (SUSHI, etc.)
 - Technical Lead for AHRQ CDS Connect



This is me doing virtual training



A US non-profit operating federally-funded research and development centers, working in the public interest. We bring a conflict-free perspective and a whole of government vantage point to bring innovative ideas into existence.



Prerequisites

- HL7 FHIR Fundamentals course
 - or equivalent experience
- Introduction to FHIR Shorthand course
 - or equivalent experience



Recommended Software

- [Node.js LTS](#) (for SUSHI and GoFSH)
- [SUSHI](#) (`npm install -g fsh-sushi`)
- [GoFSH](#) (`npm install -g gofsh`)
- Java SDK 17 ([Eclipse Temurin](#) / [Oracle](#), for IG Publisher)
- [Ruby and Jekyll](#) (for IG Publisher)
- [Visual Studio Code](#)
- [FHIR Shorthand \(FSH\) Extension](#) (for VS Code)



Agenda

- Back to the Basics
- Tools of the Trade: VS Code
- Tricks for Tackling Tediosity
- Slicing (without Losing a Finger)
- ~~Finvariants~~ Invariants
- Intensional Value Sets
- IG Configuration
- GoFSH
- Review



Cookie Time

BACK TO THE BASICS

Why pun? Just for the halibut!

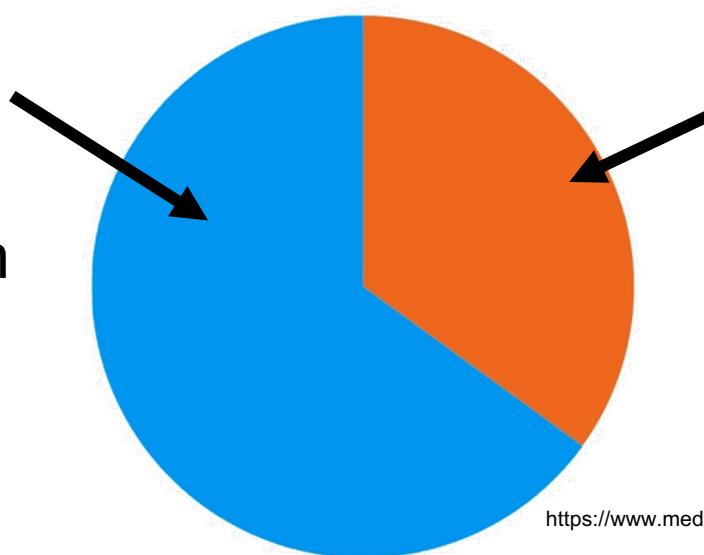


Why Create an Implementation Guide?

- FHIR is a framework, not a complete solution

Base FHIR:

- On-the-wire syntax
- API for read, write, search
- FHIR base resources
- Data types
- Extensibility mechanism



Implementation Guide:

- Specific problem to be solved
- Actors and workflow sequences
- Profiles of base resources
- Terminology and value sets
- Additional API operations
- & more

<https://www.medrxiv.org/content/10.1101/2022.03.09.22272163v1.full>



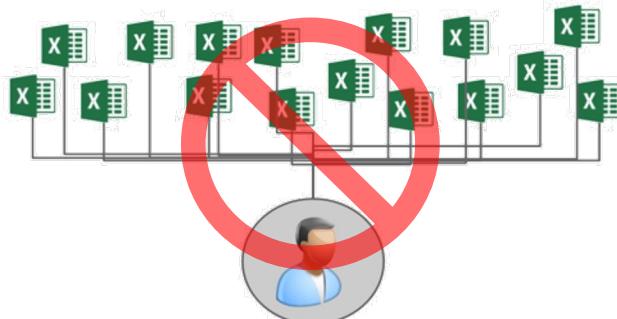
Approaches to Authoring Definitional Resources



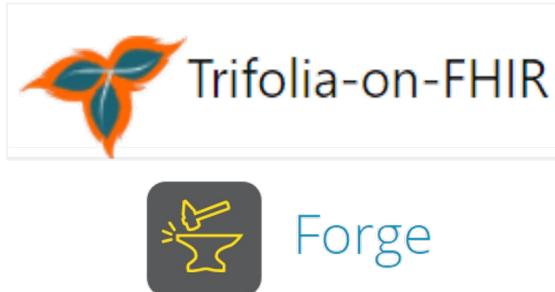
Hand-Editing



Spreadsheets



User Interfaces



Profile on Patient⁽⁵⁾: PatienNL

Properties Narrative Element Tree Element Grid Xml

Edit the meta properties of the selected resource or component.

URL

Resource ID

Name

Description

Command-Driven



MAKE ME A SANDWICH.



Profile: MyPatient
Parent: Patient
* name 1...* MS

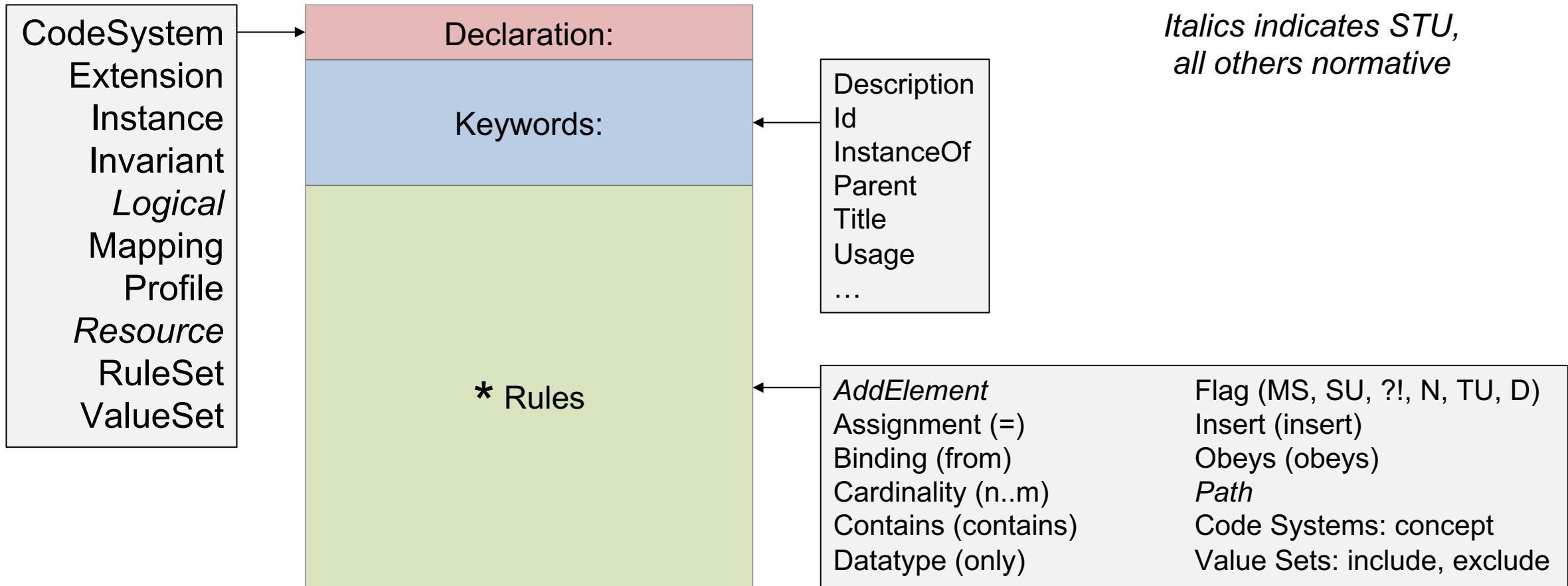


Advantages of FHIR Shorthand

- 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
- HL7 FHIR Balloted Standard (Mixed Normative / Trial Use)
- Integrated with HL7 FHIR IG Publisher
- Free and open source -- contributions welcome
- Works on Windows, Mac, Linux, ...
- Fish Puns!



Anatomy of a FSH Item



Defining Profiles in FHIR Shorthand

FSH Keyword	Usage	Element in StructureDefinition	Data Type	Required
Profile	Name of the profile	name	name	Yes
Parent	Base definition of the profile	baseDefinition	name/id/url	Yes
Id	Identifier of the profile	id	id	No
Title	Title of the profile	title	string	No
Description	Human-readable description	description	string	No

Example Profile on FHIR R4 Observation

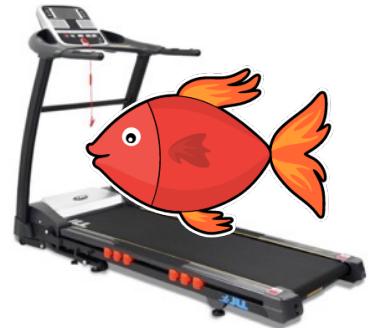
```
Profile: BodyWeightProfile
Parent: Observation
Id: example-weight-profile
Title: "Body Weight"
Description: "An example profile for collecting weight"
* code = http://loinc.org#29463-7 // Body weight
* value[x] only Quantity
* valueQuantity from BodyWeightUnits
```



Name	Flags	Card.	Type	Description & Constraints
Observation		0..*	Observation	Measurements and simple assertions
code		1..1	CodeableConcept	Type of observation (code / type)
coding		1..*	Coding	Required Pattern: At least the following Code defined by a terminology system
system		1..1	uri	Fixed Value: (complex) Identity of the terminology system
code		1..1	code	Fixed Value: http://loinc.org Symbol in syntax defined by the system
Slices for value[x]		0..1	Quantity	Fixed Value: 29463-7 Actual result
valueQuantity		0..1	Quantity	Slice: Unordered, Open by type:\$this Actual result
				Binding: Body Weight Units (required)



FSH Exercise: Back to the Basics



GOAL: Create, build, and publish a simple SUSHI project

1. Open a terminal and navigate (`cd`) to a parent folder
2. Run the command: `sushi --init` ←
3. Navigate (`cd`) to your new project folder in terminal
4. Run the command: `sushi .` ←
5. Run `./update_publisher` (.sh for mac, .bat for windows)
6. Run `./genonce` (.sh for mac, .bat for windows) ←
7. Review `./output/qa.html` and `./output/index.html`

Good times
to review
project in
VS Code



TOOLS OF THE TRADE: VS CODE

Cool and So-FSH-ticated!



Visual Studio Code + FSH Extension

To install VS Code and the FSH extension:

1. VS Code:

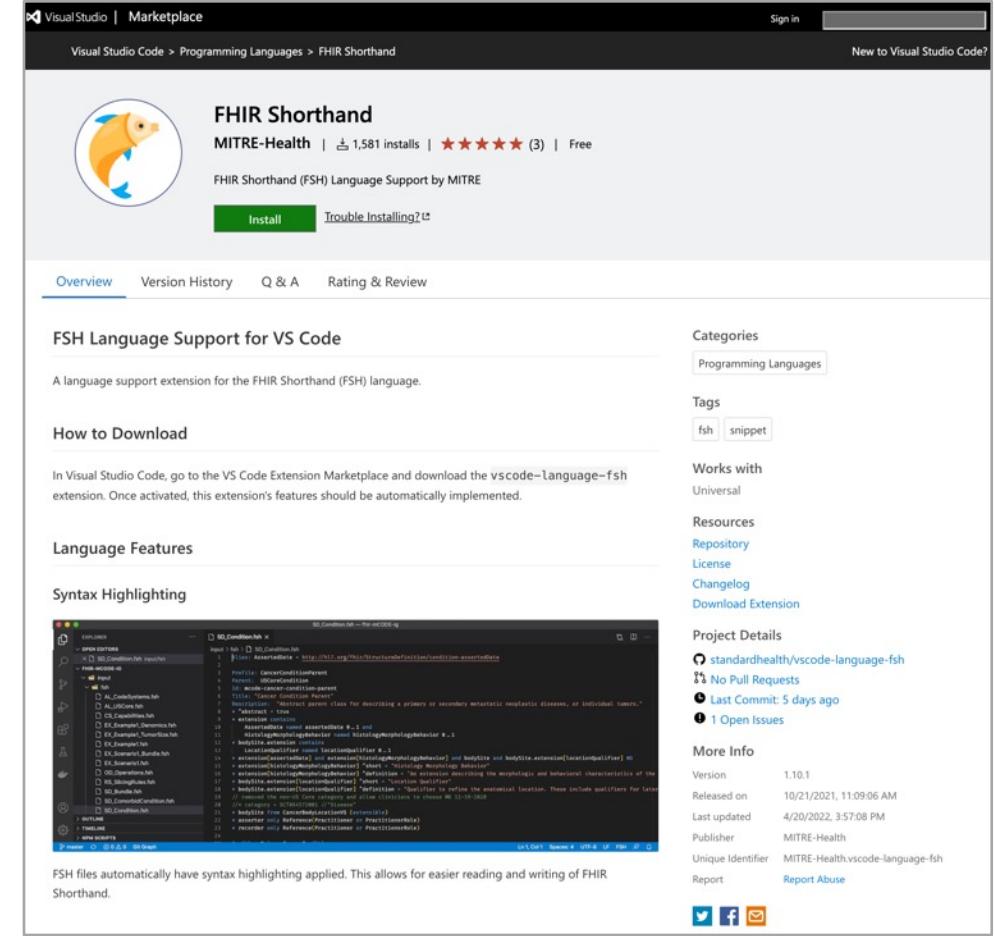
<https://code.visualstudio.com/download>

2. FSH Extension:

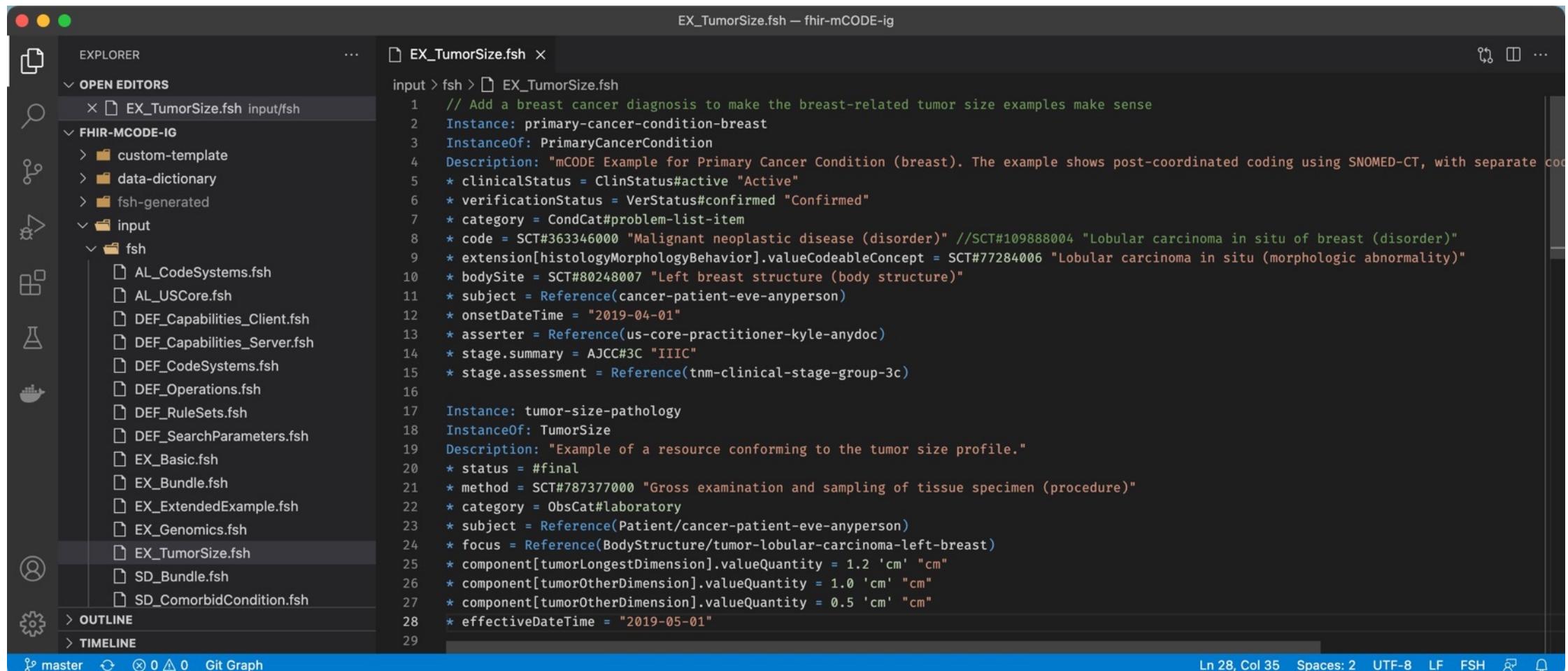
- Open a .fsh file and follow prompts, or
- Search “FHIR Shorthand” in Marketplace, or
- Go to: <https://bit.ly/vsc-fsh>

WHY?

- Syntax highlighting
- Path completion
- Snippets
- Go to definition
- Open FHIR documentation
- SUSHI build task



VS Code: FSH Syntax Highlighting



The screenshot shows the Visual Studio Code interface with the following details:

- File Explorer:** Shows the project structure under "OPEN EDITORS". The file "EX_TumorSize.fsh" is selected.
- Editor:** Displays the content of "EX_TumorSize.fsh". The code uses color-coded syntax highlighting for FSH keywords, comments, and values. For example, "fsh" is highlighted in blue, and "/*" is highlighted in green.
- Status Bar:** Shows the file path "EX_TumorSize.fsh — fhir-mCODE-ig", line count "Ln 28, Col 35", character count "Spaces: 2", encoding "UTF-8", line separator "LF", and file type "FSH".

```
input > fsh > EX_TumorSize.fsh
1 // Add a breast cancer diagnosis to make the breast-related tumor size examples make sense
2 Instance: primary-cancer-condition-breast
3 InstanceOf: PrimaryCancerCondition
4 Description: "mCODE Example for Primary Cancer Condition (breast). The example shows post-coordinated coding using SNOMED-CT, with separate cod
5 * clinicalStatus = ClinStatus#active "Active"
6 * verificationStatus = VerStatus#confirmed "Confirmed"
7 * category = CondCat#problem-list-item
8 * code = SCT#363346000 "Malignant neoplastic disease (disorder)" //SCT#109888004 "Lobular carcinoma in situ of breast (disorder)"
9 * extension[histologyMorphologyBehavior].valueCodeableConcept = SCT#77284006 "Lobular carcinoma in situ (morphologic abnormality)"
10 * bodySite = SCT#80248007 "Left breast structure (body structure)"
11 * subject = Reference(cancer-patient-eve-anyperson)
12 * onsetDateTime = "2019-04-01"
13 * asserter = Reference(us-core-practitioner-kyle-anydoc)
14 * stage.summary = AJCC#3C "IIIC"
15 * stage.assessment = Reference(tnm-clinical-stage-group-3c)
16
17 Instance: tumor-size-pathology
18 InstanceOf: TumorSize
19 Description: "Example of a resource conforming to the tumor size profile."
20 * status = #final
21 * method = SCT#787377000 "Gross examination and sampling of tissue specimen (procedure)"
22 * category = ObsCat#laboratory
23 * subject = Reference(Patient/cancer-patient-eve-anyperson)
24 * focus = Reference(BodyStructure/tumor-lobular-carcinoma-left-breast)
25 * component[tumorLongestDimension].valueQuantity = 1.2 'cm' "cm"
26 * component[tumorOtherDimension].valueQuantity = 1.0 'cm' "cm"
27 * component[tumorOtherDimension].valueQuantity = 0.5 'cm' "cm"
28 * effectiveDateTime = "2019-05-01"
29
```



VS Code: FSH Path Completion

The screenshot shows a dark-themed instance of VS Code with the title bar "EX_ExtendedExample.fsh — fhir-mCODE-ig". The left sidebar contains icons for file, search, open, and other development tools. The main editor area displays FHIR System Definition (FSH) code. At line 300, the cursor is positioned after ". component.", and a completion dropdown menu is open, listing various properties starting with a key symbol (e.g., code, dataAbsentReason, extension, id, interpretation, modifierExtension, referenceRange, value[x], valueBoolean, valueCodeableConcept, valueDateTime, valueInteger). The status bar at the bottom provides information about the file: "tempytemp", "You, 3 minutes ago", "Ln 300, Col 13", "Spaces: 3", "UTF-8", "LF", "FSH", "Spell", "Prettier", and a bell icon.

```
input > fsh > EX_ExtendedExample.fsh
293 InstanceOf: GenomicRegionStudied
294  Description: "Extended example: example showing which regions were included in the genomics panel"
295  * status = #final "final"
296  * code = LNC#53041-0 "DNA region of interest panel"
297  * subject = Reference(cancer-patient-jenny-m)
298  * effectiveDateTime = "2018-03-15"
299  * issued = "2018-03-15T00:00:01+00:00"
300  * component.    You, 3 minutes ago • tempytemp ...
301      ↗ code
302      ↗ dataAbsentReason
303      ↗ extension
304      ↗ id
305      ↗ interpretation
306      ↗ modifierExtension
307      ↗ referenceRange
308      ↗ value[x]
309      ↗ valueBoolean
310      ↗ valueCodeableConcept
311      ↗ valueDateTime
312      ↗ valueInteger
313
314
```



