HL7® FHIR® DevDays

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# Questionnaires and SDC

Brian Postlethwaite – Microsoft Research

## HL7 FHIR DevDays

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Minneapolis, MN

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# Who am I?

- Brian Postlethwaite
- Senior Software Engineer @ Microsoft Research

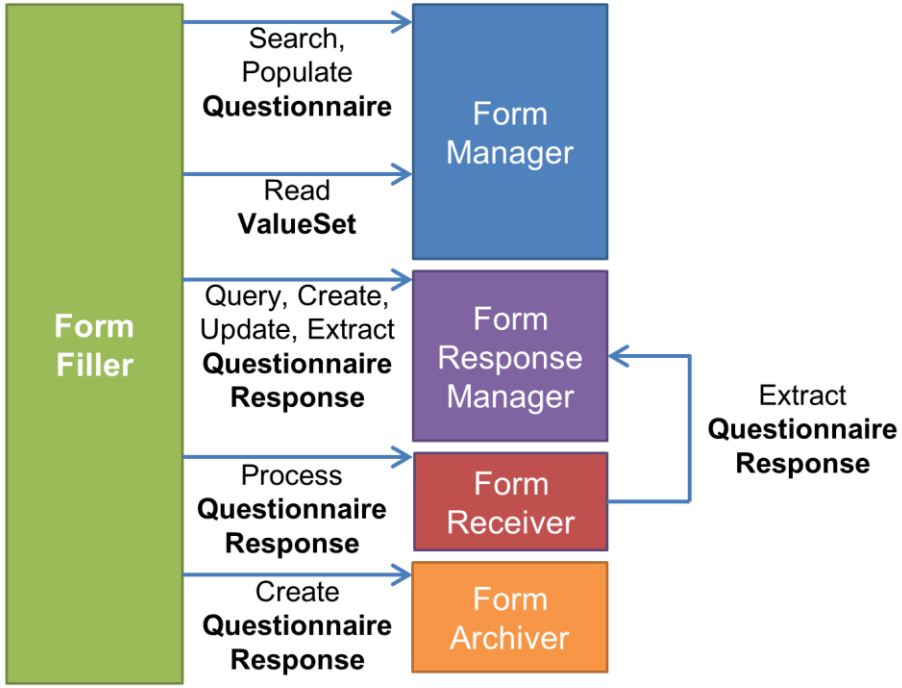
# Learning Objectives

- What is SDC?
- Questionnaire basics *(labels, fields, groups, tables)*
- Dynamic Questionnaires *(enable-when, calculated fields)*
- Validation
- Canonical URLs and version management
- What tools are available?
- How close is Generative AI in forms?

# Typical workflows

- Locate questionnaire to use (for given context)
- Load/render questionnaire (and referenced content)
  - Pre-populate questionnaire with other data (e.g., patient demographics, observations etc)
- User enters data
  - Local validations may occur during data entry
- QuestionnaireResponse is validated by server
  - Errors/Warnings/issues reported to the user
- QuestionnaireResponse is saved to the target server
  - Data extracted into other resources

