MAYO CLINIC

Foundations of AI in Genomics and Precision Medicine

It’s all about the data

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  - The content is solely the responsibility of the author and does not necessarily represent the official views of the NIH or Mayo Clinic
- I hold leadership roles within HL7 and GA4GH
- I have no personal financial conflicts of interest

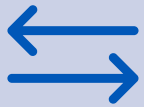
A Vision for Genomic Medicine

- Enables new discoveries
- Speeds up translation
- Access to the latest knowledge
  - Push notifications
- Personalized care
  - Risk and treatment
  - Adapting throughout life
- Portable across care settings
- Shareable with family members

Requirements

Consumers

- Patient
- Clinician
- Researcher
- Computer



Exchange

- Variety of capabilities
- Support for data types
- Differing upgrade schedules

Interpretation and Impact

- New data collected
- New biomedical knowledge
- New clinical guidance

Vision: Seamless Exchange of Genomic Data

Generation Annotation Interpretation Reporting Storage Use

Seamless Exchange of Genomic Data
Between tools, across workflows, for use cases

- Support entire spectrum of clinical and translational research
- Computable data, everywhere
- When transformations are necessary, they must be lossless
  - *Standards must be interoperable*

Ambiguous Semantics

HBOC
COMP
COMCP

“DNA Change c.-124C>T (also known as C228T)”

ACAT2

NM_198253

“c.182A>G and c.154T>G”

12 and 10 (Normal)