VS Code: FSH Snippets

1. Type a FSH trigger phrase

Trigger	FSH Item
pro	Profile
ext	Extension
log	Logical
res	Resource
vs	ValueSet
cs	CodeSystem

Trigger	FSH Item
inst	Instance
inv	Invariant
map	Map
rs	RuleSet
^slicing	(slicing rules)

```
SD_DiseaseStatus.fsh — fhir-mCODE-ig
input > fsh > SD_DiseaseStatus.fsh
1 pro
2   Profile: 
```

```
SD_DiseaseStatus.fsh — fhir-mCODE-ig
input > fsh > SD_DiseaseStatus.fsh
1 Profile:
2 Parent:
3 Id:
4 Title: ""
5 Description: ""
6 * | 
```

```
SD_DiseaseStatus.fsh — fhir-mCODE-ig
input > fsh > SD_DiseaseStatus.fsh
1 Profile: CancerDiseaseStatus
2 Parent: Observation
3 Id: cancer-disease-status
4 Title: "Cancer Disease Status"
5 Description: "A clinician's qualitative judgment on the current trend of the cancer..."
6 * extension contains EvidenceType named evidenceType 0..*
7 // ... 
```

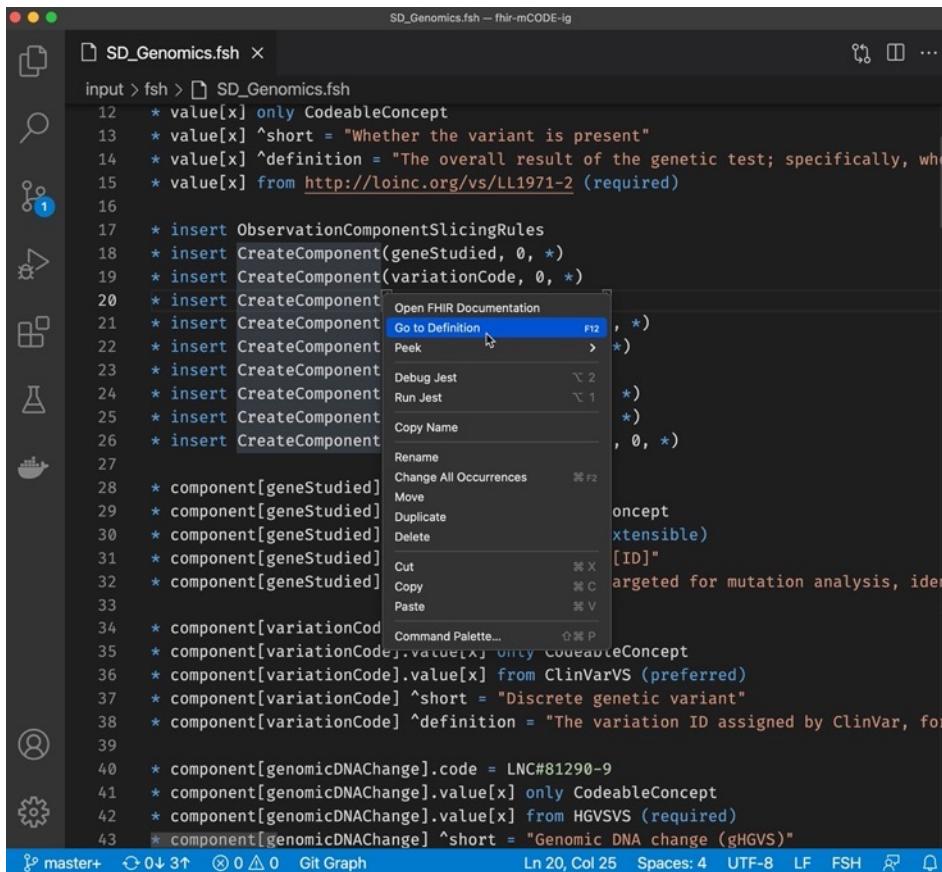
2. Hit <ENTER> or <TAB> to start

3. Use <TAB> to visit placeholders

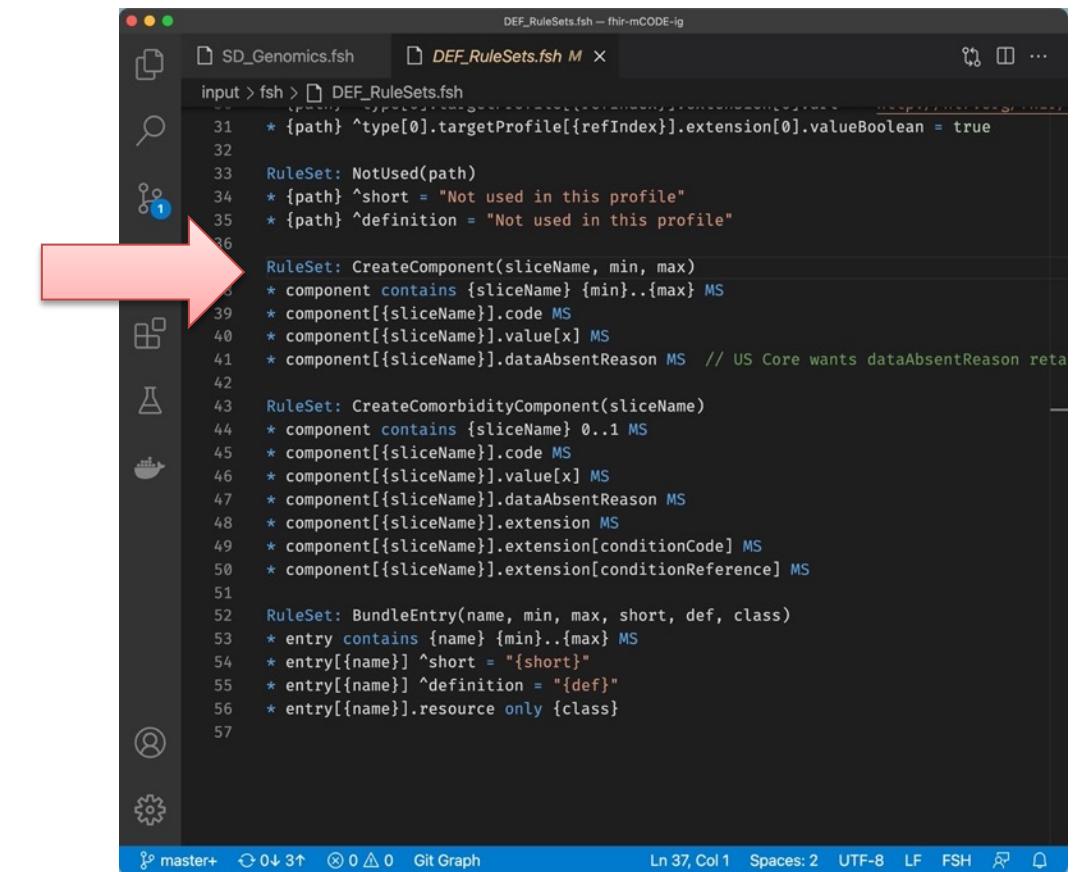


VS Code: Go to Definition

Right-click a FSH name and “Go to Definition” to see its definition



A screenshot of the VS Code interface showing the file `SD_Genomics.fsh`. A context menu is open over the word `CreateComponent`, with the option `Go to Definition` highlighted. The code editor shows FHIR Structured Definitions (FSH) with various components like `ObservationComponentSlicingRules` and `component[geneStudied]`.

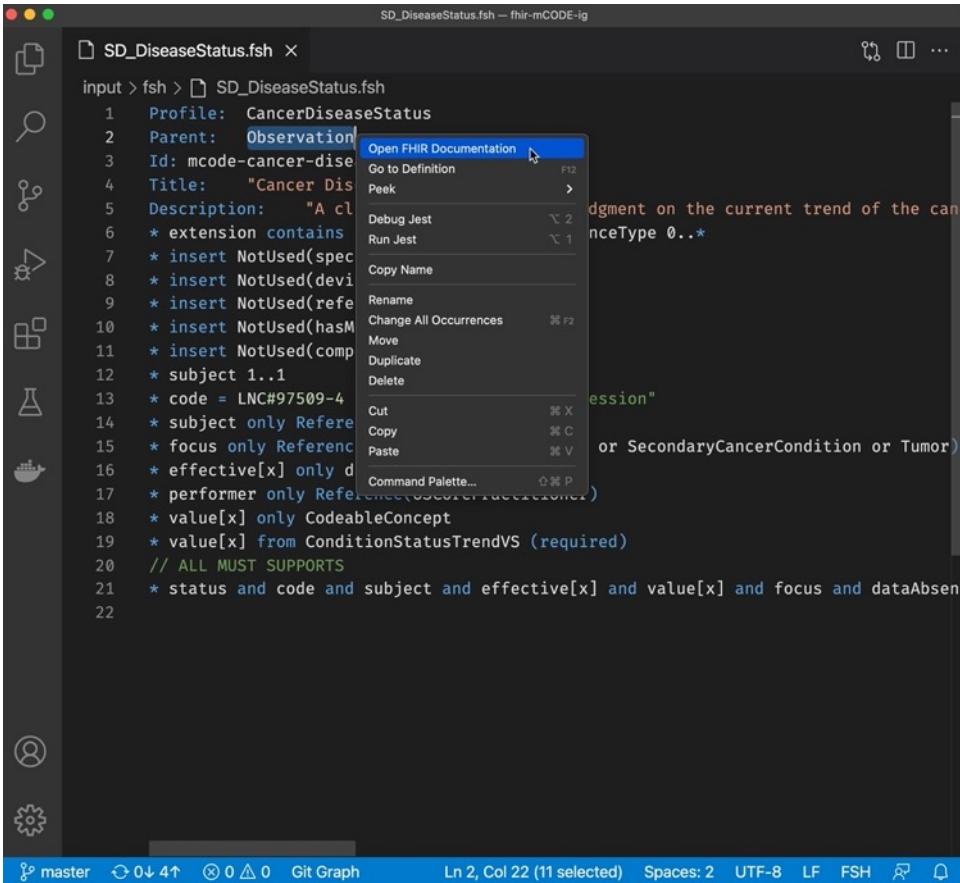


A screenshot of the VS Code interface showing the file `DEF_RuleSets.fsh`. A red arrow points from the left screenshot to this one, indicating the result of the "Go to Definition" action. The code editor shows the definition of the `CreateComponent` rule set, which includes rules for creating components based on slice names and their properties.



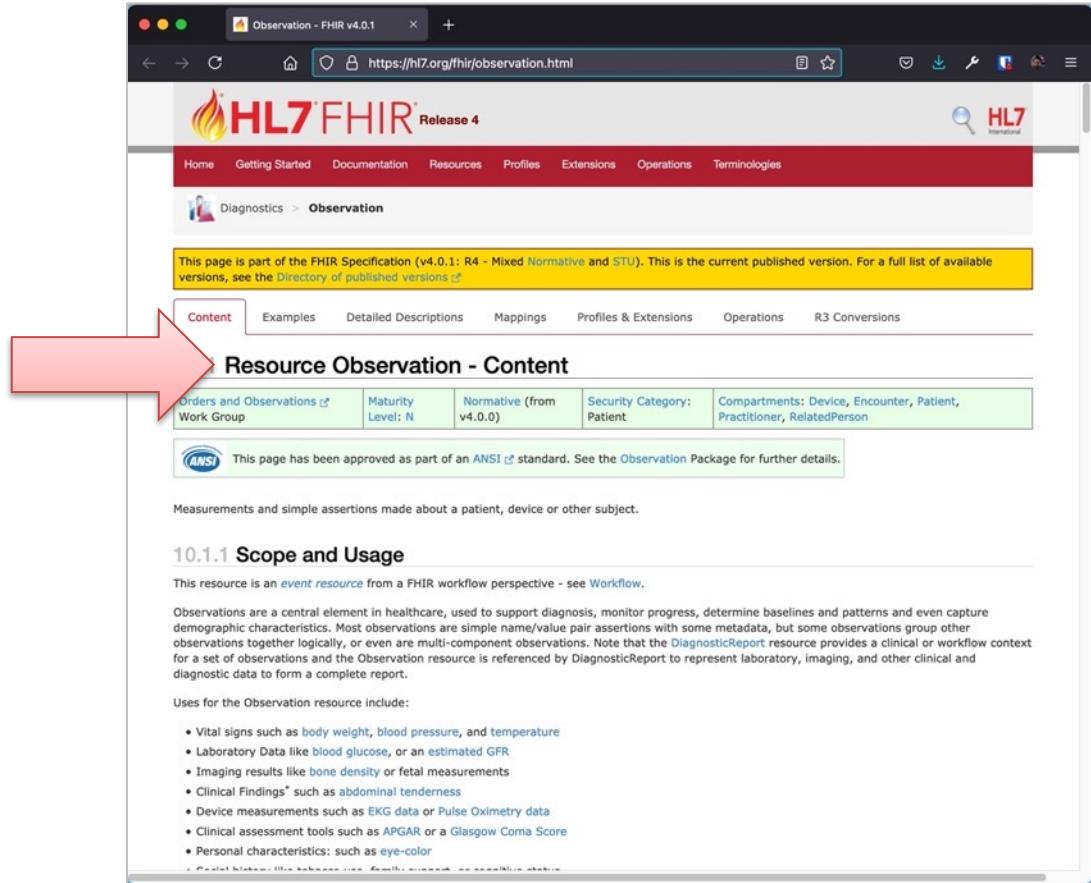
VS Code: Go to FHIR Documentation

Right-click a FHIR name and “Go to FHIR Documentation” to see its definition



A screenshot of the VS Code interface showing a FHIR resource definition file named SD_DiseaseStatus.fsh. A context menu is open over a line of code, specifically over the word "Observation". The menu items include "Open FHIR Documentation", "Go to Definition", "Peek", "Debug Jest", "Run Jest", "Copy Name", "Rename", "Change All Occurrences", "Move", "Duplicate", "Delete", "Cut", "Copy", "Paste", and "Command Palette...". The "Open FHIR Documentation" option is highlighted.

```
SD_DiseaseStatus.fsh — fhir-mCODE-ig
SD_DiseaseStatus.fsh
input > fsh > SD_DiseaseStatus.fsh
1 Profile: CancerDiseaseStatus
2 Parent: Observation
3 Id: mcode-cancer-dise
4 Title: "Cancer Dis
5 Description: "A cl
6 * extension contains
7 * insert NotUsed(spec
8 * insert NotUsed(devi
9 * insert NotUsed(refe
10 * insert NotUsed(hasM
11 * insert NotUsed(comp
12 * subject 1..1
13 * code = LNC#97509-4
14 * subject only Refere
15 * focus only Referenc
16 * effective[x] only d
17 * performer only Refe
18 * value[x] only CodeableConcept
19 * value[x] from ConditionStatusTrendVS (required)
20 // ALL MUST SUPPORTS
21 * status and code and subject and effective[x] and value[x] and focus and dataAbsent
22
```



A screenshot of a web browser displaying the HL7 FHIR website at https://hl7.org/fhir/observation.html. The page shows the "Resource Observation - Content" section. A red arrow points from the "Open FHIR Documentation" option in the VS Code context menu to the "Content" tab on the FHIR website. The page includes sections for "Orders and Observations", "Maturity Level: N", "Normative (from v4.0.0)", and "Security Category: Patient". It also mentions ANSI approval and provides details about the scope and usage of the Observation resource.

HL7 FHIR Release 4

Home Getting Started Documentation Resources Profiles Extensions Operations Terminologies

Diagnostics > Observation

This page is part of the FHIR Specification (v4.0.1: R4 - Mixed Normative and STU). This is the current published version. For a full list of available versions, see the [Directory of published versions](#).

Content Examples Detailed Descriptions Mappings Profiles & Extensions Operations R3 Conversions

Resource Observation - Content

Orders and Observations Maturity Level: N Normative (from v4.0.0) Security Category: Patient Compartments: Device, Encounter, Patient, Practitioner, RelatedPerson

ANSI This page has been approved as part of an ANSI standard. See the [Observation Package](#) for further details.

Measurements and simple assertions made about a patient, device or other subject.

10.1.1 Scope and Usage

This resource is an [event resource](#) from a FHIR workflow perspective - see [Workflow](#).

Observations are a central element in healthcare, used to support diagnosis, monitor progress, determine baselines and patterns and even capture demographic characteristics. Most observations are simple name/value pair assertions with some metadata, but some observations group other observations together logically, or even are multi-component observations. Note that the [DiagnosticReport](#) resource provides a clinical or workflow context for a set of observations and the Observation resource is referenced by DiagnosticReport to represent laboratory, imaging, and other clinical and diagnostic data to form a complete report.

Uses for the Observation resource include:

- Vital signs such as body weight, blood pressure, and temperature
- Laboratory Data like blood glucose, or an estimated GFR
- Imaging results like bone density or fetal measurements
- Clinical Findings* such as abdominal tenderness
- Device measurements such as EKG data or Pulse Oximetry data
- Clinical assessment tools such as APGAR or a Glasgow Coma Score
- Personal characteristics: such as eye-color



VS Code: SUSHI Build Task

Click Terminal

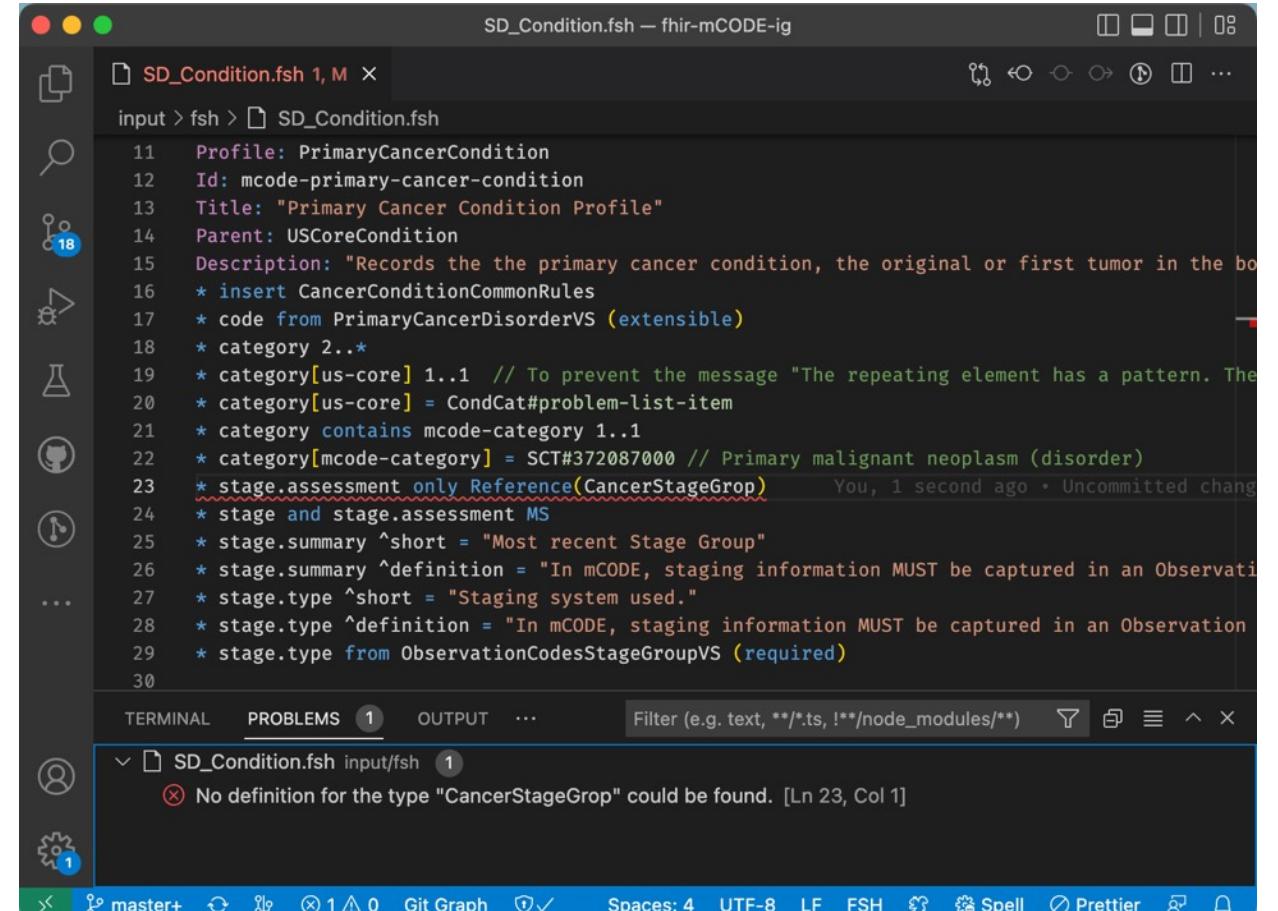
→ Run Build Task...