# What is SDC?




# Structured Data Capture IG

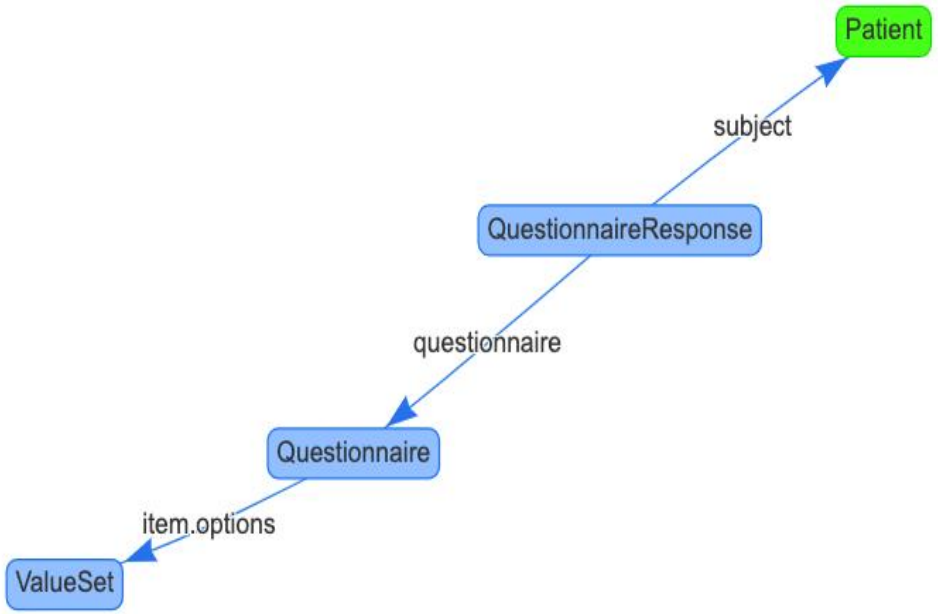
- Extensions to the core HL7 definitions
  - Advanced Rendering
  - Advanced Form Behaviour
  - Adaptive Forms
  - Importing Data into Forms
  - Extraction of Data from Forms

https://hl7.org/fhir/uv/sdc/

- Heading towards another R4 release

# Questionnaire Basics

- Questionnaire Resource
  - Definitional Resource
    - Similar to StructureDefinition
  - May include ValueSet / Terminologies
- QuestionnaireResponse Resource
  - Record of responses
  - Structure mirrors Questionnaire items
- Other
  - Extensions, Operations, Profiles, Implementation Guides (incl SDC)




**Note:** DON'T Profile Questionnaire (normally)

| Item-Type | Response Type | Definition |
|---|---|---|
| group | item*(Group)* | An item with children, may be repeating. Could be a section, table or other layout (e.g. tabs) |
| display | *(none)* | Just a label to be displayed (no answer to be collected) |
| boolean | valueBoolean | Yes/no answer (checkbox, radio group or similar) |
| decimal | valueDecimal | Real number answer (restricted textbox, slider, …) |
| integer | valueInteger | Integer answer (restricted textbox, slider, …) |
| date | valueDate | Date answer (restricted textbox, date picker …) |
| dateTime | valueDateTime | Date and time answer (restricted textbox, date picker …) |
| time | valueTime | Time only answer (hour:minute:second) answer independent of date (restricted textbox, …) |
| string | valueString | Short free-text answer (single line textbox) |
| text | valueString | Longer free-text answer, potentially multi-paragraph (multi-line textbox) |
| url | valueUri | URL (website, FTP site, etc.) answer (restricted textbox) |
| choice | valueCoding | Coding drawn from a list of options (specified in either the option property, or via the ValueSet referenced in the options property) as an answer (radio buttons, checkboxes, combobox, autocomplete …) |
| open-choice | valueCoding or valueString | Coding drawn from a list of options (as with the choice type) or a free-text entry in a string (similar controls to choice, except with ability to include textbox) |
| attachment | valueAttachment | Binary content such as a image, PDF, etc. as an answer (file selector …) |
| reference | valueReference | A reference to another resource, e.g. practitioner, organization, etc. (resource finder?) |
| quantity | valueQuantity | Question with a combination of a numeric value and unit. () |

# Dynamic Questionnaires

- Terminologies
- Variables, expressions queries & calculated fields
- Enable When
- answerExpression
- Dynamic labels (cqf-expression)
- Constraint (powerful custom validation)

https://hl7.org/fhir/uv/sdc/behavior.html#calculations

https://hl7.org/fhir/uv/sdc/expressions.html

https://build.fhir.org/ig/HL7/FHIRPath

# Dynamic Questionnaires - Terminologies

**Questionnaire structure**

- Item types
  - Choice, open-choice
- ValueSet reference (canonical!)
  - Item.answerValueSet
- Answer options
  - valueCoding, initialSelected
- Repeat
- Control selection
  - Radio buttons, comboboxes, checkboxes, autocomplete
  - Consider the number of potential entries in the list