rs114493458

CYP3A5*3

05:01, 06:01

CYP2C19 c.1016 “ref” allele

Credit: Sarah Senum

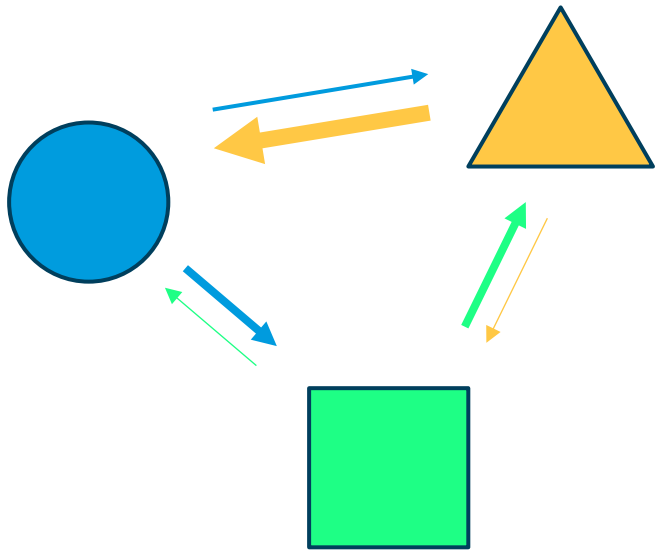
Complexity

Tesler's Law: The Law of Conservation of Complexity

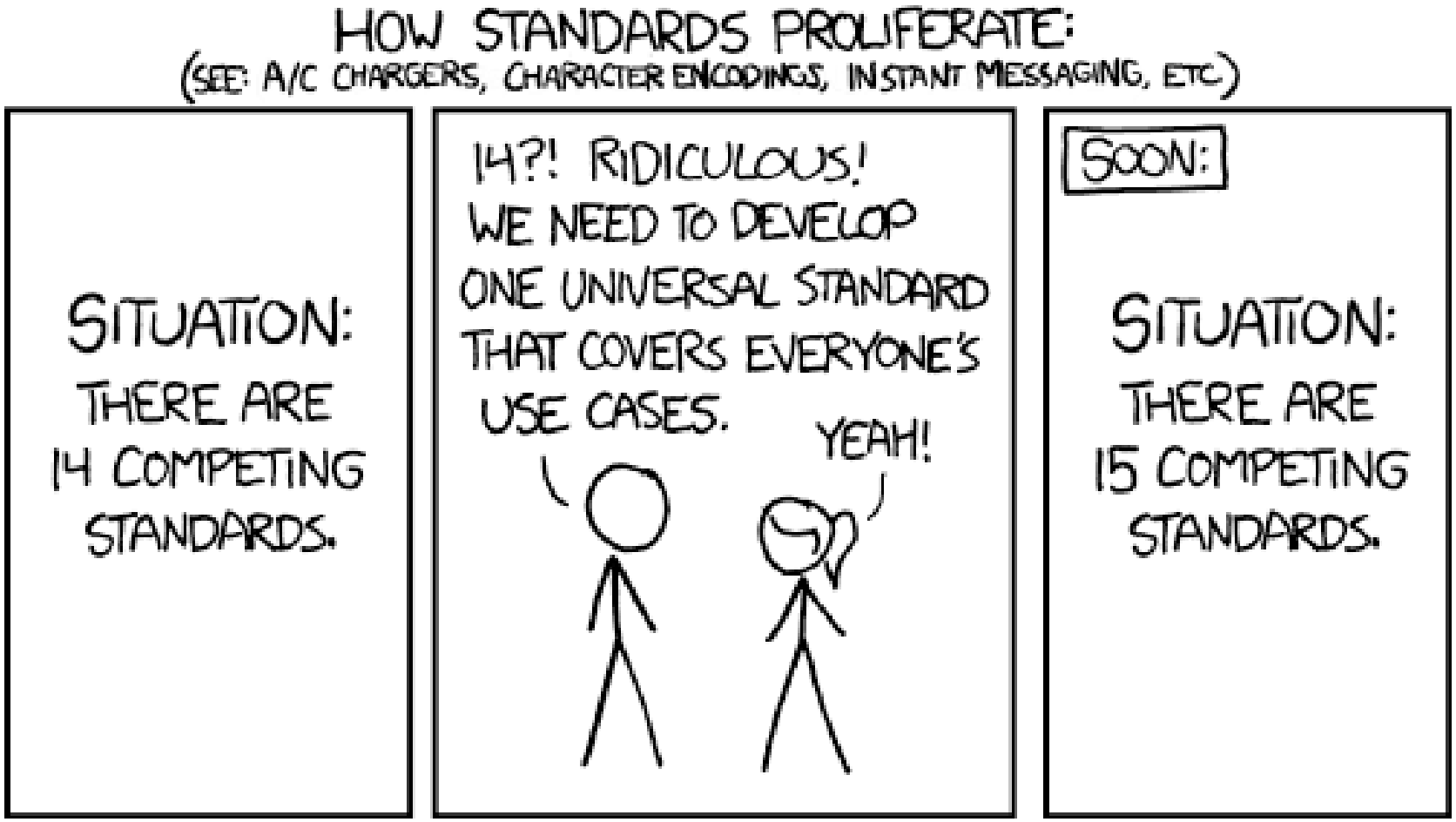
For any system there is a certain amount of complexity which cannot be reduced

Grahame Grieve's Second Law of Interoperability

Complexity: you can move it around, or externalize it, but you can't make it go away



Lossy mappings = Degraded data



https://xkcd.com/927/

Grahame Grieve's First Law of Interoperability

Interoperability: it's all about the people

"the real problems with interoperability are not technical. They've never been technical. It's the people that are the problem, because IT systems are only extensions of the people who wrote them, who maintain them, who use them. If you want two IT systems to interchange data successfully, you've got to get alignment between the people who write them, manage them, and use them. The technical challenges the system maintainers face when making changes are miniscule compared to the problem of getting the various people to agree with each other."

http://www.healthintersections.com.au/2011/04/09/law-1-interoperability-its-all-about-the-people.html