→ fsh:sushi

or

Windows: <SHIFT> + <CTL> + B

Mac: <SHIFT> + <CMD> + B



The screenshot shows a VS Code interface with a dark theme. The main editor window displays an FHIR schema file named SD_Condition.fsh. The code includes definitions for a Primary Cancer Condition profile, its ID, title, and parent condition. It also includes rules for assessment, summary, and type. A specific line (line 23) is highlighted in red, indicating an error: "stage.assessment only Reference(CancerStageGrop)". Below the editor, the terminal window shows the command "fsh input/fsh" followed by an error message: "No definition for the type 'CancerStageGrop' could be found. [Ln 23, Col 1]". The status bar at the bottom indicates the file is on branch 'master+', has 1 untracked file, and 0 staged changes.



TRICKS FOR TACKLING TEDIOSITY*

* Yes, this is a real word.

It doesn't get any betta than this!



Tricks for Tackling Tediosity

- Soft Indexing
- RuleSets
- Parameterized RuleSets
- Preprocessed FSH



Managing Lists w/ Explicit Indexing (FHIR 1.0)

```
* item[0].linkId = "sp-101"
* item[0].text = "What is your date of birth?"
* item[0].type = #date

* item[1].linkId = "sp-102"
* item[1].text = "What is your country of birth?"
* item[1].type = #code

* item[2].linkId = "sp-103"
* item[2].text = "What country do you currently reside in?"
* item[2].type = #code

* item[3].linkId = "sp-104"
* item[3].text = "What country did you travel to?"
* item[3].type = #code

* item[4].linkId = "sp-105"
* item[4].text = "When did the travel start?"
* item[4].type = #date

* item[5].linkId = "sp-106"
* item[5].text = "When did the travel end?"
* item[5].type = #date
```

Problems with explicit indexing:

- Error prone (oops, I missed one!)
- Adding/removing items in the middle requires renumbering
- Similar blocks of code are not reusable

```
* item[ ].linkId = "sp-108"
* item[ ].text = "When state do you currently reside in?"
* item[ ].type = #code
```



Managing Lists w/ Soft Indexing (FSH 2.0)

```
* item[+].linkId = "sp-101"
* item[=].text = "What is your date of birth?"
* item[=].type = #date

* item[+].linkId = "sp-102"
* item[=].text = "What is your country of birth?"
* item[=].type = #code

* item[+].linkId = "sp-103"
* item[=].text = "What country do you currently reside in?"
* item[=].type = #code

* item[+].linkId = "sp-104"
* item[=].text = "What country did you travel to?"
* item[=].type = #code

* item[+].linkId = "sp-105"
* item[=].text = "When did the travel start?"
* item[=].type = #date

* item[+].linkId = "sp-106"
* item[=].text = "When did the travel end?"
* item[=].type = #date
```

Soft indexing approach:

- [+] → next item in array
- [=] → last referenced item in the array
- Start an empty array with [+], [0], or implicit index 0

```
* item[+].linkId = "sp-108"
* item[=].text = "When state do you currently reside in?"
* item[=].type = #code
```

Advantages of soft indexing:

- No need to count (counting is hard!)
- Easily add/remove/move items
- Copy/paste and RuleSet friendly



RuleSets

```
RuleSet: ContactAndCopyright
* ^contact[+].name = "Homer Simpson"
* ^contact[=].telecom.system = #phone
* ^contact[=].telecom.value = "939-555-0113"
* ^copyright = "© 2022 Springfield Nuclear Power Plant"
```

```
Profile: RadiationTherapyPatient
Parent: Patient
* insert ContactAndCopyright
* name 1..* MS
```



SUSHI Preprocessor

```
Profile: RadiationTherapyPatient
Parent: Patient
* ^contact[+].name = "Homer Simpson"
* ^contact[=].telecom.system = #phone
* ^contact[=].telecom.value = "939-555-0113"
* ^copyright = "© 2022 Springfield Nuclear Power Plant"
* name 1..* MS
```

RuleSets allow you to:

- Define common rules *once*
- And apply them multiple times

Use the **insert** keyword to apply rulesets in definitions where they *fit*.

But wait! There's more!



Parameterized RuleSets

```
RuleSet: Context(type, expression)
* ^context[+].type = {type}
* ^context[=].expression = {expression}
```

```
Extension: OrganizationPreferredContact
* insert Context(#element, "Organization.contact")
* value[x] only boolean
```

 SUSHI Preprocessor

```
Extension: OrganizationPreferredContact
* ^context[+].type = #element
* ^context[=].expression = "Organization.contact"
* value[x] only boolean
```

Parameterized RuleSets have:

- Input parameters (*in parentheses*)
- Placeholders (*in curly braces*)

When you **insert** rulesets:

- Specify values in parentheses
- Separate values by a comma

Works like simple **find & replace**

- Escape commas & ending parentheses
- e.g., *insert RS(#foo, "a\,b\,c\,... (etc.\)")*



Example: CapabilityStatement

```
// MeasureReport requirements
* rest.resource[0].type = #MeasureReport
* rest.resource[0].extension[0].url = "http://hl7.org/fhir/StructureDefinition/capabilitystatement-expectation"
* rest.resource[0].extension[0].valueCode = #SHALL
* rest.resource[0].supportedProfile[0] = "http://hl7.org/fhir/us/saner/StructureDefinition/PublicHealthMeasureReport"
* rest.resource[0].supportedProfile[0].extension[0].url = "http://hl7.org/fhir/StructureDefinition/capabilitystatement-expectation"
* rest.resource[0].supportedProfile[0].extension[0].valueCode = #SHALL
* rest.resource[0].interaction[0].code = #create
* rest.resource[0].interaction[0].extension[0].url = "http://hl7.org/fhir/StructureDefinition/capabilitystatement-expectation"
* rest.resource[0].interaction[0].extension[0].valueCode = #SHALL
* rest.resource[0].interaction[1].code = #update
* rest.resource[0].interaction[1].extension[0].url = "http://hl7.org/fhir/StructureDefinition/capabilitystatement-expectation"
* rest.resource[0].interaction[1].extension[0].valueCode = #SHALL
// Measure requirements
* rest.resource[1].type = #Measure
* rest.resource[1].extension[0].url = "http://hl7.org/fhir/StructureDefinition/capabilitystatement-expectation"
* rest.resource[1].extension[0].valueCode = #SHALL
* rest.resource[1].supportedProfile[0] = "http://hl7.org/fhir/us/saner/StructureDefinition/PublicHealthMeasure"
* rest.resource[1].supportedProfile[0].extension[0].url = "http://hl7.org/fhir/StructureDefinition/capabilitystatement-expectation"
* rest.resource[1].supportedProfile[0].extension[0].valueCode = #SHOULD
* rest.resource[1].supportedProfile[1] = "http://hl7.org/fhir/us/saner/StructureDefinition/PublicHealthMeasureStratifier"
* rest.resource[1].supportedProfile[1].extension[0].url = "http://hl7.org/fhir/StructureDefinition/capabilitystatement-expectation"
* rest.resource[1].supportedProfile[1].extension[0].valueCode = #SHOULD
* rest.resource[1].interaction[0].code = #create
* rest.resource[1].interaction[0].extension[0].url = "http://hl7.org/fhir/StructureDefinition/capabilitystatement-expectation"
* rest.resource[1].interaction[0].extension[0].valueCode = #SHOULD
* rest.resource[1].interaction[1].code = #update
* rest.resource[1].interaction[1].extension[0].url = "http://hl7.org/fhir/StructureDefinition/capabilitystatement-expectation"
* rest.resource[1].interaction[1].extension[0].valueCode = #SHOULD
```



Example: CapabilityStatement w/ Alias & Soft Indexing

```
// MeasureReport requirements
* rest.resource[0].type = #MeasureReport
* rest.resource[=].extension[0].url = $ExpExt
* rest.resource[=].extension[=].valueCode = #SHALL
* rest.resource[=].supportedProfile[0] = "http://hl7.org/fhir/us/saner/StructureDefinition/PublicHealthMeasureReport"
* rest.resource[=].supportedProfile[=].extension[0].url = $ExpExt
* rest.resource[=].supportedProfile[=].extension[=].valueCode = #SHALL
* rest.resource[=].interaction[0].code = #create
* rest.resource[=].interaction[=].extension[0].url = $ExpExt
* rest.resource[=].interaction[=].extension[=].valueCode = #SHALL
* rest.resource[=].interaction[+].code = #update
* rest.resource[=].interaction[=].extension[0].url = $ExpExt
* rest.resource[=].interaction[=].extension[=].valueCode = #SHALL

// Measure requirements
* rest.resource[+].type = #Measure
* rest.resource[=].extension[0].url = $ExpExt
* rest.resource[=].extension[=].valueCode = #SHALL
* rest.resource[=].supportedProfile[0] = "http://hl7.org/fhir/us/saner/StructureDefinition/PublicHealthMeasure"
* rest.resource[=].supportedProfile[=].extension[0].url = $ExpExt
* rest.resource[=].supportedProfile[=].extension[=].valueCode = #SHOULD
* rest.resource[=].supportedProfile[+] = "http://hl7.org/fhir/us/saner/StructureDefinition/PublicHealthMeasureStratifier"
* rest.resource[=].supportedProfile[=].extension[0].url = $ExpExt
* rest.resource[=].supportedProfile[=].extension[=].valueCode = #SHOULD
* rest.resource[=].interaction[0].code = #create
* rest.resource[=].interaction[=].extension[0].url = $ExpExt
* rest.resource[=].interaction[=].extension[=].valueCode = #SHOULD
* rest.resource[=].interaction[+].code = #update
* rest.resource[=].interaction[=].extension[0].url = $ExpExt
* rest.resource[=].interaction[=].extension[=].valueCode = #SHOULD
```



Example: RuleSets for Repeated FSH

```
RuleSet: SupportResource (resource, expectation)
* rest.resource[+].type = {resource}
* rest.resource[=].extension[0].url = $ExpExt
* rest.resource[=].extension[0].valueCode = {expectation}

RuleSet: SupportProfile (profile, expectation)
* rest.resource[=].supportedProfile[+] = {profile}
* rest.resource[=].supportedProfile[=].extension[0].url = $ExpExt
* rest.resource[=].supportedProfile[=].extension[0].valueCode = {expectation}

RuleSet: SupportInteraction (interaction, expectation)
* rest.resource[=].interaction[+].code = {interaction}
* rest.resource[=].interaction[=].extension[0].url = $ExpExt
* rest.resource[=].interaction[=].extension[0].valueCode = {expectation}

// MeasureReport requirements
* insert SupportResource(#MeasureReport, #SHALL)
* insert SupportProfile("http://hl7.org/fhir/us/saner/StructureDefinition/PublicHealthMeasureReport", #SHALL)
* insert SupportInteraction(#create, #SHALL)
* insert SupportInteraction(#update, #SHALL)
```



Example: CapabilityStatement w/ RuleSets

```
// MeasureReport requirements
* insert SupportResource(#MeasureReport, #SHALL)
* insert SupportProfile("http://hl7.org/fhir/us/saner/StructureDefinition/PublicHealthMeasureReport", #SHALL)
* insert SupportInteraction(#create, #SHALL)
* insert SupportInteraction(#update, #SHALL)
// Measure requirements
* insert SupportResource(#Measure, #SHALL)
* insert SupportProfile("http://hl7.org/fhir/us/saner/StructureDefinition/PublicHealthMeasure", #SHOULD)
* insert SupportProfile("http://hl7.org/fhir/us/saner/StructureDefinition/PublicHealthMeasureStratifier", #SHOULD)
* insert SupportInteraction(#create, #SHOULD)
* insert SupportInteraction(#update, #SHOULD)
```



- Compact
- Consistent
- Easier to read
- Easier to write
- Fewer mistakes
- Happier FSH



Successfully Tackling Tediosity

Original CapabilityStatement

```
Instance: TestCapabilityStatement1
InstanceOf: CapabilityStatement
Usage: #example
* status = #active
* date = "2020-12-18"
* kind = #requirements
*fhirVersion = #4.0.1
*format[] = #json
*rest.mode = #server
// MeasureReport requirements
*rest.resource[0].type = #MeasureReport
*rest.resource[0].extension[0].url = "http://hl7.org/fhir/StructureDefinition/capabilitystatement-expectation"
*rest.resource[0].extension[0].valueCode = #SHALL
*rest.resource[0].supportedProfile[0] = "http://hl7.org/fhir/us/samer/StructureDefinition/PublicHealthMeasureReport"
*rest.resource[0].supportedProfile[0].extension[0].url = "http://hl7.org/fhir/StructureDefinition/capabilitystatement-expectation"
*rest.resource[0].supportedProfile[0].extension[0].valueCode = #SHALL
*rest.resource[0].interaction[0].code = #create
*rest.resource[0].interaction[0].extension[0].url = "http://hl7.org/fhir/StructureDefinition/capabilitystatement-expectation"
*rest.resource[0].interaction[0].extension[0].valueCode = #SHALL
*rest.resource[0].interaction[1].code = #update
*rest.resource[0].interaction[1].extension[0].url = "http://hl7.org/fhir/StructureDefinition/capabilitystatement-expectation"
*rest.resource[0].interaction[1].extension[0].valueCode = #SHALL
// Measure requirements
*rest.resource[1].type = #Measure
*rest.resource[1].extension[0].url = "http://hl7.org/fhir/StructureDefinition/capabilitystatement-expectation"
*rest.resource[1].extension[0].valueCode = #SHALL
*rest.resource[1].supportedProfile[0] = "http://hl7.org/fhir/us/samer/StructureDefinition/PublicHealthMeasure"
*rest.resource[1].supportedProfile[0].extension[0].url = "http://hl7.org/fhir/StructureDefinition/capabilitystatement-expectation"
*rest.resource[1].supportedProfile[0].extension[0].valueCode = #SHOULD
*rest.resource[1].supportedProfile[1] = "http://hl7.org/fhir/us/samer/StructureDefinition/PublicHealthMeasureStratifier"
*rest.resource[1].supportedProfile[1].extension[0].url = "http://hl7.org/fhir/StructureDefinition/capabilitystatement-expectation"
*rest.resource[1].supportedProfile[1].extension[0].valueCode = #SHOULD
*rest.resource[1].interaction[0].code = #create
*rest.resource[1].interaction[0].extension[0].url = "http://hl7.org/fhir/StructureDefinition/capabilitystatement-expectation"
*rest.resource[1].interaction[0].extension[0].valueCode = #SHOULD
*rest.resource[1].interaction[1].code = #update
*rest.resource[1].interaction[1].extension[0].url = "http://hl7.org/fhir/StructureDefinition/capabilitystatement-expectation"
*rest.resource[1].interaction[1].extension[0].valueCode = #SHOULD
*rest.resource[1].interaction[2].type = #Location
*rest.resource[2].extension[0].url = "http://hl7.org/fhir/StructureDefinition/capabilitystatement-expectation"
*rest.resource[2].extension[0].valueCode = #SHALL
*rest.resource[2].supportedProfile[0] = "http://hl7.org/fhir/us/samer/StructureDefinition/samer-resource-location"
*rest.resource[2].supportedProfile[0].extension[0].url = "http://hl7.org/fhir/StructureDefinition/capabilitystatement-expectation"
*rest.resource[2].supportedProfile[0].extension[0].valueCode = #SHOULD
*rest.resource[2].interaction[0].code = #create
*rest.resource[2].interaction[0].extension[0].url = "http://hl7.org/fhir/StructureDefinition/capabilitystatement-expectation"
*rest.resource[2].interaction[0].extension[0].valueCode = #SHOULD
*rest.resource[2].interaction[1].code = #update
*rest.resource[2].interaction[1].extension[0].url = "http://hl7.org/fhir/StructureDefinition/capabilitystatement-expectation"
*rest.resource[2].interaction[1].extension[0].valueCode = #SHOULD
// QuestionnaireResponse requirements
*rest.resource[3].type = #QuestionnaireResponse
*rest.resource[3].extension[0].url = "http://hl7.org/fhir/StructureDefinition/capabilitystatement-expectation"
*rest.resource[3].extension[0].valueCode = #SHALL
*rest.resource[3].supportedProfile[0] = "http://hl7.org/fhir/us/samer/StructureDefinition/SamerQuestionnaireResponse"
*rest.resource[3].supportedProfile[0].extension[0].url = "http://hl7.org/fhir/StructureDefinition/capabilitystatement-expectation"
*rest.resource[3].supportedProfile[0].extension[0].valueCode = #SHALL
*rest.resource[3].interaction[0].code = #create
*rest.resource[3].interaction[0].extension[0].url = "http://hl7.org/fhir/StructureDefinition/capabilitystatement-expectation"
*rest.resource[3].interaction[0].extension[0].valueCode = #SHALL
*rest.resource[3].interaction[1].code = #update
*rest.resource[3].interaction[1].extension[0].url = "http://hl7.org/fhir/StructureDefinition/capabilitystatement-expectation"
*rest.resource[3].interaction[1].extension[0].valueCode = #SHALL
```

+ Alias & Soft Indexing

```
Alias: $ExpExt = http://hl7.org/fhir/StructureDefinition/capabilitystatement-expectation

Instance: TestCapabilityStatement2
InstanceOf: CapabilityStatement
Usage: #example
* status = #active
* date = "2020-12-18"
* kind = #requirements
*fhirVersion = #4.0.1
*format[] = #json
*rest.mode = #server
// MeasureReport requirements
*rest.resource[1].type = #MeasureReport
*rest.resource[1].extension[0].url = "$ExpExt"
*rest.resource[1].extension[0].valueCode = #SHALL
*rest.resource[1].supportedProfile[0] = "http://hl7.org/fhir/us/samer/StructureDefinition/PublicHealthMeasureReport"
*rest.resource[1].supportedProfile[0].extension[0].url = "$ExpExt"
*rest.resource[1].supportedProfile[0].extension[0].valueCode = #SHALL
*rest.resource[1].interaction[0].code = #create
*rest.resource[1].interaction[0].extension[0].url = "$ExpExt"
*rest.resource[1].interaction[0].extension[0].valueCode = #SHALL
*rest.resource[1].interaction[1].code = #update
*rest.resource[1].interaction[1].extension[0].url = "$ExpExt"
*rest.resource[1].interaction[1].extension[0].valueCode = #SHALL
// Measure requirements
*rest.resource[1].type = #Measure
*rest.resource[1].extension[0].url = "$ExpExt"
*rest.resource[1].extension[0].valueCode = #SHALL
*rest.resource[1].supportedProfile[0] = "http://hl7.org/fhir/us/samer/StructureDefinition/PublicHealthMeasure"
*rest.resource[1].supportedProfile[0].extension[0].url = "$ExpExt"
*rest.resource[1].supportedProfile[0].extension[0].valueCode = #SHOULD
*rest.resource[1].interaction[0].code = #create
*rest.resource[1].interaction[0].extension[0].url = "$ExpExt"
*rest.resource[1].interaction[0].extension[0].valueCode = #SHOULD
*rest.resource[1].interaction[1].code = #update
*rest.resource[1].interaction[1].extension[0].url = "$ExpExt"
*rest.resource[1].interaction[1].extension[0].valueCode = #SHOULD
*rest.resource[1].interaction[2].type = #Location
*rest.resource[2].extension[0].url = "$ExpExt"
*rest.resource[2].extension[0].valueCode = #SHALL
*rest.resource[2].supportedProfile[0] = "http://hl7.org/fhir/us/samer/StructureDefinition/samer-resource-location"
*rest.resource[2].supportedProfile[0].extension[0].url = "$ExpExt"
*rest.resource[2].supportedProfile[0].extension[0].valueCode = #SHOULD
*rest.resource[2].interaction[0].code = #create
*rest.resource[2].interaction[0].extension[0].url = "$ExpExt"
*rest.resource[2].interaction[0].extension[0].valueCode = #SHOULD
*rest.resource[2].interaction[1].code = #update
*rest.resource[2].interaction[1].extension[0].url = "$ExpExt"
*rest.resource[2].interaction[1].extension[0].valueCode = #SHOULD
*rest.resource[2].interaction[2].type = #QuestionnaireResponse
*rest.resource[3].extension[0].url = "$ExpExt"
*rest.resource[3].extension[0].valueCode = #SHALL
*rest.resource[3].supportedProfile[0] = "http://hl7.org/fhir/us/samer/StructureDefinition/SamerQuestionnaireResponse"
*rest.resource[3].supportedProfile[0].extension[0].url = "$ExpExt"
*rest.resource[3].supportedProfile[0].extension[0].valueCode = #SHALL
*rest.resource[3].interaction[0].code = #create
*rest.resource[3].interaction[0].extension[0].url = "$ExpExt"
*rest.resource[3].interaction[0].extension[0].valueCode = #SHOULD
*rest.resource[3].interaction[1].code = #update
*rest.resource[3].interaction[1].extension[0].url = "$ExpExt"
*rest.resource[3].interaction[1].extension[0].valueCode = #SHOULD
*rest.resource[3].interaction[2].type = #QuestionnaireResponse
```