**Extensions**

- questionnaire-itemControl
- questionnaire-optionExclusive
- preferredTerminologyServer
- questionnaire-unitValueSet
- 11179-permitted-value-valueset
- 11179-permitted-value-conceptmap

**Operations**

- Use the ValueSet **$expand** operation to either pre-load the values, or use the filter parameter for the auto-complete style usage

# Dynamic Questionnaires – Enable when

| | | | | |
|---|---|---|---|---|
| enableWhen | ?! I | 0..* | BackboneElement | Only allow data when<br>*+ Rule: If the operator is 'exists', the value must be a boolean* |
| question | | 1..1 | string | Question that determines whether item is enabled |
| operator | | 1..1 | code | exists \| = \| != \| > \| < \| >= \| <=<br>QuestionnaireItemOperator (Required) |
| answer[x] | I | 1..1 | | Value for question comparison based on operator<br>Questionnaire Answer Codes (Example) |
| answerBoolean | | | boolean | |
| answerDecimal | | | decimal | |
| answerInteger | | | integer | |
| answerDate | | | date | |
| answerDateTime | | | dateTime | |
| answerTime | | | time | |
| answerString | | | string | |
| answerCoding | | | Coding | |
| answerQuantity | | | Quantity | |
| answerReference | | | Reference(Any) | |
| enableBehavior | I | 0..1 | code | all \| any<br>EnableWhenBehavior (Required) |

https://hl7.org/fhir/uv/sdc/StructureDefinition-sdc-questionnaire-enableWhenExpression.html

# Validation

- FHIR json/xml valid (serialization)
- Core FHIR profile validation *(maybe local profiles too)*
- QuestionnaireResponse validation
  - Item Types/Datatypes (using linkId to match)
  - Terminology
  - Required Fields
    - Enable When should be considered
    - Repeating fields are per group repetition
  - answerOptions/Extensions/Complex Validation
  - Base Questionnaires through derivedFrom reference
  - Custom validation?
- OperationOutcome
  - Content/messages appropriate to display to users?
  - Location of issue – which control (via path)

https://github.com/brianpos/fhir-net-web-api/blob/develop/src/Hl7.Fhir.StructuredDataCapture/QuestionnaireResponseValidator.cs

# Validation Results (OperationOutcome)

```
{
    "resourceType": "OperationOutcome",
    "issue": [
        {
            "severity": "error",
            "code": "required",
            "details": {
                "text": "Mandatory field Severity is missing"
            },
            "expression": [
                "QuestionnaireResponse.item[0].item[0].item[3]"
            ]
        },
        {
            "severity": "error",
            "code": "invariant",
            "details": {
                "coding": [
                    {
                        "code": "past-only"
                    }
                ],
                "text": "cannot be a future date"
            },
            "diagnostics": "answer.value <= today()",
            "expression": [
                "QuestionnaireResponse.item[0].item[0].item[5]"
            ]
        }
    ]
}
```

# Example Questionnaires

- Bit of Everything
- Groups and Tabs
- Terminology
- EnableWhen to hide groups until some data is shown
- CVD Risk or Abbey Pain Scale – calculated fields
- Validation of question based on today() expression
- Mbs715 (really big form)

# Canonical URLs and Version Management

- Link from QuestionnaireResponse to Questionnaire Definition

http://www.health.gov.au/assessments/mbs/715**|0.2**

Canonical URL
http://www.health.gov.au/assessments/mbs/715
Version

Status
active

Approval Date: (none)
Publish Date: 25/02/2020, 6:14 pm
Last Review Date: (none)

