Multi-Level, Multi-Modal CCF UIs for Data Providers and Users within the Human BioMolecular Atlas Program (HuBMAP)

MC-IU Team:

Katy Börner, Jim Sluka, Lisel Record, Bruce Herr II, Ellen Quardokus, Andreas Bueckle, and Leonard Cross

Intelligent Systems Engineering, School of informatics, Computing and Engineering
Indiana University, Bloomington, IN

Griffin Weber, Harvard Medical School, Boston, MA

Y2/Q1 Demo Day, Stanford University

September 23, 2019

HIVE MC-IU Summary

Y2 Q1 Progress Report

- A1.Q1.M1: Develop preliminary metadata specification for the CCF UIs and submit to TMCs for comments.
- A2.Q1.M1: Develop Tissue Registration UI v0.5.0
- A3.Q1.M1: Run User Studies on CCF UI v0.5.0
- A3.Q1.M2: Identify VHMOOC Topics and Timeline; Record PI Interviews at HuBMAP meeting in September.
- A4.Q1.M1.a: Plan next CCF Workshop
- A5.Q1-M1.b: Collaborate with MC-NYGC on developing mapping tools to support Consortium data releases, TCs on integration of maps with the data portal, and IEC for the infrastructure needed for CCF and CCF UIs.

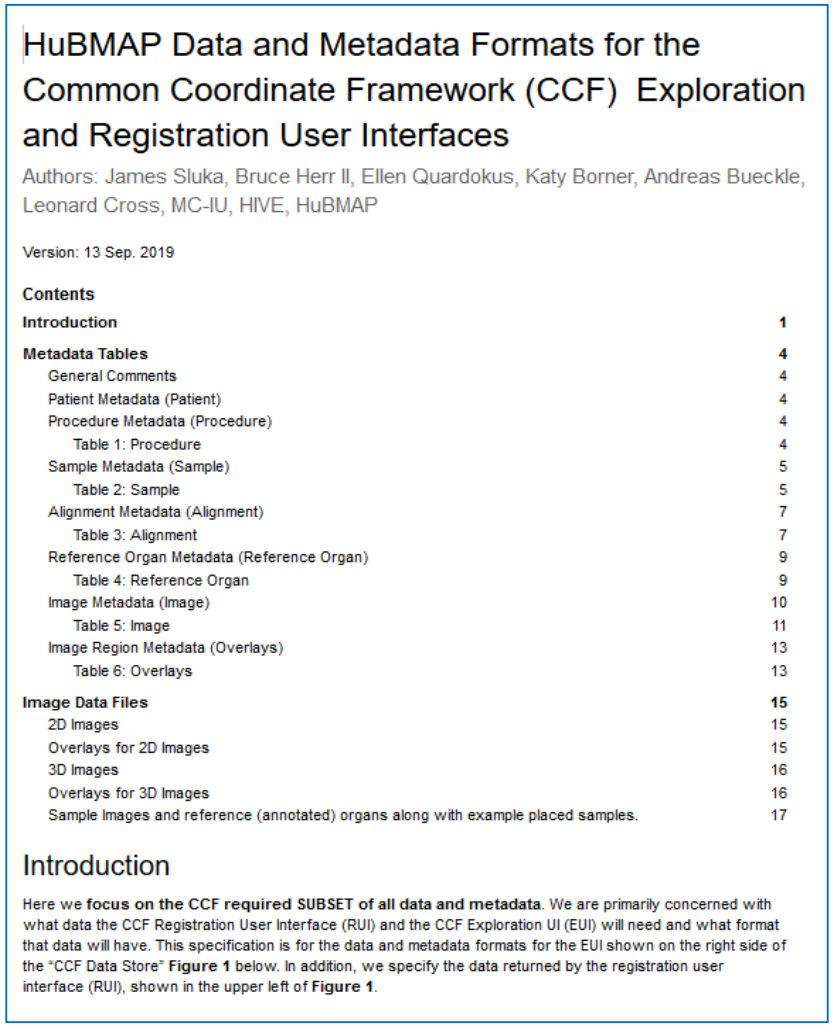
Y1 Q3 Result – CCF Data & Metadata

MC-IU has released “HuBMAP Data and Metadata Formats for the Common Coordinate Framework (CCF) Exploration and Registration User Interfaces”

Shared with the HuBMAP consortium
https://tiny.cc/ccf-data

All questions and comments are welcome.