+ Parameterized RuleSets

```
Instance: TestCapabilityStatement3
InstanceOf: CapabilityStatement
* status = #active
* date = "2020-12-18"
* kind = #requirements
*fhirVersion = #4.0.1
*format[] = #json
*rest.mode = #server
// MeasureReport requirements
* insert SupportResource(@MeasureReport, #SHALL)
* insert SupportProfile("http://hl7.org/fhir/us/samer/StructureDefinition/PublicHealthMeasureReport", #SHALL)
* insert SupportInteraction(@create, #SHALL)
* insert SupportInteraction(@update, #SHALL)
// Measure requirements
* insert SupportResource(@Measure, #SHALL)
* insert SupportProfile("http://hl7.org/fhir/us/samer/StructureDefinition/PublicHealthMeasure", #SHOULD)
* insert SupportProfile("http://hl7.org/fhir/us/samer/StructureDefinition/PublicHealthMeasureStratifier", #SHOULD)
* insert SupportInteraction(@create, #SHOULD)
* insert SupportInteraction(@update, #SHOULD)
* insert SupportInteraction(@#location, #SHOULD)
* insert SupportProfile("http://hl7.org/fhir/us/samer/StructureDefinition/samer-resource-location", #SHOULD)
* insert SupportInteraction(@create, #SHOULD)
* insert SupportInteraction(@update, #SHOULD)
// QuestionnaireResponse requirements
* insert SupportResource(@QuestionnaireResponse, #SHALL)
* insert SupportProfile("http://hl7.org/fhir/us/samer/StructureDefinition/SamerQuestionnaireResponse", #SHALL)
* insert SupportInteraction(@create, #SHALL)
* insert SupportInteraction(@update, #SHALL)
```



Trophy available for purchase at
<https://www.trophies2go.com/catch-of-the-day-trout-trophy.html>



Preprocessed FSH (sushi -p)

```
> sushi -p myproject
```

FSH in /input/fsh

```
Alias: CAT = http://hl7.org/fhir/ValueSet/observation-category

Profile: ObservationProfile
Parent: Observation
* insert Metadata
* category from CAT (required)

RuleSet: Metadata
* ^version = "1.2.3"
* ^publisher = "Example publisher"

Instance: PatientInstance
InstanceOf: Patient
* name
  * given[+] = "John"
  * given[+] = "Q"
  * family = "Patient"
```

Preprocessed FSH in /_preprocessed

```
Alias: CAT = http://hl7.org/fhir/ValueSet/observation-category

// Originally defined on lines 3 - 6
Profile: ObservationProfile
Parent: Observation
Id: ObservationProfile
* ^version = "1.2.3"
* ^publisher = "Example publisher"
* category from http://hl7.org/fhir/ValueSet/observation-category (required)

// Originally defined on lines 12 - 17
Instance: PatientInstance
InstanceOf: Patient
Usage: #example
* name.given[0] = "John"
* name.given[1] = "Q"
* name.family = "Patient"
```

Resolved alias

Inserted RuleSet

Expanded paths

Explicit indices



Exercise: Tackling Tediosity



GOAL: Use RuleSets to create a FetchDocumentReference OperationDefinition

1. Review USCore FetchDocumentReference
2. Copy starter FSH code to your SUSHI project
3. Convert explicit indices to soft indices
4. Create & use a RuleSet for recurring rules

Starter FSH Code for Exercise: <https://bit.ly/fsh-docref-starter>

US Core FetchDocumentReference: <https://bit.ly/usc501-docref>

FHIR OperationDefinition: <https://bit.ly/fhir4-od>

FSH Soft Indexing: <https://bit.ly/fsh2-si>

FSH RuleSets: <https://bit.ly/fsh2-rs>

US Core FetchDocumentReference Parameters

Use	Name	Cardinality	Type	Binding	Documentation
IN	patient	1..1	id		The id of the patient resource located on the server on which this operation is executed. If there is no match, an empty Bundle is returned
IN	start	0..1	dateTime		The date range relates to care dates, not record currency dates - e.g. all records relating to care provided in a certain date range. If no start date is provided, all documents prior to the end date are in scope. If neither a start date nor an end date is provided, the most recent or current document is in scope. The client SHOULD provide values precise to the second + time offset.
IN	end	0..1	dateTime		The date range relates to care dates, not record currency dates - e.g. all records relating to care provided in a certain date range. If no end date is provided, all documents subsequent to the start date are in scope. If neither a start date nor an end date is provided, the most recent or current document is in scope. The client SHOULD provide values precise to the second + time offset.
IN	type	0..1	CodeableConcept	http://hl7.org/fhir/ValueSet/c80-document-typecodes (Required)	The type relates to document type e.g. for the LOINC code for a C-CDA Clinical Summary of Care (CCD) is 34133-9 (Summary of episode note). If no type is provided, the CCD document, if available, SHALL be in scope and all other document types MAY be in scope
IN	on-demand	0..1	boolean		This on-demand parameter allows client to dictate whether they are requesting only 'on-demand' or both 'on-demand' and 'stable' documents (or delayed/deferred assembly) that meet the query parameters
OUT	return	1..1	Bundle		The bundle type is "searchset" containing DocumentReference resources which SHOULD conform to the US Core DocumentReference Profiles



CARETS GO WELL WITH FSH

Fin-tastic job!



Using Caret Paths to Set Elements in StructureDefinition



Syntax for setting elements in StructureDefinition:

* ^<element of StructureDefinition> = {value}

```
Profile: PatientMetadata
Parent: Patient
Id: example-patient-metadata
Title: "Patient Metadata Profile"
Description: "Demonstrates setting metadata"
* ^version = "0.0.1"
* ^status = #draft
* ^experimental = true
* ^date = 2021-09-30
* ^contact.name = "Shorty the FSH Fish"
```

A screenshot of the SUSHI configuration code. The 'version' element is highlighted with a red box. A red arrow points from this element to the corresponding element in the FHIR StructureDefinition JSON schema.

SUSHI

```
{ "resourceType": "StructureDefinition", "id": "example-patient-metadata", "extension": [ ], "url": "http://example.org/StructureDefinition/example-patient-metadata", "version": "0.0.1", "name": "PatientMetadata", "title": "Patient Metadata Profile", "status": "draft", "experimental": true, "date": "2021-09-30", "contact": [ { "name": "Shorty the FSH Fish" } ], "description": "Demonstrates setting metadata", "fhirVersion": "4.0.1", "mapping": [ ], "kind": "resource", "abstract": false, "type": "Patient", "baseDefinition": "http://hl7.org/FHIR/StructureDefinition/Patient", "derivation": "constraint", "differential": { } }
```

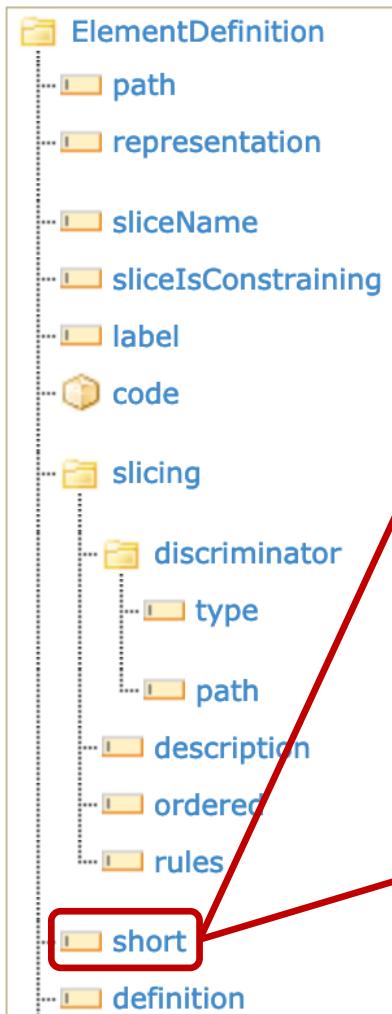
A screenshot of the IG Publisher interface. The 'Version' field is highlighted with a red box. A red arrow points from this field to the corresponding element in the FHIR StructureDefinition JSON schema.

IG Publisher

2.16.1 Resource Profile: Patient Metadata Profile	
Defining URL:	http://example.org/StructureDefinition/example-patient-metadata
Version:	0.1.0
Name:	PatientMetadata
Title:	Patient Metadata Profile
Status:	Draft as of 2021-09-30
Definition:	Demonstrates setting metadata
Publisher:	Example Publisher
Source Resource:	XML / JSON / Turtle



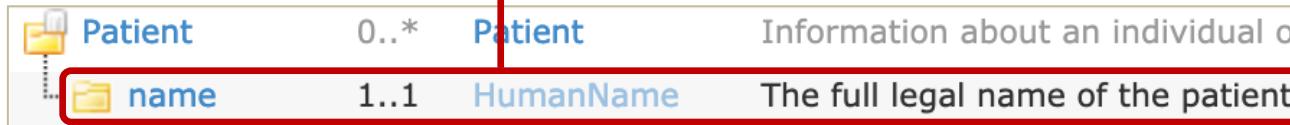
Using Caret Paths to Set Elements in ElementDefinition



Syntax for setting elements in ElementDefinition:

```
* <element> ^<element of ElementDefinition> = {value}
```

Profile: PatientNameMetadata
Parent: Patient
Id: example-patient-name-metadata
* name 1..1
* name ^short = "The full legal name of the patient"
* name ^definition = "Although the patient may have multiple..."



SUSHI

```
"differential": {  
  "element": [  
    {  
      "id": "Patient.name",  
      "path": "Patient.name",  
      "short": "The full legal name of the patient",  
      "definition": "Although the patient may have multiple...",  
      "min": 1,  
      "max": "1"  
    }  
  ]  
}
```

IG Publisher

Use special dot path to represent the “self” element

Profile: PatientRootElementMetadata
Parent: Patient
Id: example-patient-root-metadata
* . ^short = "A patient from the course on authoring FHIR Implementation Guides"
* . ^definition = "Patients who attend FHIR IG courses have characteristics..."



SUSHI

```
"differential": {  
  "element": [  
    {  
      "id": "Patient",  
      "path": "Patient",  
      "short": "A patient from the course on authoring FHIR Implementation Guides",  
      "definition": "Patients who attend FHIR IG courses have characteristics...",  
    }  
  ]  
}
```

IGP



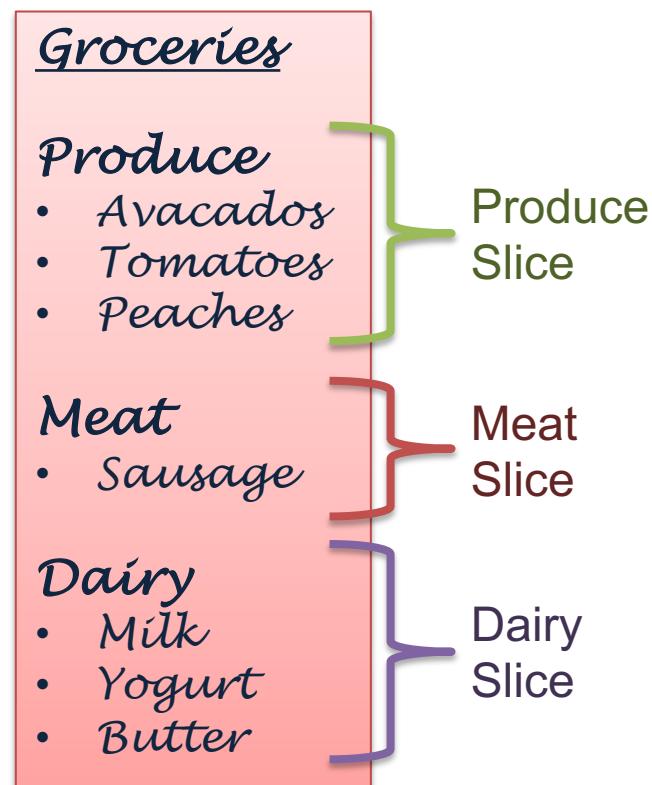
SLICING (WITHOUT LOSING A FINGER)

You're pirhana roll!

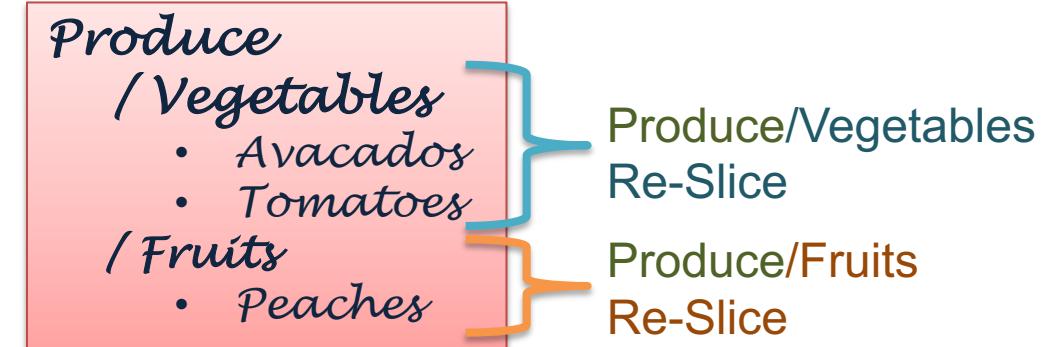


Slicing: Defining & Constraining Sub-Lists

Slicing allows you to split a list into one or more sub-lists (*slices*)



- Slices must be mutually exclusive
 - Sort items into slices using discriminators
 - Apply different constraints to each slice
 - Optionally require slices to be in order
 - Optionally allow items that don't fit in any slice
-
- Re-slice to support sub-sub-lists (*expert level*)



Slicing Element in ElementDefinition

slicing	Σ I	0..1	Element	This element is sliced - slices follow + Rule: If there are no discriminators, there must be a definition
discriminator	Σ	0..*	Element	Element values that are used to distinguish the slices
type	Σ	1..1	code	value exists pattern type profile DiscriminatorType (Required)
path	Σ	1..1	string	Path to element value
description	Σ I	0..1	string	Text description of how slicing works (or not)
ordered	Σ	0..1	boolean	If elements must be in same order as slices
rules	Σ	1..1	code	closed open openAtEnd SlicingRules (Required)

Understanding **slicing.discriminator.type**:

- **value**: match if the value is exactly the same as the value* in the slice
- **pattern**: match if the value fits the pattern* in the slice
- **exists**: match based on the presence or absence of the element
- **type**: match if the element has the same type as the element in the slice
- **profile**: match if the element has the same profile as the element in the slice

* or is a member of the value set



Real World Slicing: US Core Blood Pressure

systolic slice

Slices for component		S	2..*	BackboneElement	Component observations
component:systolic		S	1..1	BackboneElement	Slice: Unordered, Open by pattern:code
code		S	1..1	CodeableConcept	Systolic Blood Pressure
coding			1..*	Coding	Systolic Blood Pressure Code
system			1..1	uri	Required Pattern: At least the following
code			1..1	code	Code defined by a terminology system
Fixed Value:	(complex)				Fixed Value: (complex)
Identity of the terminology system					Identity of the terminology system
Fixed Value:	http://loinc.org				Fixed Value: http://loinc.org
Symbol in syntax defined by the system					Symbol in syntax defined by the system
Fixed Value:	8480-6				Fixed Value: 8480-6
valueQuantity		S	0..1	Quantity	Vital Sign Component Value
value		S	1..1	decimal	Numerical value (with implicit precision)
unit		S	1..1	string	Unit representation
system		S	1..1	uri	System that defines coded unit form
code		S	1..1	code	Fixed Value: http://unitsofmeasure.org
Coded form of the unit					Coded form of the unit
Fixed Value:	http://unitsofmeasure.org				Fixed Value: http://unitsofmeasure.org
Diastolic Blood Pressure					Diastolic Blood Pressure
component:diastolic		S	1..1	BackboneElement	
code		S	1..1	CodeableConcept	Diastolic Blood Pressure Code
coding			1..*	Coding	Required Pattern: At least the following
system			1..1	uri	Code defined by a terminology system
code			1..1	code	Fixed Value: (complex)
Identity of the terminology system					Identity of the terminology system
Fixed Value:	http://loinc.org				Fixed Value: http://loinc.org
Symbol in syntax defined by the system					Symbol in syntax defined by the system
Fixed Value:	8462-4				Fixed Value: 8462-4
valueQuantity		S	0..1	Quantity	Vital Sign Component Value
value		S	1..1	decimal	Numerical value (with implicit precision)
unit		S	1..1	string	Unit representation
system		S	1..1	uri	System that defines coded unit form
code		S	1..1	code	Fixed Value: http://unitsofmeasure.org
Coded form of the unit					Coded form of the unit
Fixed Value:	http://unitsofmeasure.org				Fixed Value: http://unitsofmeasure.org
mm[Hg]					mm[Hg]

diastolic slice

Slice the Observation.component list by pattern on code

systolic code = LOINC 8480-6
(discriminator)

systolic units = UCUM mm[Hg]

diastolic code = LOINC 8462-4
(discriminator)

diastolic units = UCUM mm[Hg]



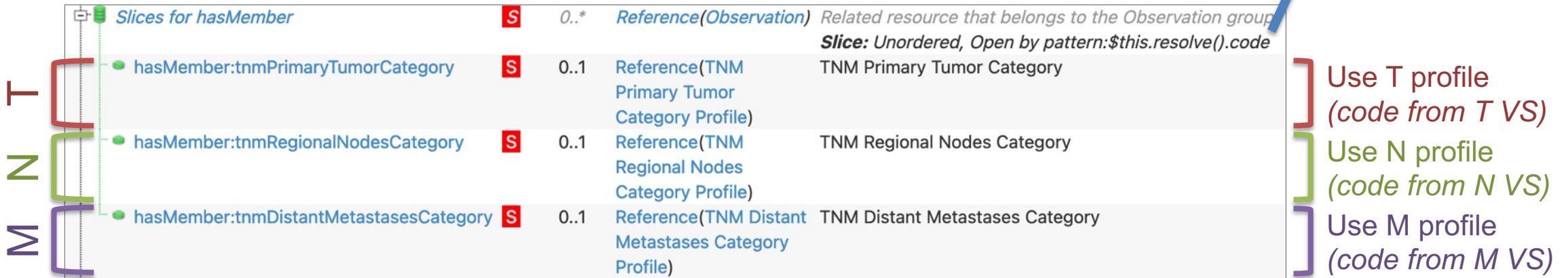
Real World Slicing: US Core Practitioner

Slice the Practitioner.identifier list By pattern on \$this (identifier)				
NPI	<i>Slices for identifier</i>	S	1..*	<i>Identifier</i>
	identifier:All Slices			An identifier for the person as this agent Slice: Unordered, Open by pattern:\$this Content/Rules for all slices
	system	S	1..1	uri The namespace for the identifier value
	value	S	1..1	string The value that is unique
	identifier:NPI	S	0..1	Identifier An identifier for the person as this agent Required Pattern: At least the following The namespace for the identifier value Fixed Value: http://hl7.org/fhir/sid/us-npi
	system		1..1	uri