Available From
Available Till

Publisher
aehrc

Copyright

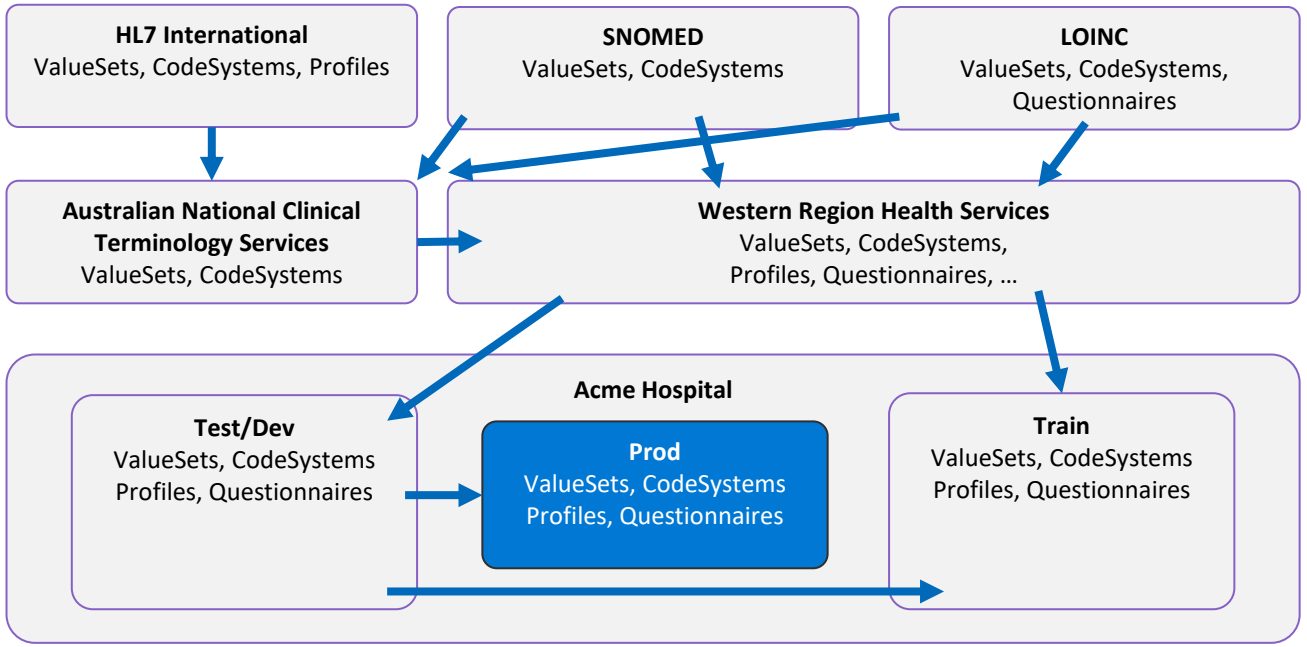
| ID | Canonical Version | Status | Version | Modified |
|---|---|---|---|---|
| mbs715-fixed | 0.3 | retired | 7 | 11/02/2022, 6:15 pm |
| mbs715-join | 0.2 | retired | 4 | 11/02/2022, 6:16 pm |
| mbs715-string | 0.1 | retired | 5 | 11/02/2022, 6:19 pm |
| mbs715-orig | 0.0 | retired | 4 | 11/02/2022, 6:16 pm |
| **mbs715** | | **active** | **187** | **11/02/2022, 6:14 pm** |

- NOT resource versioning
- Questionnaire status
  - Only 1 version active
  - Other drafts
  - And retired
- Modular forms and $assemble

https://brianpos.com/2022/12/13/canonical-versioning-in-your-fhir-server

# Canonical Content Distribution

- Multiple environments
- Multiple sources
- CRMI $package operation



https://confluence.hl7.org/display/FHIRI/SDC+Implementations

# Tooling: Renderers

**Open Source**

- https://github.com/lhncbc/questionnaire-viewer
  USNLM (Paul Lynch)
- https://github.com/aehrc/smart-forms
  CSIRO Renderer (Sean Fong)
- https://pub.dev/packages/faiadashu
  (https://fhirfli.dev/)
- https://github.com/helsenorge/refero
  Helse Norge (Kenneth Myhra)
- https://github.com/clinical-cloud/QuestionnaireKit