Graphs of Graphs

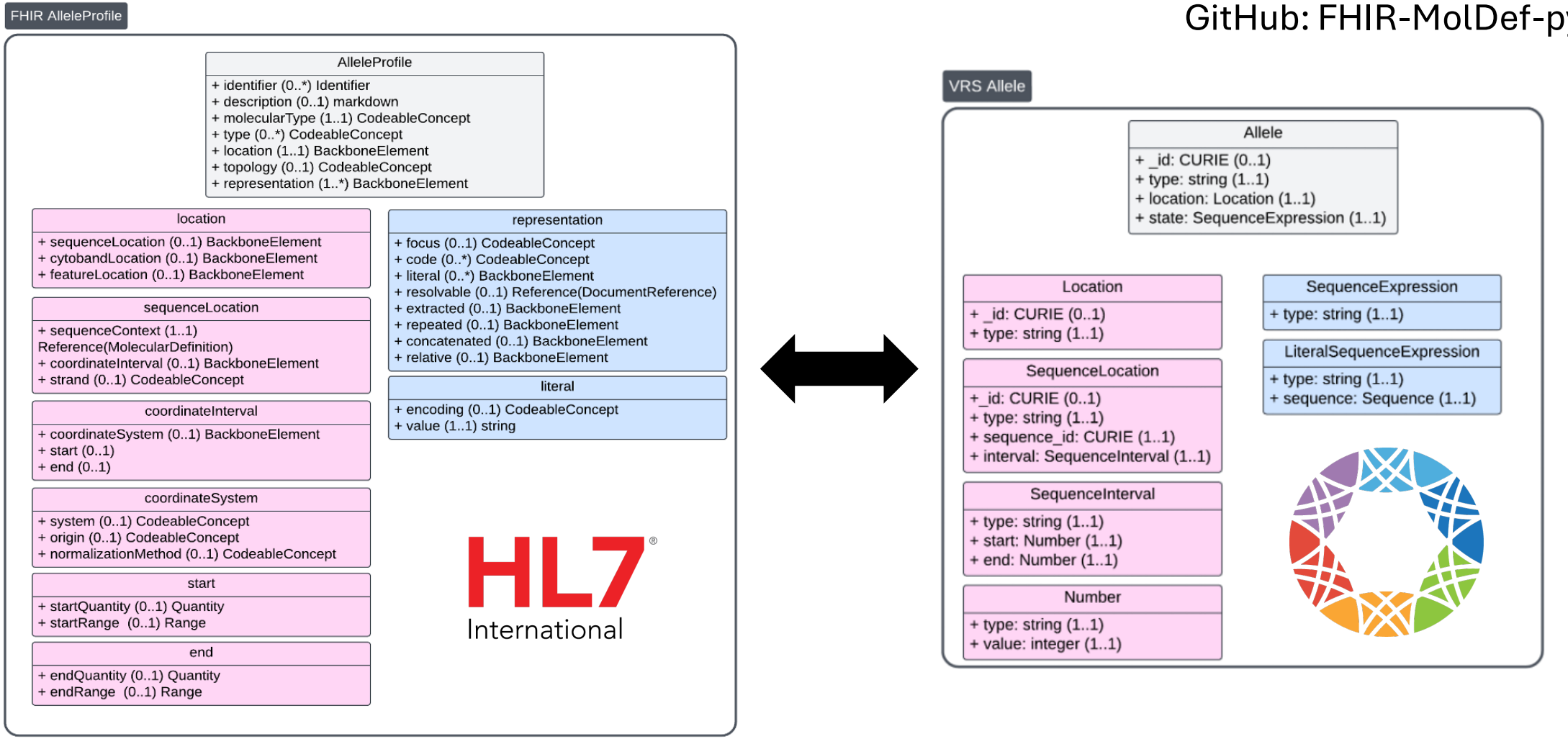
Clinical Guidance

Patient Data

Biomedical Knowledge

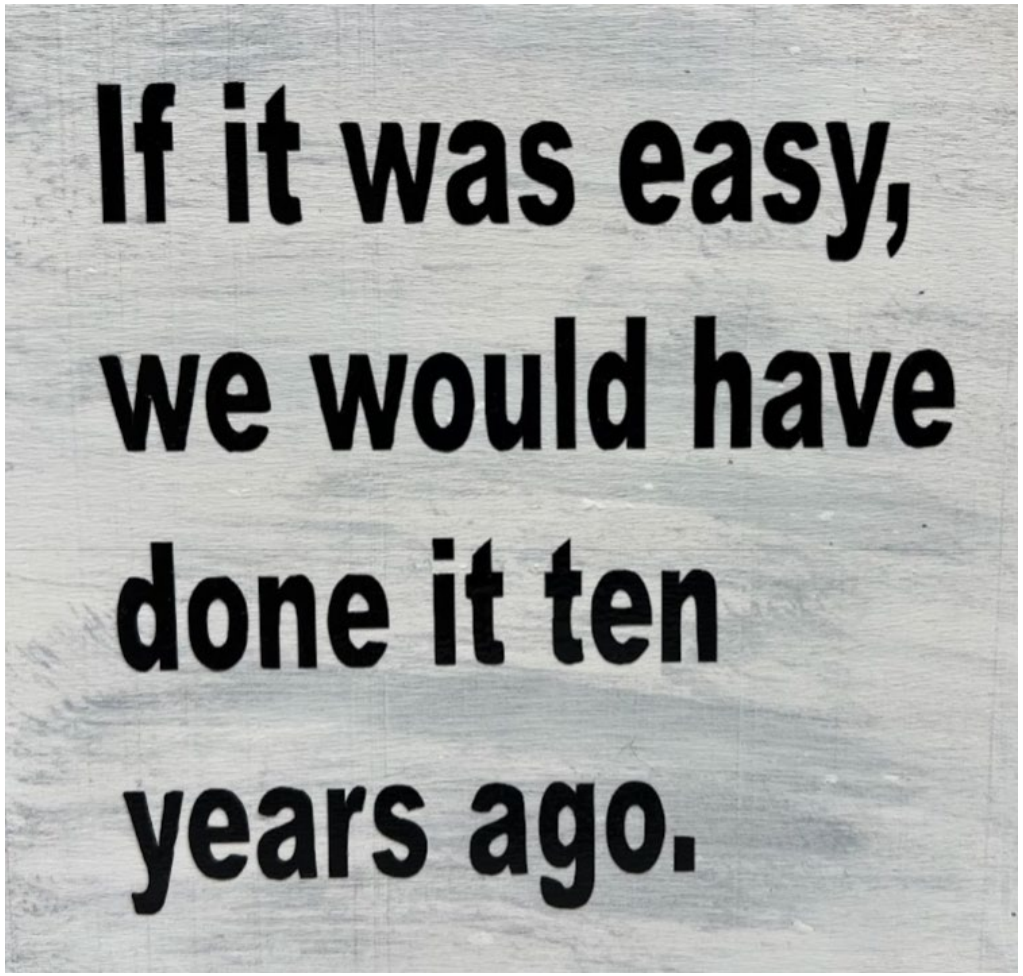
Semantically Aligned Specifications

GitHub: FHIR-MolDef-python



Isn’t there an easier way?

- Can we just use AI to do it?
  - Grahame’s First Law of Interoperability: it’s about the people
- Robust data standards are necessary but not sufficient for interoperability
  - Agreement on semantics
  - Conformant implementations
  - Conformant usage (data)



AI and Clinical Genomic Data

Reality check:

Clinical data are messy!