Real World Slicing: mCODE Cancer Stage Group

Slice the Observation.hasMember list
By pattern on \$this.resolve().code

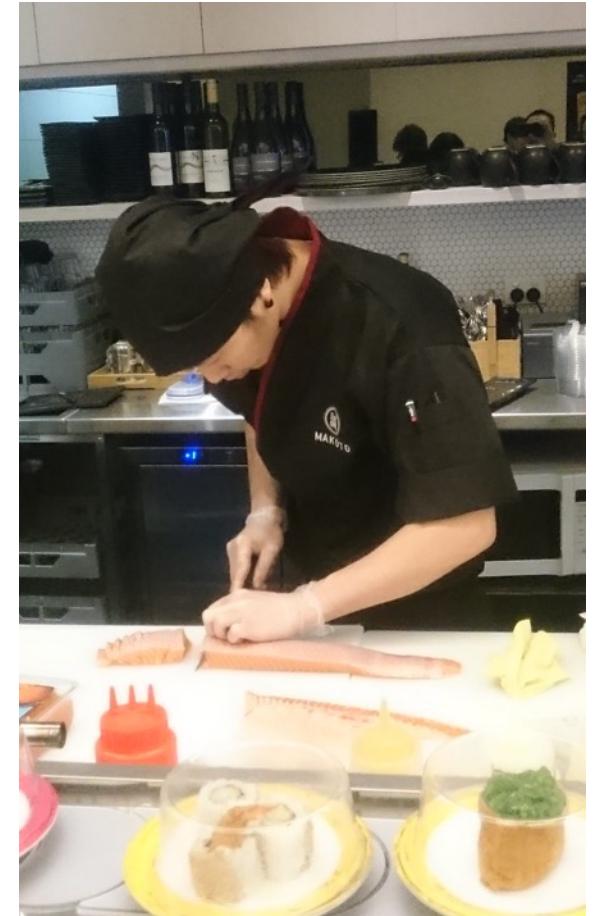


T: Primary Tumor Category
N: Regional Nodes Category
M: Distant Metastases Category



Slicing with FSH in Three Steps

1. Define the slicing logic
2. Identify the slices
3. Define each slice



Slicing Step 1: Define the Slicing Logic

Slicing logic elements defined in ElementDefinition:

slicing	Σ I	0..1	Element	This element is sliced - slices follow + Rule: If there are no discriminators, there must be a definition
discriminator	Σ	0..*	Element	Element values that are used to distinguish the slices
type	Σ	1..1	code	value exists pattern type profile DiscriminatorType (Required)
path	Σ	1..1	string	Path to element value
description	Σ I	0..1	string	Text description of how slicing works (or not)
ordered	Σ	0..1	boolean	If elements must be in same order as slices
rules	Σ	1..1	code	closed open openAtEnd SlicingRules (Required)

FSH example of Blood Pressure slicing logic:

```
// Step 1: Define the slicing logic
* component ^slicing.discriminator.type = #pattern // or #value, #profile
* component ^slicing.discriminator.path = "code"    // any FHIRPath expression
* component ^slicing.rules = #open     // additional elements are ok
* component ^slicing.ordered = false   // by default, array elements in any order
* component ^slicing.description = "Slice pattern for component.code" // optional
```



Slicing Step 2: Identify the Slices

Component slices in Blood Pressure profile:



element:sliceName

FSH example of identifying component slices in Blood Pressure profile:

```
// Step 2: Identify the slices
* component contains
    systolic 1..1 and // each slice is identified by name, card, & optional flags
    diastolic 1..1      // using "and" to separate each slice identification
```



Slicing Step 3: Define Each Slice

Component slices in Blood Pressure profile:

Slices for component		2..*	BackboneElement	Component results Slice: Unordered, Open by pattern:code
component:systolic		1..1	BackboneElement	Component results
code		1..1	CodeableConcept	Type of component observation (code / type) Required Pattern: At least the following
coding		1..*	Coding	Code defined by a terminology system Fixed Value: (complex)
system		1..1	uri	Identity of the terminology system Fixed Value: http://loinc.org
code		1..1	code	Symbol in syntax defined by the system Fixed Value: 8480-6
value[x]		0..1	Quantity	Actual component result Required Pattern: At least the following
system		1..1	uri	System that defines coded unit form Fixed Value: http://unitsofmeasure.org
code		1..1	code	Coded form of the unit Fixed Value: mm[Hg]

Discriminator element

FSH example of identifying component slices in Blood Pressure profile:

```
// Step 3: Define each slice: systolic
* component[systolic].code = $LNC#8480-6 // LNC#8480-6 distinguishes the slice
* component[systolic].value[x] only Quantity
* component[systolic].value[x] = $UCUM#mm[Hg]
```



Slicing Steps 1-3



```
Profile: BloodPressureProfile
Id: example-bp
Parent: Observation
Title: "Blood Pressure"
Description: "An example blood pressure profile"
* code = $LNC#85354-9

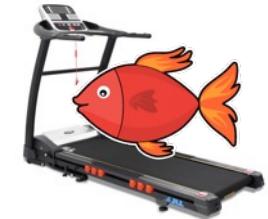
// Step 1: Define the slicing logic
* component ^slicing.discriminator.type = #pattern // or #value, #profile
* component ^slicing.discriminator.path = "code" // any FHIRPath expression
* component ^slicing.rules = #open // additional elements are ok
* component ^slicing.ordered = false // by default, array elements in any order
* component ^slicing.description = "Slice pattern for component.code" // optional

// Step 2: Identify the slices
* component contains
    systolic 1..1 and // each slice is identified by name, card, & optional flags
    diastolic 1..1 // using "and" to separate each slice identification

// Step 3: Define each slice: systolic
* component[systolic].code = $LNC#8480-6 // LNC#8480-6 distinguishes the slice
* component[systolic].value[x] only Quantity
* component[systolic].value[x] = $UCUM#mm[Hg]

// Step 3: Define each slice: diastolic
* component[diastolic].code = $LNC#8462-4 // LNC#8462-4 distinguishes the slice
* component[diastolic].value[x] only Quantity
* component[diastolic].value[x] = $UCUM#mm[Hg]
```

Exercise: Slicing



GOAL: Define and use a partial Continuity of Care Document (CCD)

1. Copy starter FSH code to your SUSHI project
2. Edit PartialCCD to slice *section* into 3 slices
3. Edit PartialCCDExample to add section data

Starter FSH Code for Exercise: <https://bit.ly/fsh-ccd-starter>

FHIR Composition: <https://bit.ly/fhir4-comp>

FSH Contains Rules for Slicing: <https://bit.ly/fsh2-contains>

FSH Sliced Array Paths: <https://bit.ly/fsh2-sap>

FSH Type Rules: <https://bit.ly/fsh2-type>

Section	LOINC	Entry Reference
allergies	48765-2	AllergyIntolerance
medications	10160-0	MedicationRequest
problems	11450-4	Condition



COOKIE TIME!



~~FIN~~VARIANTS INVARIANTS

That went swimmingly!



Why Use Invariants?

Invariants use FHIRPath to define logical constraints over one or more elements

- Best used when you can't express the criteria using other constraints
- Allows for two levels of severity: *error* or *warning*

Id	Path	Details
us-core-2	Observation	If there is no component or hasMember element then either a value[x] or a data absent reason must be present <code>: (component.empty() and hasMember.empty()) implies (dataAbsentReason.exists() or value.exists())</code>

Top-level Invariant
on Observation

[FHIRPath](#)

Id	Path	Details
pat-1	Patient.contact	SHALL at least contain a contact's details or a reference to an organization <code>: name.exists() or telecom.exists() or address.exists() or organization.exists()</code>

Element-level Invariant
on Patient.contact

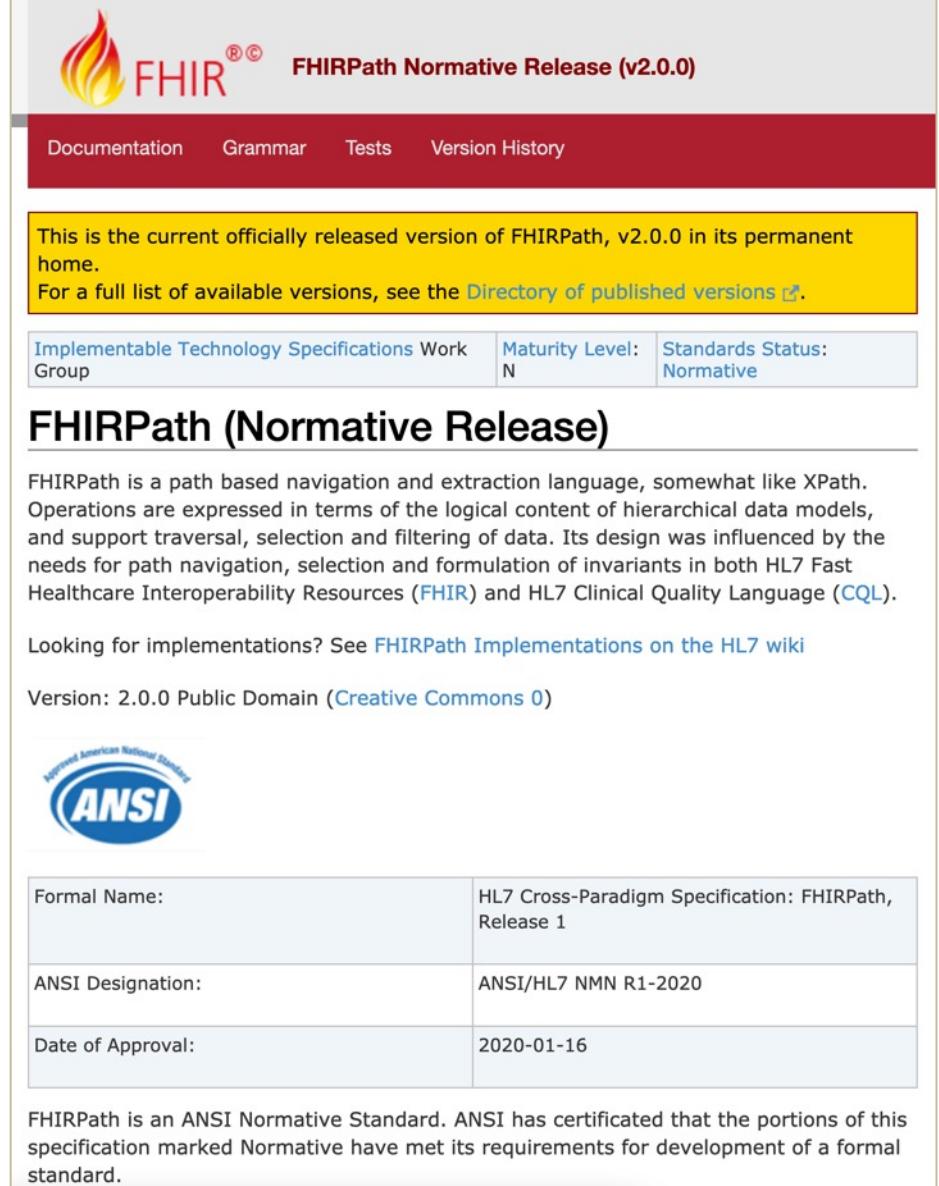
[FHIRPath](#)



FHIRPath

- Path-based navigation and extraction
- Not specific to FHIR (despite the name)
- Two specs of interest for FHIR users:
 - **FHIRPath Specification:** Core FHIRPath spec
 - **FHIR Specification:** How to use FHIRPath in FHIR
- Primary use cases for IGs:
 - Defining slice discriminators*
 - Defining invariants
 - Defining search parameters

* Limited to a restricted subset of FHIRPath (“Simple” FHIRPath)



The screenshot shows the FHIRPath Normative Release (v2.0.0) website. At the top right is the FHIR logo. To its right, the text "FHIRPath Normative Release (v2.0.0)" is displayed. Below the header is a red navigation bar with links: Documentation, Grammar, Tests, and Version History. A yellow callout box contains the text: "This is the current officially released version of FHIRPath, v2.0.0 in its permanent home. For a full list of available versions, see the [Directory of published versions](#).
Implementable Technology Specifications Work Group Maturity Level: N Standards Status: Normative". Below this is a section titled "FHIRPath (Normative Release)". It describes FHIRPath as a path based navigation and extraction language, influenced by HL7 Fast Healthcare Interoperability Resources (FHIR) and HL7 Clinical Quality Language (CQL). It also mentions FHIRPath Implementations on the HL7 wiki and the fact that it is a 2.0.0 Public Domain (Creative Commons 0). An ANSI logo is shown with the text "Approved American National Standard" and "ANSI". A table provides formal details:

Formal Name:	HL7 Cross-Paradigm Specification: FHIRPath, Release 1
ANSI Designation:	ANSI/HL7 NMN R1-2020
Date of Approval:	2020-01-16

FHIRPath is an ANSI Normative Standard. ANSI has certified that the portions of this specification marked Normative have met its requirements for development of a formal standard.



FHIRPath Basics: Path Navigation

- Path navigation is accomplished by concatenating element names
- Result is *always* a list (even for 0..1 / 1..1 elements)

Example results for FHIRPath expression: **Patient.name.given** (or simply **name.given**)

```
"name": [{  
    "given": [ "Jan" ],  
    "family": "Jansen"  
}]
```

```
"name": [{  
    "given": [ "John", "Jacob", "Jingleheimer" ],  
    "family": "Schmidt"  
}]
```

```
"name": [{  
    "given": [ "Jan" ],  
    "family": "Jansen"  
}, {  
    "given": [ "John", "Jacob", "Jingleheimer" ],  
    "family": "Schmidt"  
}]
```

name.given

name.given

name.given

```
[  
    "Jan"  
]
```

```
[  
    "John",  
    "Jacob",  
    "Jingleheimer"  
]
```

```
[  
    "Jan",  
    "John",  
    "Jacob",  
    "Jingleheimer"  
]
```



FHIRPath Basics: Common Expressions

Choose a specific choice type using “as”

```
Observation.value as Quantity
```

Check existence using “.exists()”

```
Observation.component.exists()
```

Query a list using “.where(...)”

```
Patient.telecom.where(use = 'mobile')
```

Specify causal relationships using “implies”

```
MedicationAdministration.status = 'not-done'  
| implies MedicationAdministration.statusReason.exists()
```

Keywords:

\$index	milliseconds
\$this	minute
\$total	minutes
and	mod
as	month
contains	months
day	or
days	second
div	seconds
false	true
hour	week
hours	weeks
implies	xor
in	year
is	years
	millisecond



FHIR-Specific FHIRPath: Common Expressions

Select extensions using “extension(…)”

```
Patient.extension('http://hl7.org/fhir/StructureDefinition/patient-birthPlace')
```

Resolve references using “resolve()”

```
Encounter.reasonReference.resolve().exists($this is FHIR.Condition)
```

Check profile conformance using “conformsTo(…)”

```
Practitioner.conformsTo('http://hl7.org/fhir/us/core/StructureDefinition/us-core-practitioner')
```

Check value set membership using “memberOf(…)”

```
Procedure.reasonCode.memberOf('http://hl7.org/fhir/us/mcode/ValueSet/mcode-cancer-disorder-vs')
```



Defining Invariants in FHIR Shorthand

FSH Keyword	Usage	Element in ElementDefinition	Data Type	Required
Invariant	Identifier	constraint.key	id	Yes
Severity	#error or #warning	constraint.severity	code	Yes
Description	Human description of constraint	constraint.human	string	Yes
Expression	FHIRPath expression of constraint	constraint.expression	FHIRPath string	No
XPath	XPath expression of constraint	constraint.xpath	Xpath string	No

Syntax for Applying Invariants (obeys):

- * obeys {Invariant}
 - * obeys {Invariant} and {Invariant2} and ...
 - * <element> obeys {Invariant}
 - * <element> obeys {Invariant} and {Invariant2}
- and ...

Example using FHIR R4 Patient.contact

```
Invariant: pat-1
Severity: #error
Description: "SHALL at least contain a contact's details or a reference to an organization"
Expression: "name.exists() or telecom.exists() or address.exists() or organization.exists()"
XPath: "exists(f:name) or exists(f:telecom) or exists(f:address) or exists(f:organization)"
```

```
Profile: PatientWithContactInvariant
Id: example-patient-w-contact-invariant
Parent: Patient
* contact obeys pat-1
```



L... contact I 0..*	BackboneElement	A contact party (e.g. guardian, partner, friend) for the patient
pat-1	Patient.contact	SHALL at least contain a contact's details or a reference to an organization : name.exists() or telecom.exists() or address.exists() or organization.exists()



Testing & Debugging FHIRPath

- FHIRPath Lab (New!)
 - Test and explore FHIRPath from multiple sources
 - Choose from four FHIRPath implementations
 - <https://fhirpath-lab.azurewebsites.net/>
- FHIRPath.js Test App
 - Test FHIRPath against arbitrary JSON/YAML
 - Uses JavaScript FHIRPath implementation
 - <https://hl7.github.io/fhirpath.js/>
- IG Publisher / Validator
 - Flags instances that fail FHIRPath-based invariants
 - Testing and debugging is possible via trial and error
 - Uses Java (HAPI) FHIRPath implementation

The screenshot shows the FHIRpath Lab interface. On the left, there's a sidebar with 'Patient/example' and a 'TRACE' button. The main area has tabs for 'fx EXPRESSION' and 'RESULTS'. In the 'fx EXPRESSION' tab, the input is 'name' and the FHIRpath Expression is 'trace('trc').given'. In the 'RESULTS' tab, the output is a list of names: Peter, James, Jim, Peter, and James. To the right, there's a 'Test Resource Id' section with 'Patient/example' and a 'Test Resource JSON' section containing a patient resource. At the bottom, it says 'Terminology Server' with the URL 'https://sqlonfhir-r4.azurewebsites.net/fhir'.

```
1- {
2-   "resourceType": "Patient",
3-   "id": "example",
4-   "meta": {
5-     "versionId": "14",
6-     "lastUpdated": "2021-12-09T09:03:14
.0632036+00:00"
7-   },
8-   "text": { },
12-   "identifier": { },
13-   "active": true,
14-   "name": [
15-     {
16-       "use": "official",
17-       "text": "Chalmers, Peter James",
18-       "family": "Chalmers",
19-       "given": [
20-         "Peter",
21-         "James"
22-       ]
23-     },
24-     {
25-       "use": "usual",
26-       "text": "Jim",
27-       "given": [
28-         "Jim"
29-       ]
30-     },
31-     {
32-       "use": "maiden",
33-       "text": "Chalmers, Peter James"
34-     }
35-   ]
36- }
```



INTENSIONAL VALUE SETS

You are dolphinitely doing great!



Value Sets (Review)

- Value Sets define a set of codes for a purpose
 - Codes can be drawn from one or more Code Systems
- Value Sets are *intentional* or *extensional*
 - **Intensional:** defined by algorithms; dynamically updated.
 - **Extensional:** defined code-by-code; manually updated.
- Value Set composition can *include* or *exclude* codes
- Value Set expansion uses the Value Set composition to produce a fully enumerated set of codes

HINT: Authors should prefer intensional composition for large Value Sets since extensional Value Sets can be hard to maintain.

10.117.1 ValueSet: Detailed ethnicity

Summary

Defining URL:	http://hl7.org/fhir/us/core/ValueSet/detailed-ethnicity
Version:	4.0.0
Name:	DetailedEthnicity
Title:	Detailed ethnicity
Status:	Active as of 2019-05-21
Definition:	The 41 CDC ethnicity codes that are grouped under one of the 2 OMB ethnicity category codes.
Publisher:	HL7 International - US Realm Steering Committee
Copyright:	Used by permission of HL7 International, all rights reserved Creative Commons License
Source Resource:	XML / JSON / Turtle

References

- [US Core Ethnicity Extension](#)

10.117.1.1 Logical Definition (CLD)

This value set includes codes based on the following rules:

- Include codes from [urn:oid:2.16.840.1.113883.6.238](#) where concept is-a [2133-7](#)

This value set excludes codes based on the following rules:

- Exclude these codes as defined in [urn:oid:2.16.840.1.113883.6.238](#)

Code	Display	Definition
2135-2	Hispanic or Latino	Hispanic or Latino
2186-5	Not Hispanic or Latino	Note that this term remains in the table for completeness, even though within HL7, the notion of "not otherwise coded" term is deprecated.