**Commercial/Tech demos**

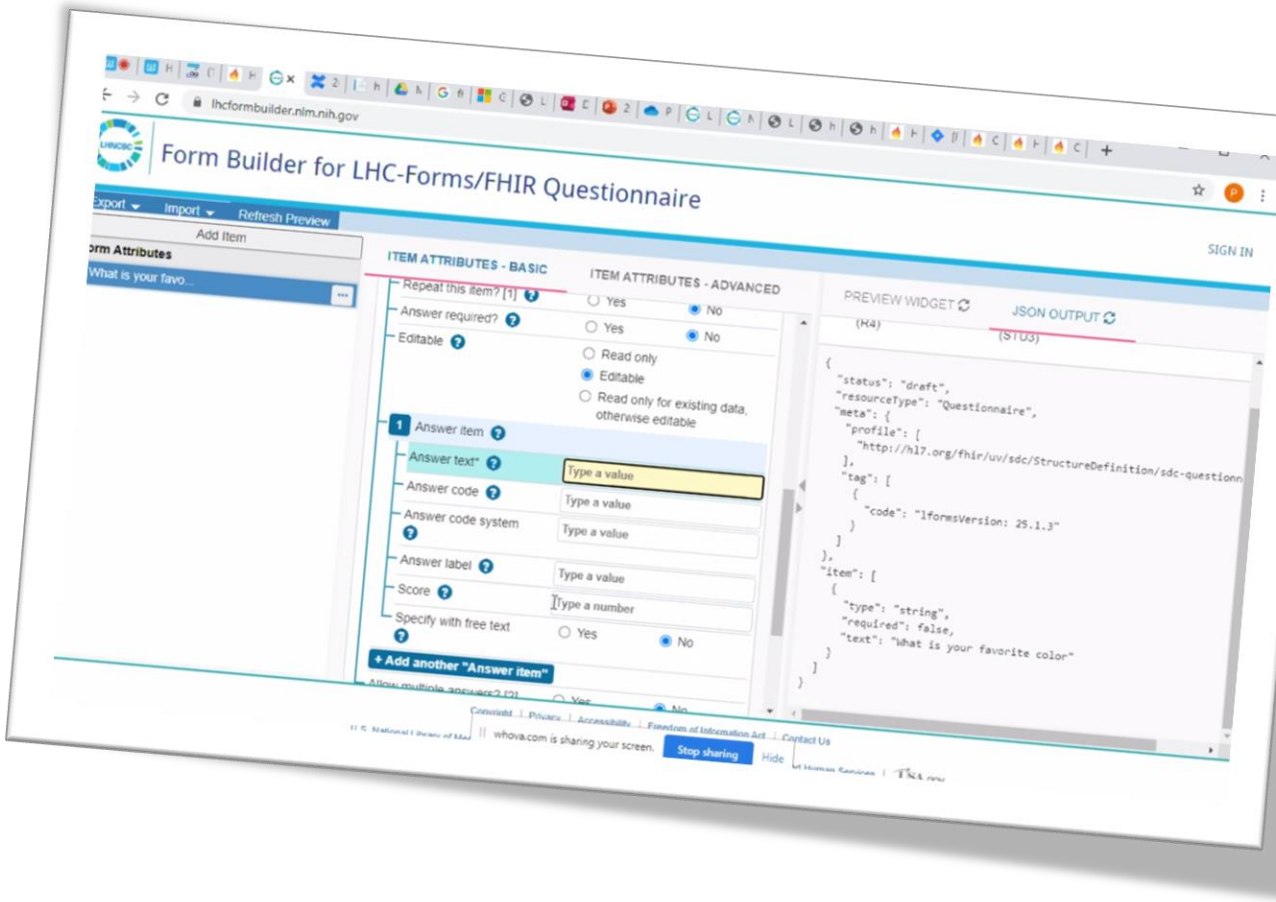
- https://fhirpower.bitrix24.site/
  NursIT Intitute (Stoyan Halaliev)