- Not enough time
- Not enough incentive
- It is too difficult

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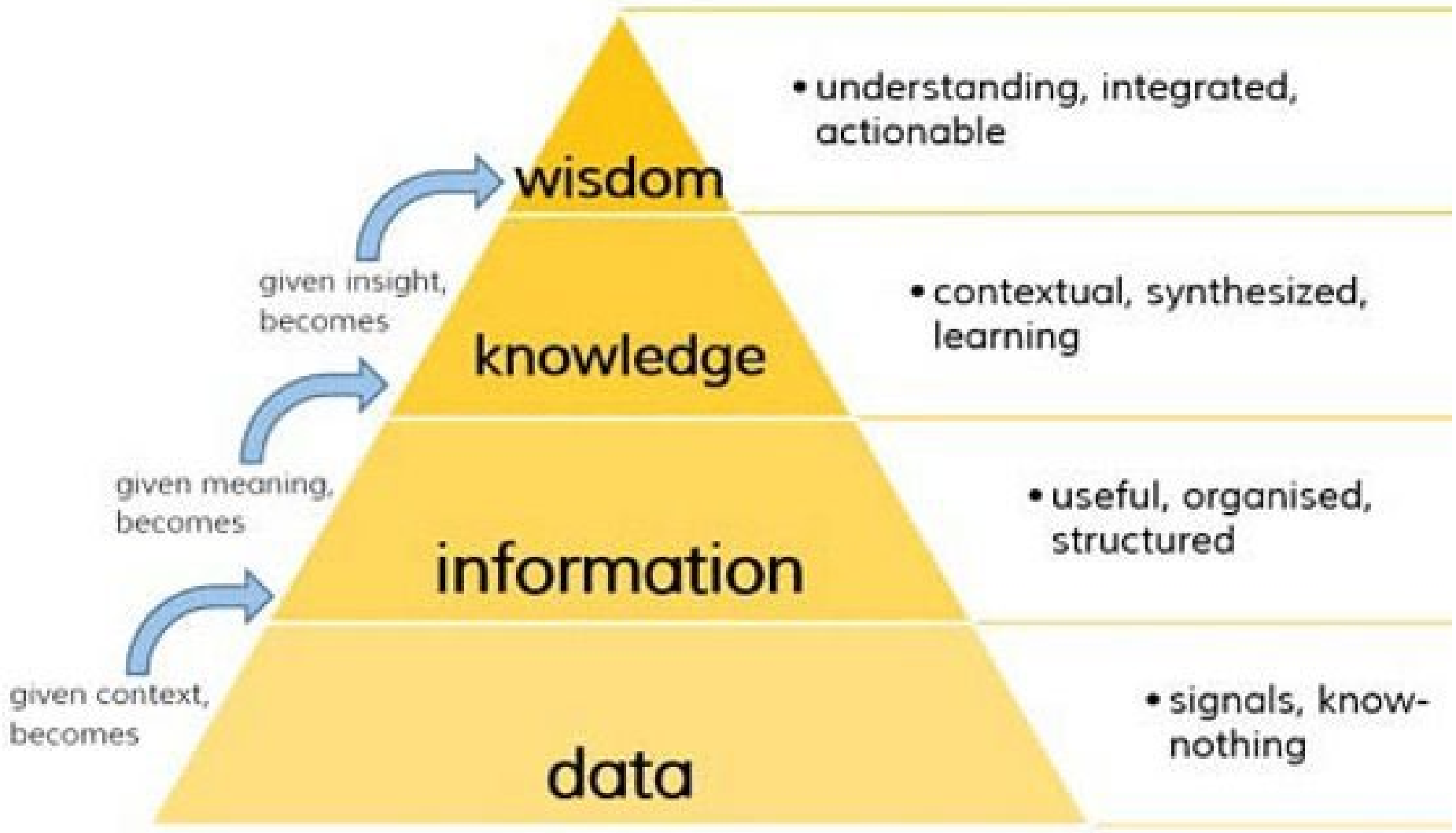
AI can help eliminate the toil!

- Automated QC
- Propose corrections
- Improve quality, computability, and semantic expressivity
- Rigor assured through scientific domains of medical informatics, data science, and knowledge representation

Data is Foundational



https://dmice.ohsu.edu/hersh/whatis/

Imperatives for AI, Genomics, & Precision Medicine

Locally: Invest in data as an asset and enabling resource

- Representation
- Governance

Within a Community: Prioritize robust semantics

- Support complexity of the domain
- AI-assisted QC and enrichment

Globally: Actively work towards harmonization

- Required for interoperability
- Requires change in culture

Thank you!