10.117.1.2 Expansion

This value set contains 42 concepts

Expansion based on [Race & Ethnicity - CDC v4.0.0 \(CodeSystem\)](#)

All codes from system [urn:oid:2.16.840.1.113883.6.238](#)

Code	Display	Definition
2133-7	Ethnicity	Ethnicity Note that this is an abstract 'grouping' concept and not for use as a real concept
2137-8	Spaniard	Spaniard
2148-5	Mexican	Mexican
2155-0	Central American	Central American

US Core Detailed Ethnicity (Partial Screenshot)



Defining Value Sets in FSH

FSH Keyword	Usage	Element in ValueSet	Data Type	Required
ValueSet	Name of the value set	name	name	Yes
Id	Identifier of the value set	id	id	No
Title	Title of the value set	title	string	No
Description	Human-readable description	description	string	No

Example Extensional Value Set

```
ValueSet: OmbEthnicityCategories
Id: example-omb-ethnicity-categories
Title: "OMB Ethnicity Categories"
Description: "The codes for the ethnicity categories..."
* $CDC_RACE_ETHN#2135-2 "Hispanic or Latino"
* $CDC_RACE_ETHN#2186-5 "Non Hispanic or Latino"
```

2.23.1 ValueSet: OMB Ethnicity Categories

Summary

Defining URL:	http://example.org/ValueSet/example-omb-ethnicity-categories
Version:	0.1.0
Name:	OmbEthnicityCategories
Title:	OMB Ethnicity Categories
Status:	Active as of 2021-09-24T21:40:03-04:00
Definition:	The codes for the ethnicity categories...
Publisher:	Example Publisher
Source Resource:	XML / JSON / Turtle

References

- [Ethnicity Extension](#)

2.23.1.1 Logical Definition (CLD)

- Include these codes as defined in [urn:oid:2.16.840.1.113883.6.238](#)

Code	Display	Definition
2135-2	Hispanic or Latino	Hispanic or Latino
2186-5	Non Hispanic or Latino	Note that this term remains in the table for completeness, even though within HL7, the notion o



Value Set Rules

Include or exclude individual codes

- * \$SCT#1149162008 "International Staging System for multiple myeloma (staging scale)"
- * include \$SCT#1149162008 "International Staging System for multiple myeloma (staging scale)"
- * exclude \$SCT#42114005 "Walter Reed stage 1 (tumor staging)"

Include or exclude entire code systems

- * include codes from system <http://www.cms.gov/Medicare/Coding/ICD10>
- * exclude codes from system <http://www.ama-assn.org/go/cpt>

Include or exclude entire value sets

- * include codes from valueset BodyLocationAndLateralityQualifierVS
- * exclude codes from valueset LateralityQualifierVS

NOTE: As shown above, you can refer to code systems and value sets using URL, alias, name, or id.



Value Set Rules: Unions & Intersections

Use multiple include rules to specify a *union*

```
// Include all codes from TeleradiotherapyModalityVS and BrachytherapyModalityVS
* include codes from valueset TeleradiotherapyModalityVS
* include codes from valueset BrachytherapyModalityVS
```

Use one include rule with “and” to specify an *intersection*

```
// Include only codes that UnitsOfTime and AgeUnits have in common
* include codes from valueset $UnitsOfTime and $AgeUnits
```

```
// Include only SNOMED codes from ImmunizationStatusReason
* include codes from system $SCT and valueset $ImmunizationStatusReason
```



Value Set Rules: Filters

Filters specify codes using *system-specific* expressions

```
* include codes from system {CodeSystem} where {filter1} and {filter2}...
// where each filter has syntax {property} {operator} {value}
```

Example of a filter rule using SNOMED-CT

```
* include codes from system $SCT where concept is-a #123037004 "Body Structure"
```

system-specific
property

system-allowed
operator

system-specific
value



FHIR-defined Filter Operators

From filter-operator value set documentation (<http://hl7.org/fhir/valueset-filter-operator.html>)

Code	Display	Definition
=	Equals	The specified property of the code equals the provided value.
is-a	Is A (by subsumption)	Includes all concept ids that have a transitive is-a relationship with the concept Id provided as the value, including the provided concept itself (include descendant codes and self).
descendent-of	Descendent Of (by subsumption)	Includes all concept ids that have a transitive is-a relationship with the concept Id provided as the value, excluding the provided concept itself i.e. include descendant codes only).
is-not-a	Not (Is A) (by subsumption)	The specified property of the code does not have an is-a relationship with the provided value.
regex	Regular Expression	The specified property of the code matches the regex specified in the provided value.
in	In Set	The specified property of the code is in the set of codes or concepts specified in the provided value (comma separated list).
not-in	Not in Set	The specified property of the code is not in the set of codes or concepts specified in the provided value (comma separated list).
generalizes	Generalizes (by Subsumption)	Includes all concept ids that have a transitive is-a relationship from the concept Id provided as the value, including the provided concept itself (i.e. include ancestor codes and self).
exists	Exists	The specified property of the code has at least one value (if the specified value is true; if the specified value is false, then matches when the specified property of the code has no values).

NOTE: Most code systems only support a subset of filter operators.



Hint: Check “Using {CodeSystem}” for valid filters

From “Using SNOMED CT with FHIR” (<http://hl7.org/fhir/snomedct.html>)

4.3.1.0.8 SNOMED CT Filters

This section documents the property filters that can be used with the SNOMED CT code system in value set composition. These property filters are documented in terms of the [SNOMED CT Expression Constraint Language](#), but this does not imp

4.3.1.0.8.1 By Subsumption

Description	Select a set of concepts based on subsumption testing
Property Name	concept
Operations Allowed	is-a
Values Allowed	[concept id]
Comments	Includes all concept ids that have a transitive is-a relationship with the concept id provided as the value (including the concept itself)
Example	Administration Methods
SCT ECL	<< [concept] (Long syntax: descendantOrSelfOf [concept])

4.3.1.0.8.2 By Reference Set

Description	Select a set of concepts based on their membership of a SNOMED CT reference set
Property Name	concept
Operations Allowed	in
Values Allowed	[concept id]
Comments	Includes all concept ids that are active members of the reference set identified by the concept id provided as the value
SCT ECL	^ [concept] (Long syntax: memberOf [concept])

Property Name	concept
Operations Allowed	is-a
Values Allowed	[concept id]

Property Name	concept
Operations Allowed	in
Values Allowed	[concept id]



Review of Value Set Rules

- * \$SCT#1149162008 "International Staging System for multiple myeloma (staging scale)"
 - * include \$SCT#1149162008 "International Staging System for multiple myeloma (staging scale)"
 - * exclude \$SCT#42114005 "Walter Reed stage 1 (tumor staging)"
-
- * include codes from system <http://www.cms.gov/Medicare/Coding/ICD10>
 - * exclude codes from system <http://www.ama-assn.org/go/cpt>
-
- * include codes from valueset BodyLocationAndLateralityQualifierVS
 - * exclude codes from valueset LateralityQualifierVS
-
- * include codes from valueset \$UnitsOfTime and \$AgeUnits
-
- * include codes from system \$SCT and valueset \$ImmunizationStatusReason
-
- * include codes from system \$SCT where concept is-a #123037004 "Body Structure"

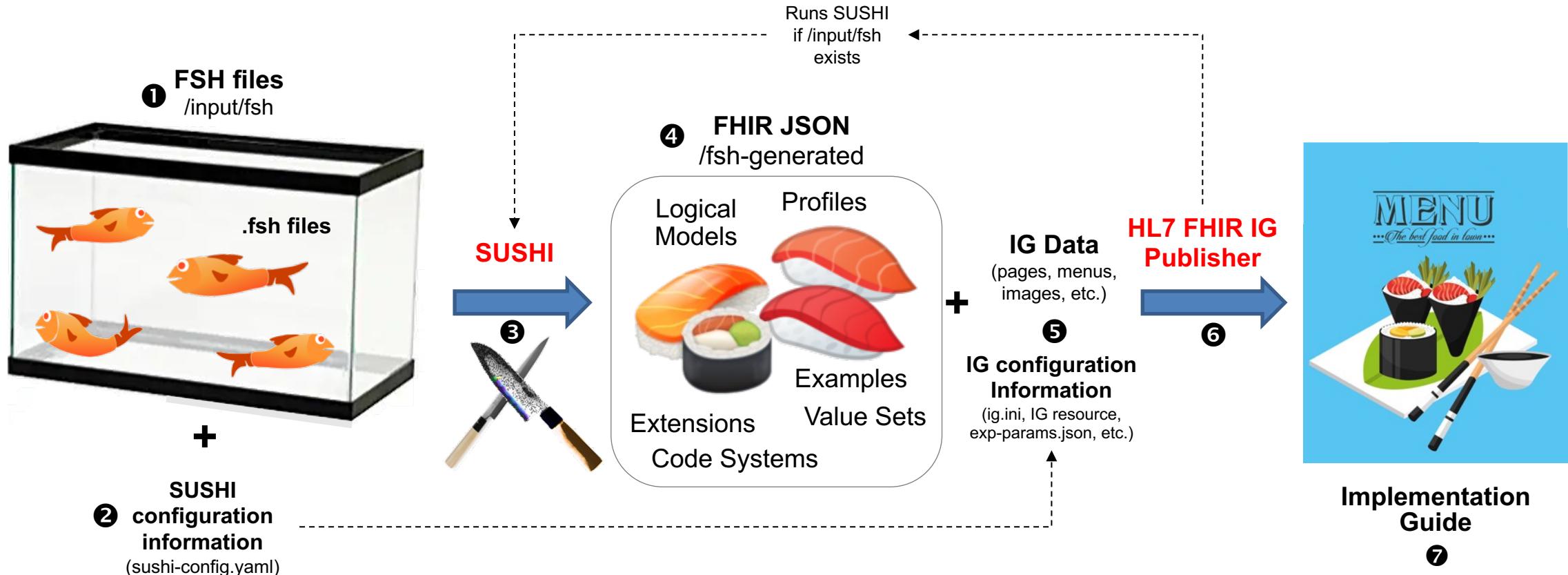


IG CONFIGURATION

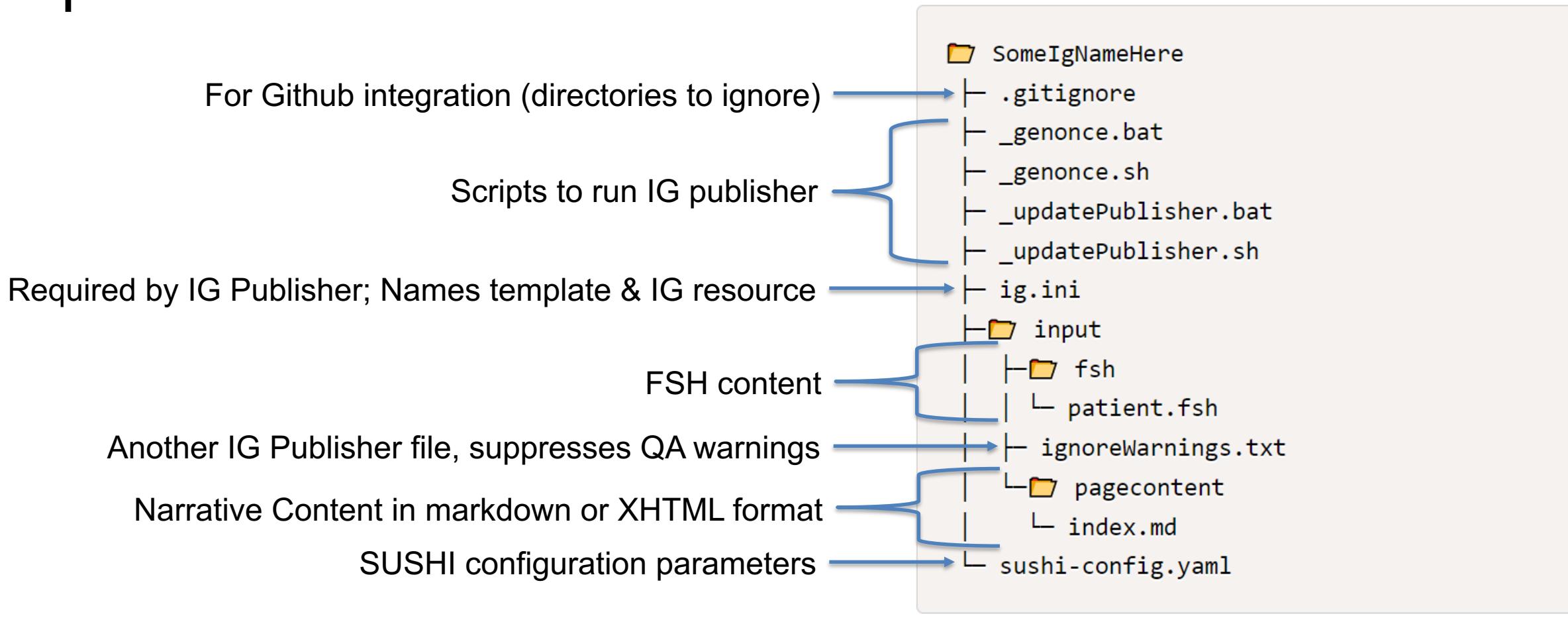
Ac-clam-ations!



Overview of FSH Publishing Workflow



Minimal SUSHI IG Project Directory Structure



publisher.jar goes in input-cache
directory (not shown)



Configuration: sushi-config.yaml

- Configuration defined by `sushi-config.yaml` in root of project
- `sushi-config.yaml` is in YAML format
 - White space (new lines and indentation) is significant
 - Information is presented in `key:value` pairs
 - Strings don't have to be quoted unless they contain reserved characters
 - Items in arrays (a.k.a. sequences) have a preceding “-”
- Properties and values *loosely* follow `ImplementationGuide` resource
 - All properties in `ImplementationGuide` are accessible in `sushi-config.yaml`
 - Some property names and formats are optimized for user-friendly access
 - Additional (non-IG) properties are available to specify SUSHI behavior



Minimal sushi-config.yaml for IG

```
id: fhir.us.example
canonical: http://hl7.org/fhir/us/example
name: ExampleIG
status: draft
version: 0.1.0
fhirVersion: 4.0.1
copyrightYear: 2022+
releaseLabel: ci-build
```

Status

draft
active
retired
unknown

ReleaseLabel

ci-build
draft
qa-preview
ballot
trial-use
release
update
normative+trial-use



Recommended sushi-config.yaml for IG

```
id: fhir.us.example
canonical: http://hl7.org/fhir/us/example
name: ExampleIG
title: "HL7 FHIR Implementation Guide: Example IG Release 1 - US Realm | STU1"
description: An example IG that exercises many of the fields in a SUSHI configuration
status: draft
license: CC0-1.0
version: 0.1.0
fhirVersion: 4.0.1
copyrightYear: 2022+
releaseLabel: ci-build
publisher:
  name: HL7 International - US Realm Steering Committee
  url: http://www.hl7.org/Special/committees/usrealm/index.cfm
  email: usrsc@lists.HL7.org
dependencies:
  hl7.fhir.us.core: 5.0.1
```



Configuration: IG Parameters

Control IG Publisher behavior using IG parameters

- E.g., apply, logging, special-url, suppressed-ids, validation, ...
- Use *key:value* pairs in `sushi-config.yaml`, where parameter code is the key
- As of Sep 2022, allowed parameters are now specified in two code systems:
 - <http://build.fhir.org/valueset-guide-parameter-code.html>
 - <http://build.fhir.org/ig/FHIR/fhir-tools-ig/branches/master/CodeSystem-ig-parameters.html>

```
parameters:  
  excludttl: true  
  validation: [allow-any-extensions, no-broken-links]  
  show-inherited-invariants: false
```



Configuration: SUSHI-specific Properties

```
# The FSHOnly flag indicates if only FSH resources should be exported.  
# If set to true, no IG related content will be generated.  
# The default value for this property is false.  
FSHOnly: false  
  
# When set to true, the "short" and "definition" field on the root element of an Extension will  
# be set to the "Title" and "Description" of that Extension. Default is true.  
applyExtensionMetadataToRoot: false  
  
# The instanceOptions property is used to configure certain aspects of how SUSHI processed instances.  
# See the individual option definitions below for more detail.  
instanceOptions:  
  # Determines for which types of Instances SUSHI will automatically set meta.profile  
  # if InstanceOf references a profile. Options are:  
  # - always: Set meta.profile for all Instances of profiles (default)  
  # - never: Do not set meta.profile on any Instances  
  # - inline-only: Set meta.profile for only Instances of profiles with Usage set to #inline  
  # - standalone-only: Set meta.profile for only Instances of profiles where Usage is any value other than #inline  
setMetaProfile: always  
  # Determines for which types of Instances SUSHI will automatically set id  
  # if InstanceOf references a profile. Options are:  
  # - always: Set id for all Instances (default)  
  # - standalone-only: Set id for only Instances where Usage is any value other than #inline  
setId: always
```



Adding Pages to an IG

- Pages are defined using Markdown or XHTML
- Markdown pages are rendered using Jekyll
- Authors can use automatic or manual page organization
- Relevant folders in an IG project
 - `input/pagecontent`: markdown (.md) and XHTML (.xml) files
 - `input/intro-notes`: content to embed in formal resource views
 - `input/images`: binary files such as images and downloads
 - `input/includes`: special includes files for Jekyll power users



Markdown Cheat Sheet (Part 1)

```
# Level 1 Header  
## Level 2 Header  
### Level 3 Header
```

Use two asterisks to specify ****bold text****.

Use underscores to specify *italic text*.

Use backticks for `inline code`.

Link to [HL7 FHIR](<https://www.hl7.org/fhir/>).

Ordered list:

1. item a
2. item b

Unordered list:

- item a
- item b

Level 1 Header

1 Level 2 Header

1.1 Level 3 Header

Use two asterisks to specify **bold text**.

Use underscores to specify *italic text*.

Use backticks for `inline code`.

Link to [HL7 FHIR](#).

Ordered list:

1. item a
2. item b

Unordered list:

- item a
- item b



Markdown Cheat Sheet (Part 2)

```
```  
Use three backticks before and after
a multi-line block of code.
```
```

- > Use leading greater-than symbol for
- > a quoted block of text.

Question	Answer
-----	-----
Is this a table?	Yes
Do I have to align it?	No, but it looks nice.

```
{: .grid }  
  
![HL7 Logo](hl7-logo.png)
```

Use three backticks before and after
a multi-line block of code.

Use leading greater-than symbol for a quoted block of text.

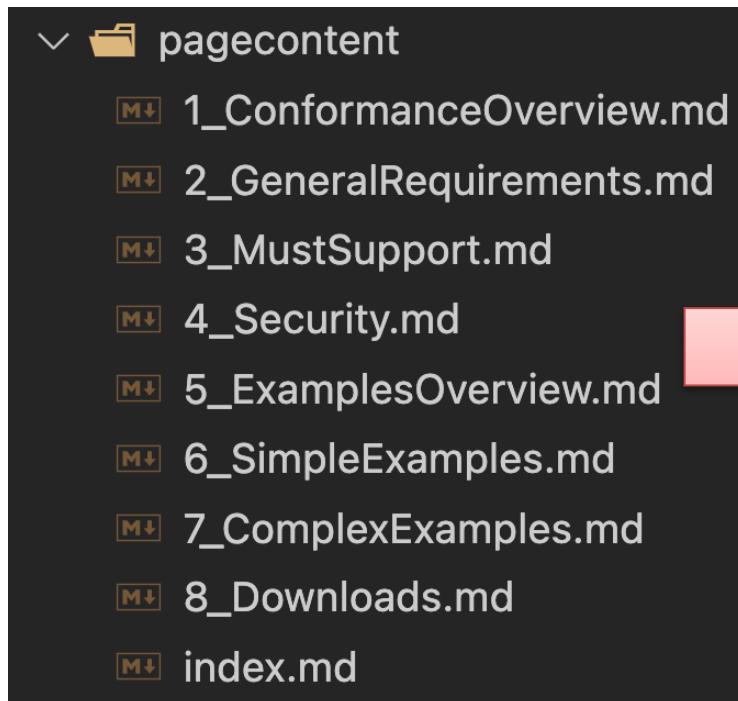
Question	Answer
Is this a table?	Yes
Do I have to align it?	No, but it looks nice.