**Others**

- https://fhirpath-lab.com/Questionnaire/tester
  Brian Postlethwaite
- https://github.com/google/android-fhir/tree/master/datacapture
- https://github.com/beda-software/sdc-ide
- https://github.com/ahdis/ng-fhir-sample
  *(https://ahdis.github.io/ng-fhir-sample/#/questionnaire/sdc-render)*
- Aidbox *(new from Health Samurai)*
- https://github.com/asbi-cds-tools/questionnaire-to-survey
- https://github.com/dermatologist/fhir-questionnaire-render-react

# Tooling: Questionnaire Builders

- Converting existing non FHIR definitions
- U.S National Library of Medicine's Form Builder for LHC-Forms/FHIR Questionnaire (STU3, R4, R5)
- Grahame Grieve's editor (FHIR Toolkit) http://www.healthintersections.com.au/FhirServer/
- FhirPath-Lab & Forms-Lab (Brian Postlethwaite) – in progress https://fhirpath-lab.com https://forms-lab.com
- Beda Software editor http://ui.hl7.beda.software/
- Helse Norge (Kenneth Myhra) https://github.com/helsenorge/structor
- https://fhirpower.bitrix24.site/ Stoyan Halaliev
- Using text editor
- Others?

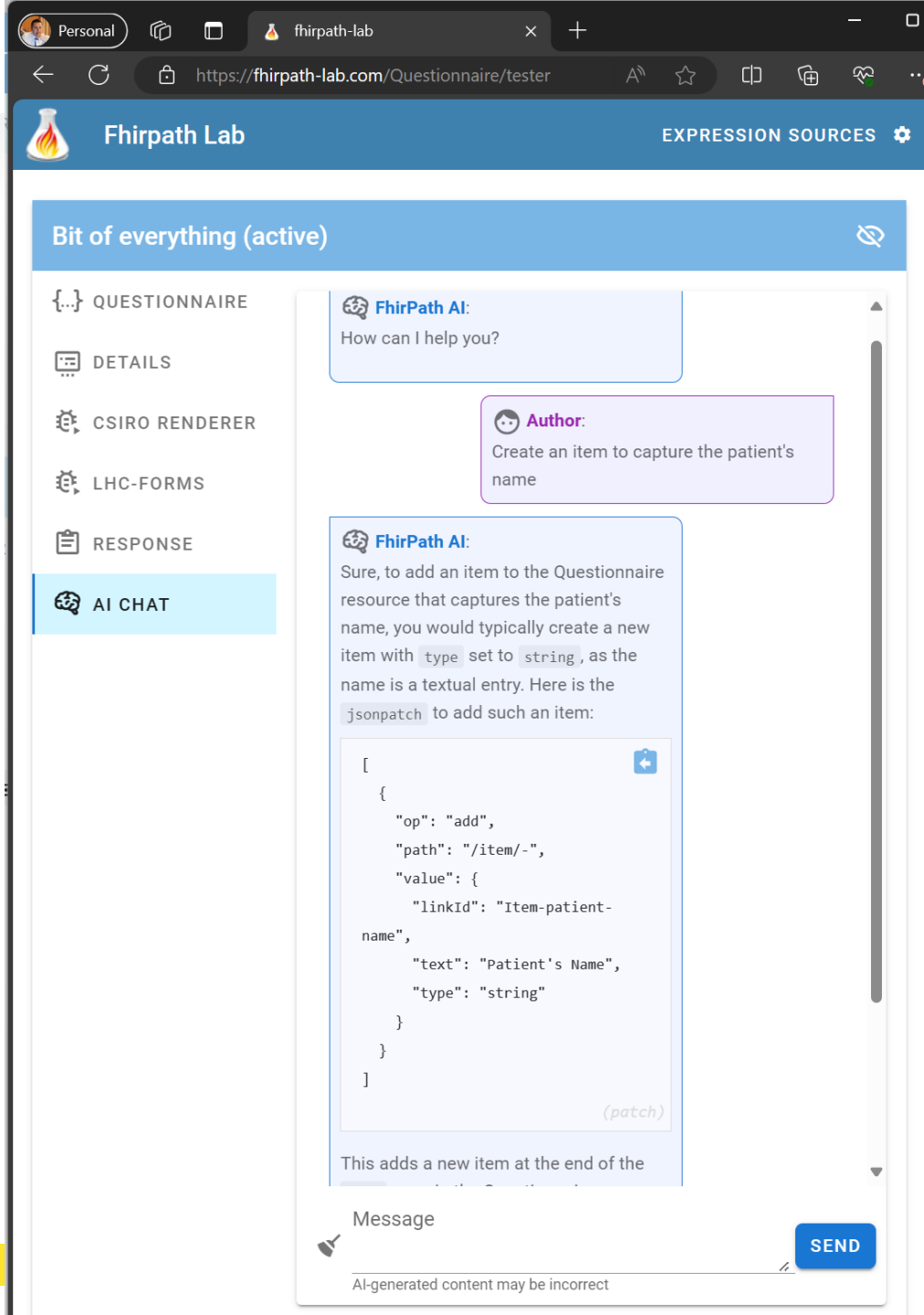


# Tooling: Open-source components/projects

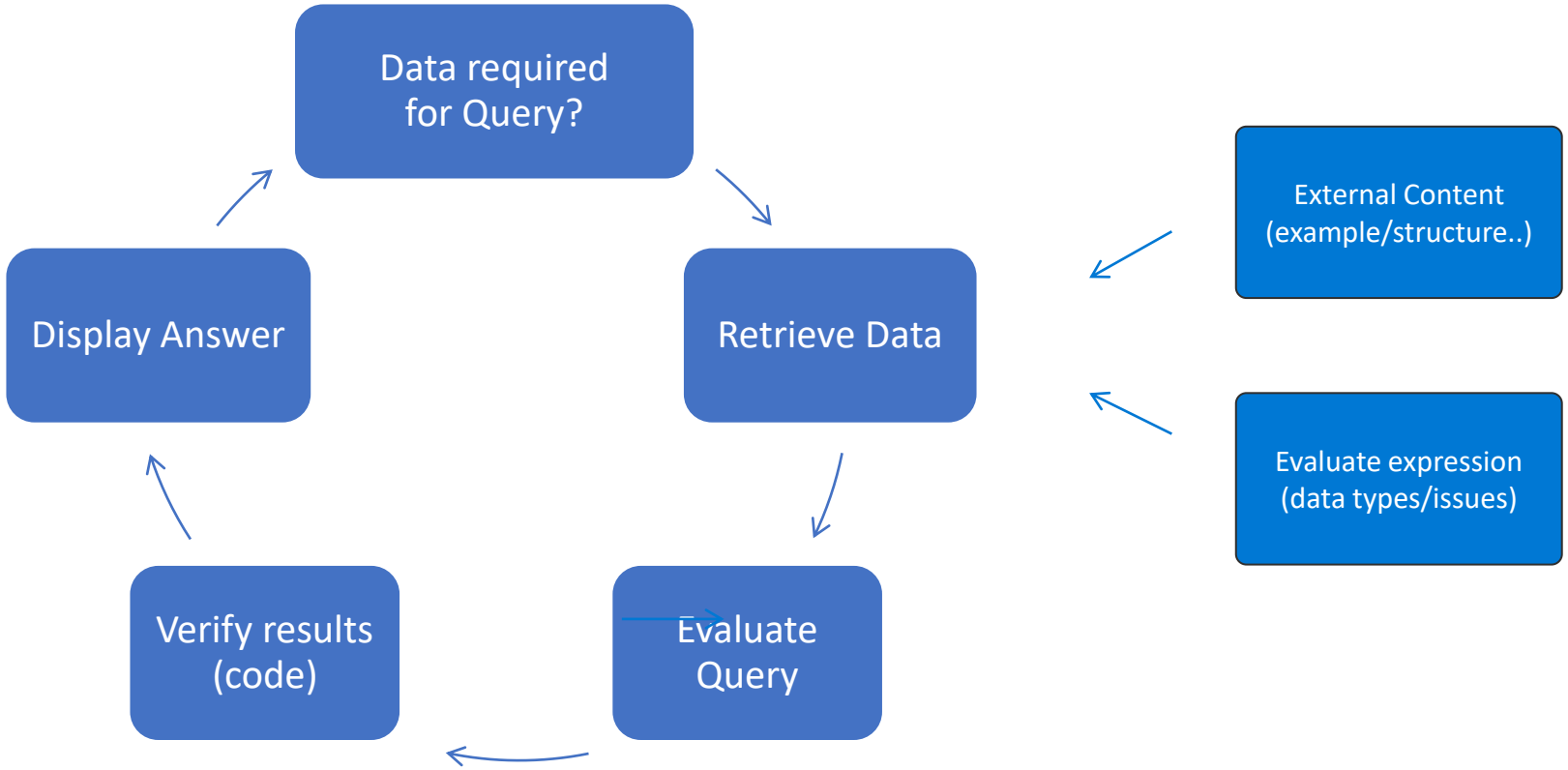
- TypeScript/JavaScript
  - https://www.npmjs.com/package/fhir-sdc-helpers
  - https://github.com/brianpos/fhir-sdc-helpers
  - https://www.npmjs.com/package/fhir-extension-helpers
  - https://www.npmjs.com/package/@types/fhir
  - https://www.npmjs.com/package/fhirpath
- Dotnet
  - Structured Data Capture Validator
    https://www.nuget.org/packages/brianpos.Fhir.R4B.StructuredDataCapture/5.3.0-beta8
    https://github.com/brianpos/fhir-net-web-api/tree/develop/src/Hl7.Fhir.StructuredDataCapture
- Other
  - FhirPathTester (https://github.com/brianpos/FhirPathTester)
  - FhirPath-lab (https://fhirpath-lab.com)

# Generative AI and forms?

- Hack-week Project recap
  - Dynamic form pre-population
  - Form design assistant
- FhirPath-Lab Form tester
  - https://fhirpath-lab.com/Questionnaire/tester
  - BYO Models – in the settings (Open AI, Azure, local Ollama)
  - Share your experiences



# Generative AI




RAG VS FINE-TUNING: https://arxiv.org/pdf/2401.08406.pdf

# Contact

- You can find / reach me here:
  - Via Whova App – Speaker's Gallery
  - https://chat.fhir.org

  - GitHub: https://github.com/brianpos
  - My personal blog https://brianpos.com

- My Other sessions
  - SDC Pre-Population and Extract (Wed 12th @ 2:30)
  - FhirPath Tutorial & Let's Build (Thurs 13th @10:15 and 11:15)

# Q&A

- Questionnaire / QuestionnaireResponse
  - Basics
  - Data Types
  - Terminology Interactions
  - Validation
  - Dynamic Capabilities
  - Canonical URLs and version management
- Open Source / Existing tooling
- Forms and Generative AI

*Where will you use Questionnaires?*

# Feedback

- Include link and/or QR code to collect feedback on your talk and DevDays

https://www.devdays.com/feedback/

Feedback?

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