Automatic Page Organization

SUSHI can automatically organize your pages based on file name

- Order is determined by numeric prefixes, otherwise alphabetical
- Word separation in titles is determined by camel-case



SUSHI

```
"page": [  
  {  
    "nameUrl": "index.html",  
    "title": "Home",  
    "generation": "markdown"  
  },  
  {  
    "nameUrl": "1_ConformanceOverview.html",  
    "title": "Conformance Overview",  
    "generation": "markdown"  
  },  
  {  
    "nameUrl": "2_GeneralRequirements.html",  
    "title": "General Requirements",  
    "generation": "markdown"  
  },  
  {  
    "nameUrl": "3_MustSupport.html",  
    "title": "Must Support",  
    "generation": "markdown"  
  },  
  {  
    "nameUrl": "4_Security.html",  
    "title": "Security",  
    "generation": "markdown"  
  },  
  {  
    "nameUrl": "5_ExamplesOverview.html",  
    "title": "Examples Overview",  
    "generation": "markdown"  
  },  
  {  
    "nameUrl": "6_SimpleExamples.html",  
    "title": "Simple Examples",  
    "generation": "markdown"  
  },  
  {  
    "nameUrl": "7_ComplexExamples.html",  
    "title": "Complex Examples",  
    "generation": "markdown"  
  },  
  {  
    "nameUrl": "8_Downloads.html",  
    "title": "Downloads",  
    "generation": "markdown"  
  }]
```

IG Publisher

A table of contents interface titled '0 Table of Contents'. It lists 11 items, each represented by a blue square icon and a title. The items are:
0 Table of Contents
1 Home
2 Conformance Overview
3 General Requirements
4 Must Support
5 Security
6 Examples Overview
7 Simple Examples
8 Complex Examples
9 Downloads
10 Artifacts Summary
10.1 MyPatient
10.2 PatientExample



Manual Page Organization

Authors can specify page titles & organization in `sushi-config.yaml`

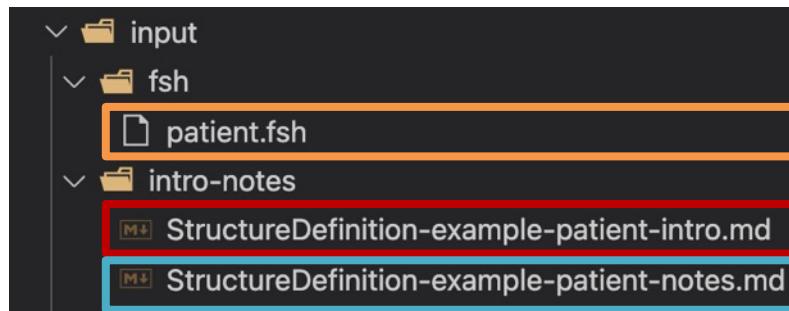
- File name is key, with optional *title* and *generation* sub-properties
- Nested file name keys indicate page hierarchy



Intro and Notes Documentation

Content before/after formal views

- Put content in *input/intro-notes*
- Before formal: {type}-{id}-intro.{md|xml}
- After formal: {type}-{id}-notes.{md|xml}



```
patient.fsh
Profile: ExamplePatientProfile
Parent: Patient
Id: example-patient
Description: "An example profile of the Patient resource."
* name 1..*
* name ^short = "Example name(s) for the patient (consider using Simpsons characters)"

StructureDefinition-example-patient-intro.md
### Things You Ought To Know About This Profile
There are a few things you ought to know about this profile:
1. It is not a serious profile.
2. It will never be a serious profile.
3. I'm sorry.

StructureDefinition-example-patient-notes.md
Just In Case You Forgot
1. This is not a serious profile.
2. This will never be a serious profile.
3. I'm sorry.
4. OK, not really.
```

5.1.1 Resource Profile: ExamplePatientProfile

Defining URL:	http://example.org/StructureDefinition/example-patient
Version:	0.1.0
Name:	ExamplePatientProfile
Status:	Active as of 2021-09-28T16:00:39-04:00
Definition:	An example profile of the Patient resource.
Publisher:	Example Publisher
Source Resource:	XML / JSON / Turtle

The official URL for this profile is:
http://example.org/StructureDefinition/example-patient

5.1.1.1 Things You Ought To Know About This Profile

There are a few things you ought to know about this profile:

1. It is not a serious profile.
2. It will never be a serious profile.
3. I'm sorry.

5.1.1.2 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 Patient.

Name	Flags	Card.	Type	Description & Constraints
Patient		0..*	Patient	Information about an individual or animal receiving health care services
name	S	1..*	HumanName	Example name(s) for the patient (consider using Simpsons characters)

Documentation for this format

Other representations of profile: CSV, Excel, Schematron

5.1.1.2.1 Terminology Bindings

Path	Conformance	ValueSet
Patient.language	preferred	CommonLanguages Max Binding: AllLanguages
Patient.gender	required	AdministrativeGender
Patient.maritalStatus	extensible	Marital Status Codes
Patient.contact.relationship	extensible	PatientContactRelationship
Patient.contact.gender	required	AdministrativeGender
Patient.communication.language	preferred	CommonLanguages Max Binding: AllLanguages
Patient.link.type	required	LinkType

5.1.1.2.2 Constraints

Id	Path	Details	Requirements
pat-1	Patient.contact	SHALL at least contain a contact's details or a reference to an organization : name.exists() or telecom.exists() or address.exists() or organization.exists()	

5.1.1.3 Notes:

Just In Case You Forgot

1. This is not a serious profile.
2. This will never be a serious profile.
3. I'm sorry.
4. OK, not really.

IG © 2021+ Example Publisher. Package fhir.example#0.1.0 based on FHIR 4.0.1. Generated 2021-09-28



Configuring the Menu

Configure the top-level menu in `sushi-config.yaml`

- Key is menu item and value is HTML file name or nested menu items
- Menus can only go one level deep

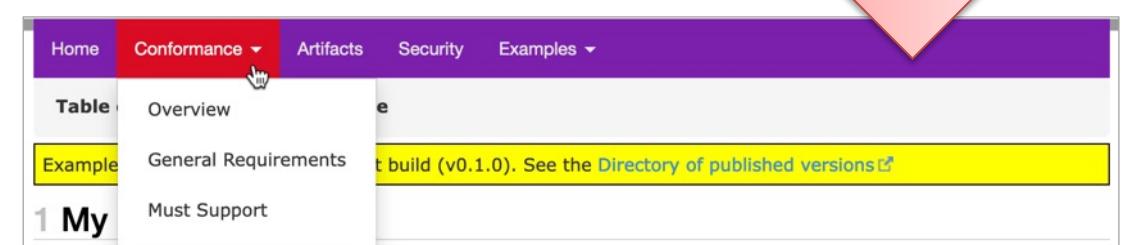
```
menu:  
  Home: index.html  
  Conformance:  
    Overview: conformance.html  
    General Requirements: requirements.html  
    Must Support: must-support.html  
  Artifacts: artifacts.html  
  Security: security.html  
  Examples:  
    Overview: examples.html  
    Simple Examples: simple-examples.html  
    Complex Examples: complex-examples.html
```

SUSHI

```
<ul xmlns="http://www.w3.org/1999/xhtml" class="nav navbar-nav">  
  <li><a href="index.html">Home</a></li>  
  <li class="dropdown">  
    <a data-toggle="dropdown" href="#" class="dropdown-to...>Conformance  
      <b class="caret"></b>  
    </a>  
    <ul class="dropdown-menu">  
      <li><a href="conformance.html">Overview</a></li>
```

Publisher

IG



Specify the IG's Template in ig.ini

template = fhir.base.template#current

0.1.0 - ci-build

Home Conformance Artifacts Security Examples

Table of Contents > My IG Home

ExamplePagesIG - Local Development build (v0.1.0). See the [Directory of published versions](#).

1 My IG Home

Official URL: http://example.org/ImplementationGuide/hl7.fhir.uv.example	Version: 0.1.0
Draft as of 2022-09-14	Computable Name: ExamplePagesIG

My Implementation Guide

Welcome to my implementation guide!

IG © 2022+ Example Publisher. Package hl7.fhir.uv.example#0.1.0 based on FHIR 4.0.1. Generated 2022-09-14
Links: [Table of Contents](#) | [QA Report](#)

template = hl7.base.template#current

0.1.0 - ci-build

Home Conformance Artifacts Security Examples

Table of Contents > My IG Home

ExamplePagesIG - Local Development build (v0.1.0). See the [Directory of published versions](#).

1 My IG Home

Official URL: http://example.org/ImplementationGuide/hl7.fhir.uv.example	Version: 0.1.0
Draft as of 2022-09-14	Computable Name: ExamplePagesIG

My Implementation Guide

Welcome to my implementation guide!

IG © 2022+ Example Publisher. Package hl7.fhir.uv.example#0.1.0 based on FHIR 4.0.1. Generated 2022-09-14
Links: [Table of Contents](#) | [QA Report](#)

template = hl7.fhir.template#current

0.1.0 - ci-build

Home Conformance Artifacts Security Examples

Table of Contents > My IG Home

ExamplePagesIG - Local Development build (v0.1.0). See the [Directory of published versions](#).

1 My IG Home

Official URL: http://example.org/ImplementationGuide/hl7.fhir.uv.example	Version: 0.1.0
Draft as of 2022-09-14	Computable Name: ExamplePagesIG

My Implementation Guide

Welcome to my implementation guide!

IG © 2022+ Example Publisher. Package hl7.fhir.uv.example#0.1.0 based on FHIR 4.0.1. Generated 2022-09-14
Links: [Table of Contents](#) | [QA Report](#) | [Version History](#) | [\(O\) PUBLIC DOMAIN](#) | [Propose a change](#)

template = hl7.cda.template#current

0.1.0 - ci-build

Home Conformance Artifacts Security Examples

Table of Contents > My IG Home

ExamplePagesIG - Local Development build (v0.1.0). See the [Directory of published versions](#).

1 My IG Home

Official URL: http://example.org/ImplementationGuide/hl7.fhir.uv.example	Version: 0.1.0
Draft as of 2022-09-14	Computable Name: ExamplePagesIG

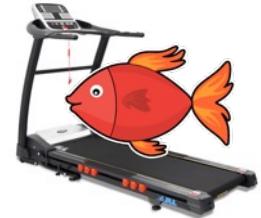
My Implementation Guide

Welcome to my implementation guide!

IG © 2022+ Example Publisher. Package hl7.fhir.uv.example#0.1.0 based on FHIR 4.0.1. Generated 2022-09-14
Links: [Table of Contents](#) | [QA Report](#) | [Version History](#) | [\(O\) PUBLIC DOMAIN](#) | [Propose a change](#)



Exercise: IG Configuration



GOAL: Fill out your IG with additional documentation

1. Add at least two additional pages to your IG
2. Add an image to your IG and display it on a page
3. Update your IG's menu to point to the new pages
4. Add an introduction and notes to a profile's page

FSH Project Structure: <https://bit.ly/fsh-ps>

FSH Configuration: <https://bit.ly/fsh-config>

Using IG Templates: <https://bit.ly/fhir-templates>

The screenshot shows a web-based FHIR Implementation Guide (IG) interface. At the top, there is a purple header bar with links for 'Home', 'Artifacts', 'Markdown Cheat Sheet', and 'Downloads'. Below this is a yellow navigation bar with 'Table of Contents' and 'Advanced FSH Home'. The main content area is titled 'AdvancedFSHExercises - Local Development build (v0.1.0). See the [Directory of published versions](#) of this package.' It includes sections for 'Advanced FSH Home' (with an 'Official URL' of <http://example.org/ImplementationGuide/fhir.example>, 'Version: 0.1.0', and 'Computable Name: AdvancedFSHExercises'), and 'AdvancedFSHExercises' (with a 'Welcome to my excellent IG!' message and a large image of a school of fish swimming in the ocean). A copyright notice at the bottom left reads 'IG © 2022+ Example Publisher | Package fhir.example#0.1.0 based on FHIR 4.0.1 | Generated 2022-09-16'. On the right side of the image, there is a small caption: 'Fishy, a lot of fish' by Michal Osmeda, CC BY-SA 2.0 via Wikimedia Commons.



GOFSH

Well hooked and landed!



GoFSH

Convert FHIR XML/JSON to FSH

- Command line interface
- Supports FSH 2.0
- Multiple output styles
- Common uses:
 - Kickstart an IG conversion to FSH
 - Learn about FSH through examples

Install: `npm install -g gofsh`



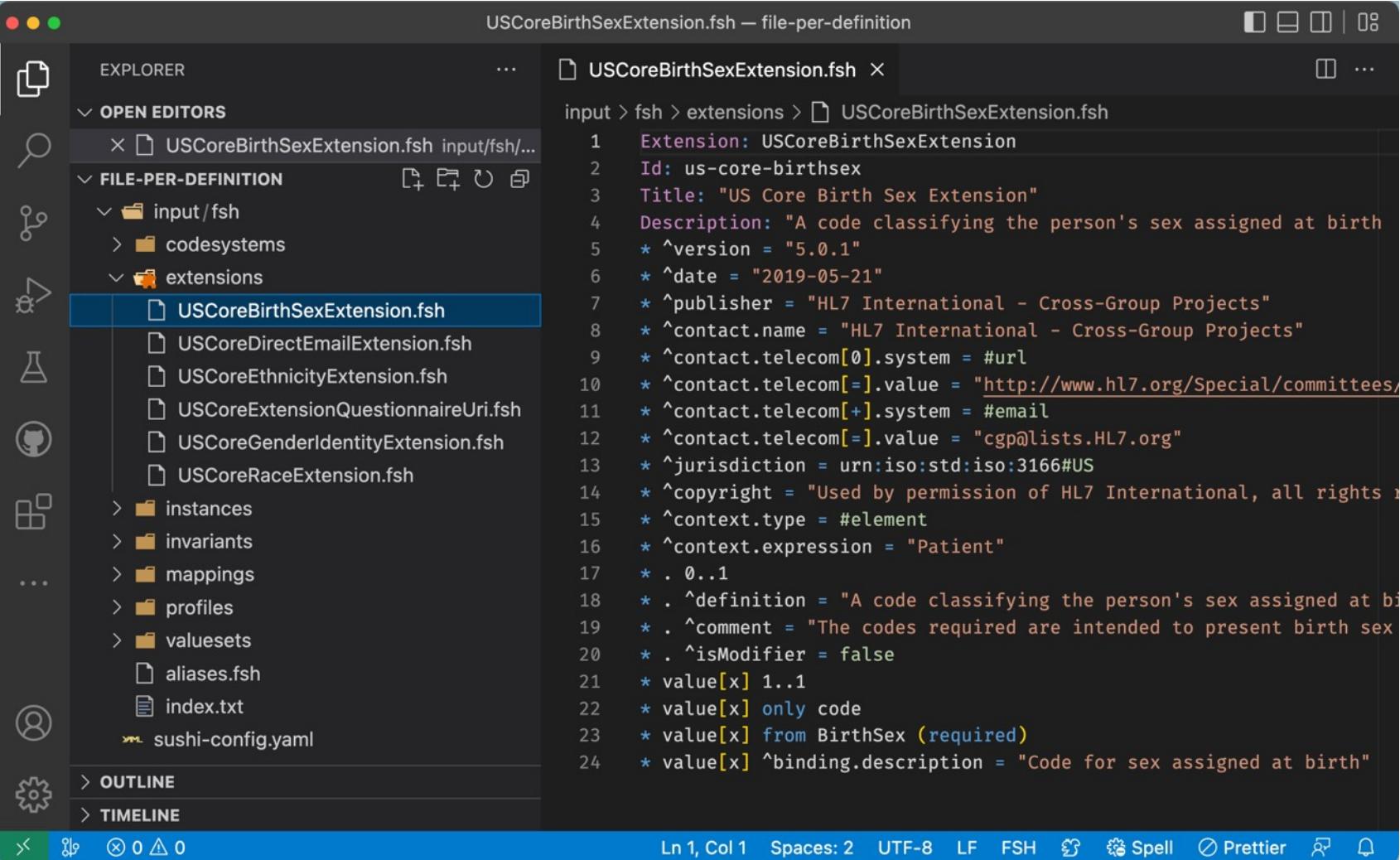
GoFSh Usage

```
> gofsh --help
Usage: goFSh [path-to-fhir-resources] [options]

Options:
  -o, --out <out>                      the path to the output folder
  -l, --log-level <level>                 specify the level of log messages: error, warn, info (default), debug
  -d, --dependency <dependency...>       specify dependencies to be loaded using format dependencyId@version (FHIR R4
                                         included by default)
  -s, --style <style>                    specify how the output is organized into files: file-per-definition (default),
                                         group-by-fsh-type, group-by-profile, single-file
  -f, --fshing-trip                      run SUSHI on the output of GoFSh and generate a comparison of the round trip
                                         results
  -i, --installed-sushi                  use the locally installed version of SUSHI when generating comparisons with the
                                         "-f" option
  -t, --file-type <type>                 specify which file types GoFSh should accept as input: json-only (default),
                                         xml-only, json-and-xml
  --indent                                output FSH with indented rules using context paths
  --meta-profile <mode>                  specify how meta.profile on Instances should be applied to the InstanceOf
                                         keyword: only-one (default), first, none
  -a, --alias-file <alias-filePath>      specify an existing FSH file containing aliases to be loaded.
  --no-alias                               output FSH without generating Aliases
  -u, --useFHIRVersion <fhirVersion>     specify which FHIR version to use when it cannot be inferred
  -v, --version                            print goFSh version
  -h, --help                               display help for command
```



GoFSH Options: --style file-per-definition

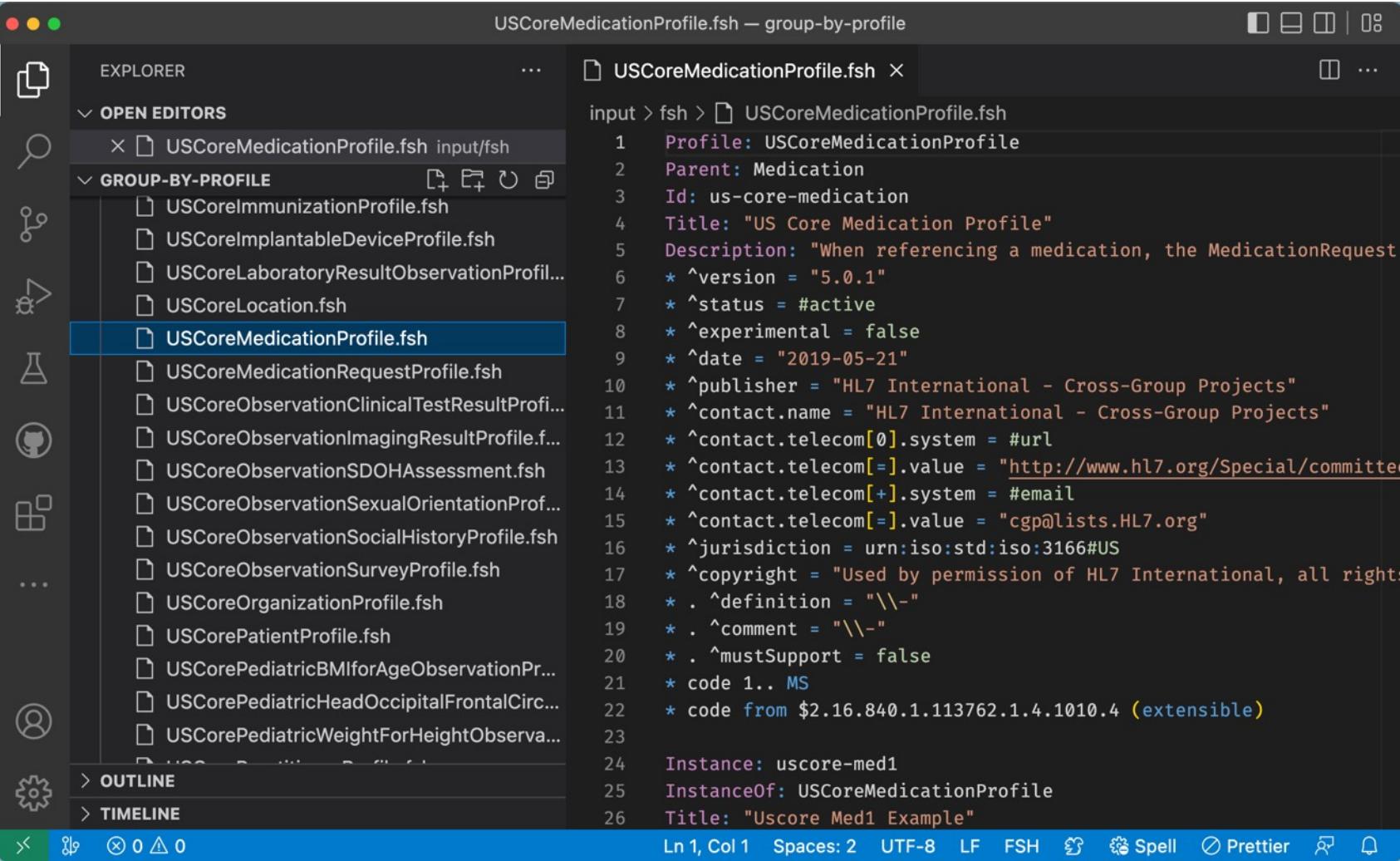


```
USCoreBirthSexExtension.fsh — file-per-definition
USCoreBirthSexExtension.fsh ×

input > fsh > extensions > USCoreBirthSexExtension.fsh
1 Extension: USCoreBirthSexExtension
2 Id: us-core-birthsex
3 Title: "US Core Birth Sex Extension"
4 Description: "A code classifying the person's sex assigned at birth"
5 * ^version = "5.0.1"
6 * ^date = "2019-05-21"
7 * ^publisher = "HL7 International - Cross-Group Projects"
8 * ^contact.name = "HL7 International - Cross-Group Projects"
9 * ^contact.telecom[0].system = #url
10 * ^contact.telecom[=].value = "http://www.hl7.org/Special/committees/"
11 * ^contact.telecom[+].system = #email
12 * ^contact.telecom[=].value = "cgp@lists.HL7.org"
13 * ^jurisdiction = urn:iso:std:iso:3166#US
14 * ^copyright = "Used by permission of HL7 International, all rights reserved. © HL7 International 2019. All rights reserved. This code is licensed under the MIT License. The original code can be found at https://github.com/HL7/USCore/blob/master/extension/us-core-birthsex.fsh"
15 * ^context.type = #element
16 * ^context.expression = "Patient"
17 * . 0..1
18 * . ^definition = "A code classifying the person's sex assigned at birth"
19 * . ^comment = "The codes required are intended to present birth sex"
20 * . ^isModifier = false
21 * value[x] 1..1
22 * value[x] only code
23 * value[x] from BirthSex (required)
24 * value[x] ^binding.description = "Code for sex assigned at birth"
```



GoFSH Options: --style group-by-profile

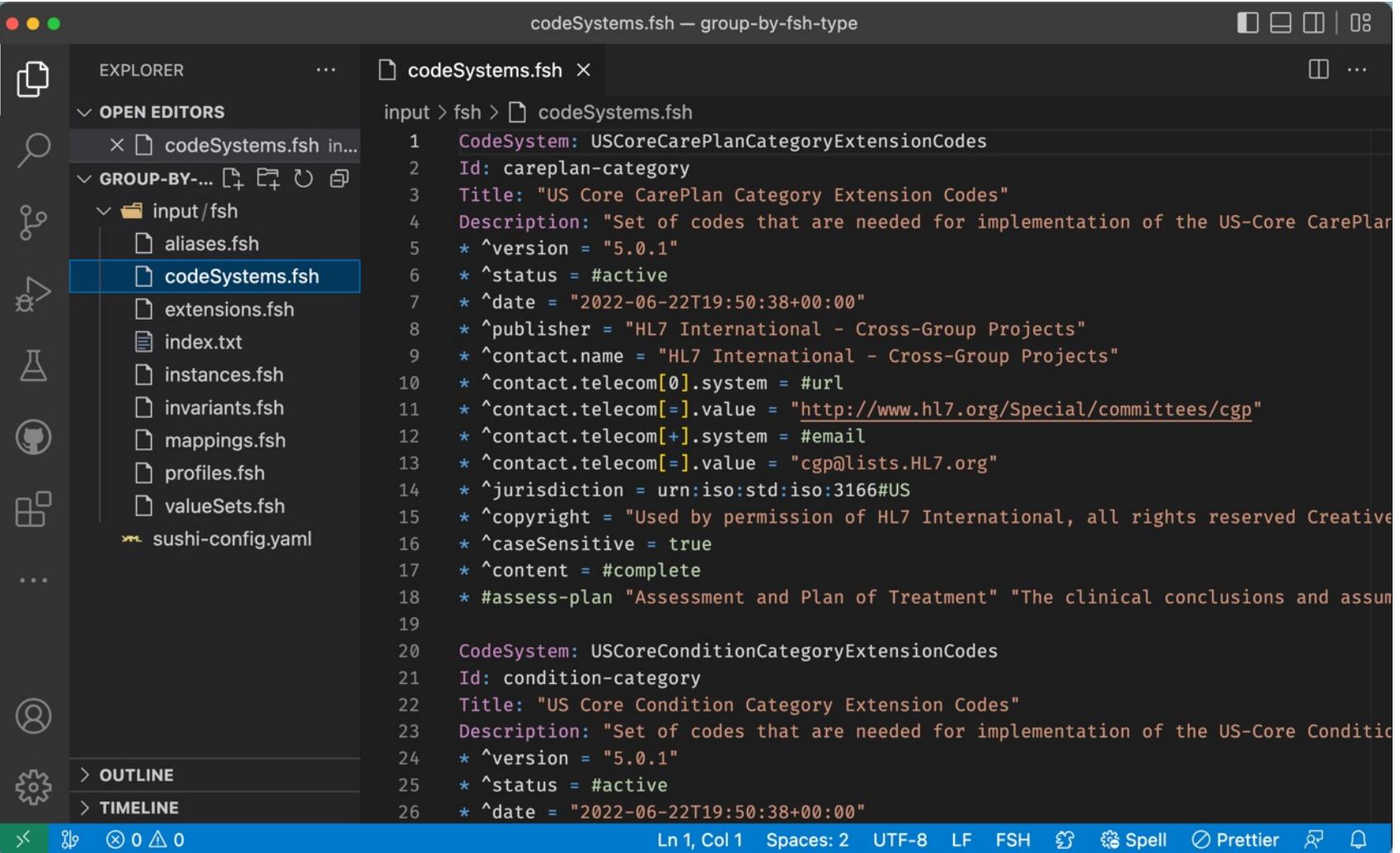


The screenshot shows a code editor window titled "USCoreMedicationProfile.fsh — group-by-profile". The left sidebar has icons for Explorer, Open Editors, Group-By-Profile, Outline, and Timeline. The "OPEN EDITORS" section shows "USCoreMedicationProfile.fsh input/fsh" and "GROUP-BY-PROFILE" which contains several FSH files. The file "USCoreMedicationProfile.fsh" is selected and highlighted with a blue background. The main editor area displays the following GoFSH code:

```
input > fsh > USCoreMedicationProfile.fsh
1 Profile: USCoreMedicationProfile
2 Parent: Medication
3 Id: us-core-medication
4 Title: "US Core Medication Profile"
5 Description: "When referencing a medication, the MedicationRequest
6 * ^version = "5.0.1"
7 * ^status = #active
8 * ^experimental = false
9 * ^date = "2019-05-21"
10 * ^publisher = "HL7 International - Cross-Group Projects"
11 * ^contact.name = "HL7 International - Cross-Group Projects"
12 * ^contact.telecom[0].system = #url
13 * ^contact.telecom[=].value = "http://www.hl7.org/Special/committees/cgp/lists.HL7.org"
14 * ^contact.telecom[+].system = #email
15 * ^contact.telecom[=].value = "cgp@lists.HL7.org"
16 * ^jurisdiction = urn:iso:std:iso:3166#US
17 * ^copyright = "Used by permission of HL7 International, all rights reserved"
18 * . ^definition = "\\"-
19 * . ^comment = "\\"-
20 * . ^mustSupport = false
21 * code 1.. MS
22 * code from $2.16.840.1.113762.1.4.1010.4 (extensible)
23
24 Instance: uscore-med1
25 InstanceOf: USCoreMedicationProfile
26 Title: "Uscore Med1 Example"
```



GoFSH Options: --style group-by-fsh-type

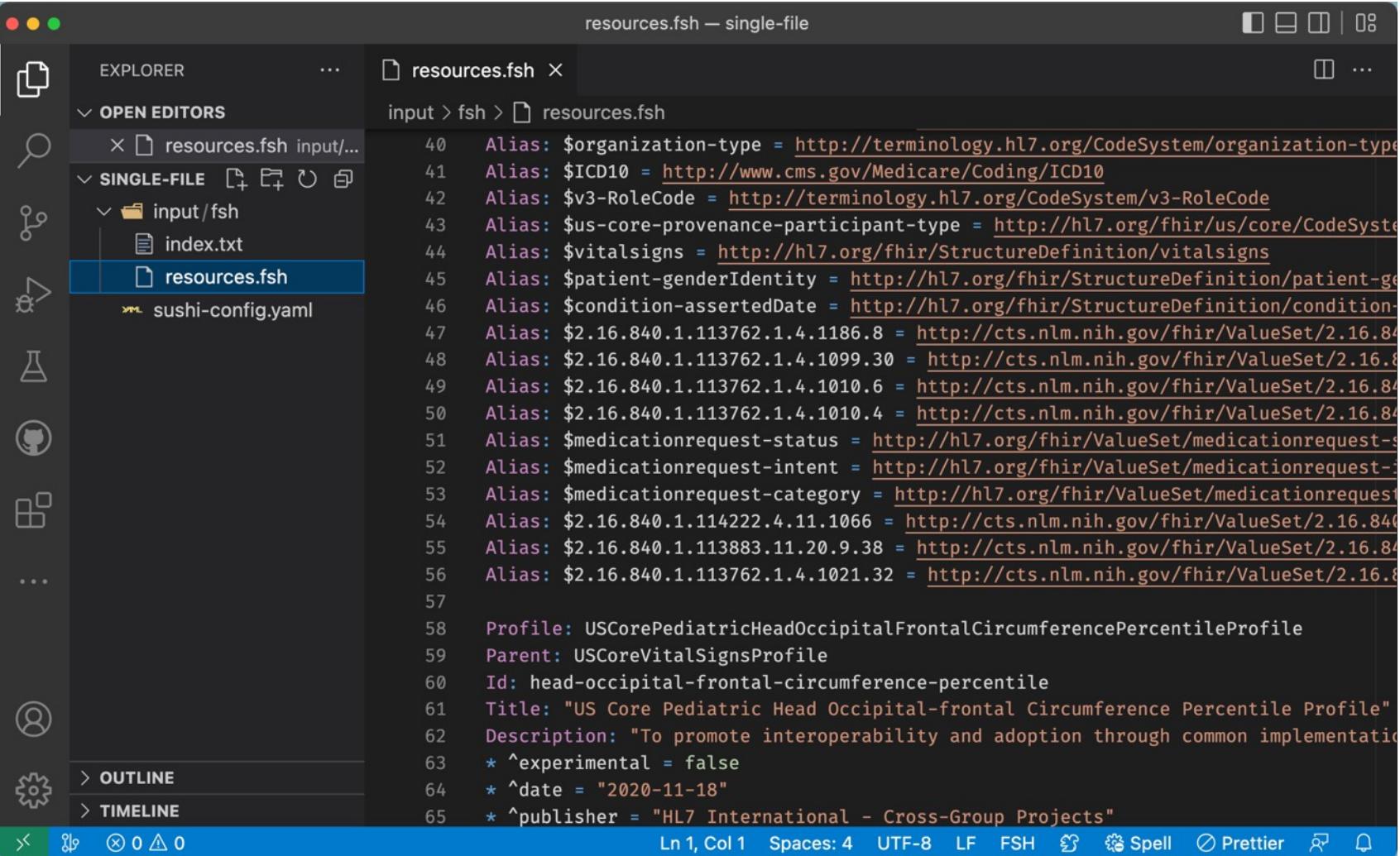


The screenshot shows a code editor window titled "codeSystems.fsh — group-by-fsh-type". The left sidebar displays a file tree under "OPEN EDITORS" and "GROUP-BY...". The "codeSystems.fsh" file is selected in the tree. The main editor area contains FHIR System Definition (FSH) code. The code defines two CodeSystem resources: "USCoreCarePlanCategoryExtensionCodes" and "USCoreConditionCategoryExtensionCodes". Both definitions have the same structure, including an Id ("careplan-category" and "condition-category"), Title ("US Core CarePlan Category Extension Codes" and "US Core Condition Category Extension Codes"), Description ("Set of codes that are needed for implementation of the US-Core CarePlan" and "Set of codes that are needed for implementation of the US-Core Condition"), and various metadata fields like version, status, date, publisher, contact, jurisdiction, copyright, caseSensitive, content, and assess-plan.

```
1 CodeSystem: USCoreCarePlanCategoryExtensionCodes
2 Id: careplan-category
3 Title: "US Core CarePlan Category Extension Codes"
4 Description: "Set of codes that are needed for implementation of the US-Core CarePlan"
5 * ^version = "5.0.1"
6 * ^status = #active
7 * ^date = "2022-06-22T19:50:38+00:00"
8 * ^publisher = "HL7 International - Cross-Group Projects"
9 * ^contact.name = "HL7 International - Cross-Group Projects"
10 * ^contact.telecom[0].system = #url
11 * ^contact.telecom[=].value = "http://www.hl7.org/Special/committees/cgp"
12 * ^contact.telecom[+].system = #email
13 * ^contact.telecom[=].value = "cgp@lists.HL7.org"
14 * ^jurisdiction = urn:iso:std:iso:3166#US
15 * ^copyright = "Used by permission of HL7 International, all rights reserved Creative Commons"
16 * ^caseSensitive = true
17 * ^content = #complete
18 * #assess-plan "Assessment and Plan of Treatment" "The clinical conclusions and assumptions made by the system regarding the patient's condition and proposed treatment plan"
19
20 CodeSystem: USCoreConditionCategoryExtensionCodes
21 Id: condition-category
22 Title: "US Core Condition Category Extension Codes"
23 Description: "Set of codes that are needed for implementation of the US-Core Condition"
24 * ^version = "5.0.1"
25 * ^status = #active
26 * ^date = "2022-06-22T19:50:38+00:00"
```



GoFSH Options: --style single-file



```
resources.fsh — single-file
resources.fsh

input > fsh > resources.fsh

40 Alias: $organization-type = http://terminology.hl7.org/CodeSystem/organization-type
41 Alias: $ICD10 = http://www.cms.gov/Medicare/Coding/ICD10
42 Alias: $v3-RoleCode = http://terminology.hl7.org/CodeSystem/v3-RoleCode
43 Alias: $us-core-provenance-participant-type = http://hl7.org/fhir/us/core/CodeSystem
44 Alias: $vitalsigns = http://hl7.org/fhir/StructureDefinition/vitalsigns
45 Alias: $patient-genderIdentity = http://hl7.org/fhir/StructureDefinition/patient-gender
46 Alias: $condition-assertedDate = http://hl7.org/fhir/StructureDefinition/condition-assertedDate
47 Alias: $2.16.840.1.113762.1.4.1186.8 = http://cts.nlm.nih.gov/fhir/ValueSet/2.16.840.1.113762.1.4.1186.8
48 Alias: $2.16.840.1.113762.1.4.1099.30 = http://cts.nlm.nih.gov/fhir/ValueSet/2.16.840.1.113762.1.4.1099.30
49 Alias: $2.16.840.1.113762.1.4.1010.6 = http://cts.nlm.nih.gov/fhir/ValueSet/2.16.840.1.113762.1.4.1010.6
50 Alias: $2.16.840.1.113762.1.4.1010.4 = http://cts.nlm.nih.gov/fhir/ValueSet/2.16.840.1.113762.1.4.1010.4
51 Alias: $medicationrequest-status = http://hl7.org/fhir/ValueSet/medicationrequest-status
52 Alias: $medicationrequest-intent = http://hl7.org/fhir/ValueSet/medicationrequest-intent
53 Alias: $medicationrequest-category = http://hl7.org/fhir/ValueSet/medicationrequest-category
54 Alias: $2.16.840.1.114222.4.11.1066 = http://cts.nlm.nih.gov/fhir/ValueSet/2.16.840.1.114222.4.11.1066
55 Alias: $2.16.840.1.113883.11.20.9.38 = http://cts.nlm.nih.gov/fhir/ValueSet/2.16.840.1.113883.11.20.9.38
56 Alias: $2.16.840.1.113762.1.4.1021.32 = http://cts.nlm.nih.gov/fhir/ValueSet/2.16.840.1.113762.1.4.1021.32
57
58 Profile: USCorePediatricHeadOccipitalFrontalCircumferencePercentileProfile
59 Parent: USCoreVitalSignsProfile
60 Id: head-occipital-frontal-circumference-percentile
61 Title: "US Core Pediatric Head Occipital-frontal Circumference Percentile Profile"
62 Description: "To promote interoperability and adoption through common implementation"
63 * ^experimental = false
64 * ^date = "2020-11-18"
65 * ^publisher = "HL7 International - Cross-Group Projects"
```



GoFSH Options: --fshing-trip

FSHing Trip provides a *round-trip* analysis of generated FSH



FSHing Trip Comparison

Files changed (61) hide

→ {package/example → fshing-trip/fsh-generated/resources}/Bundle-66c8856b-ba11-4876-8aa8-467aad8c11a2.json	+8	-20
→ {package/example → fshing-trip/fsh-generated/resources}/Bundle-c887e62f-6166-419f-8268-b5ecd6c7b901.json	+6	-14
→ {package/example → fshing-trip/fsh-generated/resources}/Bundle-uscore-mo3.json	+1	-9
→ {package/example → fshing-trip/fsh-generated/resources}/CarePlan-colonoscopy.json	+8	-8
→ {package → fshing-trip/fsh-generated/resources}/CodeSystem-careplan-category.json	+16	-16



GoFSH: FSHing Trip Comparison

<pre> 96 "patternCodeableConcept": { 97 "coding": [98 { 99 "system": "http://loinc.org", 100 "code": "39156-5" 101 } 102] 103 }, 104 "mustSupport": true 105 }, 106 { 107 "id": "Observation.valueQuantity", 108 "path": "Observation.valueQuantity", 109 "min": 0, 110 "max": "1", </pre>	<p style="text-align: center;">re-ordered properties; insignificant difference</p>	<pre> 90 + 91 + 92 + 93 + 94 + </pre>	<pre> "patternCodeableConcept": { "coding": [{ "code": "39156-5", "system": "http://loinc.org" }] }, { "id": "Observation.valueQuantity", "path": "Observation.valueQuantity", "min": 0, "max": "1", "type": [{ "code": "Quantity", "extension": [{ "url": "http://hl7.org/fhir/StructureDefinition/elementdefinition-valueBoolean" }] }], "mustSupport": true }, { "id": "Observation.valueQuantity.value", "path": "Observation.valueQuantity.value", "min": 1, "max": "1", "type": [{ "code": "decimal" }], "mustSupport": true } </pre>
<pre> 111 "mustSupport": true 112 }, 113 { 114 "id": "Observation.valueQuantity.value", 115 "path": "Observation.valueQuantity.value", 116 "min": 1, 117 "max": "1", 118 "type": [119 { 120 "code": "decimal" 121 } 122], </pre>	<p style="text-align: center;">Inherited from parent; no need to repeat</p>		<p style="text-align: center;">Best practice is to explicitly specify type in type slices</p>



GoFSH: FSHing Trip Comparison



Missing a whole slice?
That could be a problem...

```
107  {
108 -   "id": "Observation.category:us-core/social-history",
109 -   "path": "Observation.category",
110 -   "sliceName": "us-core/social-history",
111 -   "requirements": "Used for filtering that this is a social history observa
112 -   "min": 1,
113 -   "max": "1",
114 -   "patternCodeableConcept": {
115 -     "coding": [
116 -       {
117 -         "system": "http://terminology.hl7.org/CodeSystem/observation-catego
118 -         "code": "social-history"
119 -       }
120 -     ],
121 -   },
122 -   "mustSupport": true
123 - },
124 - {
125 -   "id": "Observation.category:sdoh",
126 -   "path": "Observation.category",
```

```
114  {
115 -   "id": "Observation.category:sdoh",
116 -   "path": "Observation.category",
```

Better
Investigate!

GoFSH *did* emit an error that hinted there might be an issue here:

error Element sliceName "us-core/social-history" is not correctly used to populate id "Observation.category:us-core/social-history" according to the algorithm specified here: <https://www.hl7.org/fhir/elementdefinition.html#id>. The value implied by the id will be used.

And so did SUSHI:

error No element found at path category[us-core] for ContainsRule in USCoreObservationSocialHistoryProfile, skipping rule
File: /Users/cmoesel/dev/HL7/uscore-501/fshing-trip/input/fsh/profiles/USCoreObservationSocialHistoryProfile.fsh
Line: 24

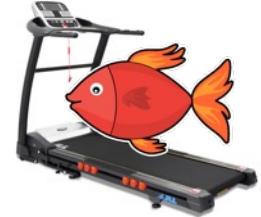


GoFSHing Tips

- GoFSH works best when provided clean input
 - Ideally, no (or few) errors in the IG's QA report
 - Preferably, from a downloaded package or IG /output folder
 - If possible, use packages that contain profiles' snapshots
 - If possible, avoid duplicate files and non-FHIR XML/JSON files
- GoFSH or SUSHI may find problems in the original source
- GoFSH is not perfect
 - Always review the generated FSH and final outputs
 - Consider optimizing FSH (e.g., reduce redundancy w/ RuleSets)



Exercise: GoFSH



GOAL: Convert US Core FHIR definitions to FHIR Shorthand

1. Download and unzip the US Core 5.0.1 package
2. Run GoFSH against the unzipped package
3. Run SUSHI against the resulting files in “gofsh”
4. Find and fix the errors in the FSH source code
 - Cannot override required binding with extensible binding
 - Incorrect slice paths in the social history profile

US Core 5.0.1 Package: <https://bit.ly/usc501-pkg>

Running GoFSH: <https://bit.ly/gofsh-run>

USC-GOFSH-EXERCISE	
	└ gofsh
	> fsh-generated
	└ input/fsh
	> codesystems
	> extensions
	> instances
	> invariants
	> mappings
	> profiles
	> valuesets
	└ aliases.fsh
	└ index.txt
	5 fshing-trip-comparison.html
	XML sushi-config.yaml



REVIEW

Tank you very much!



What You (Hopefully) Learned

- Back to the Basics
- Tools of the Trade: VS Code
- Tricks for Tackling Tediosity
- Slicing (without Losing a Finger)
- ~~Finvariants~~ Invariants
- Intensional Value Sets
- IG Configuration
- GoFSH
- Review



So long and thanks
for all the FSH!