WANTED: Comments



HuBMAP Data and Metadata Formats for the Common Coordinate Framework (CCF) Exploration and Registration User Interfaces

Authors: James Sluka, Bruce Herr II, Ellen Quardokus, Katy Borner, Andreas Bueckle, Leonard Cross, MC-IU, HIVE, HuBMAP

Version: 13 Sep. 2019

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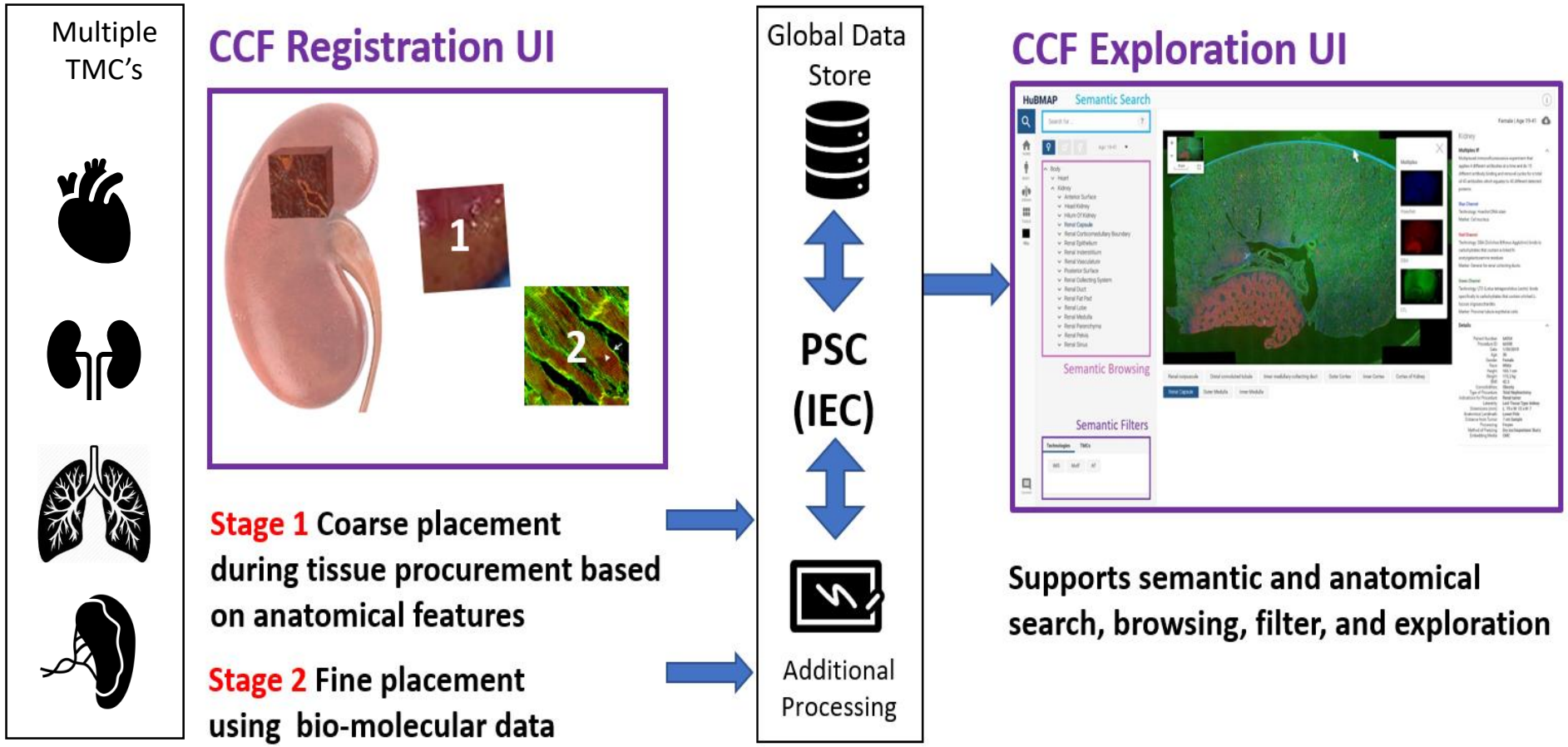
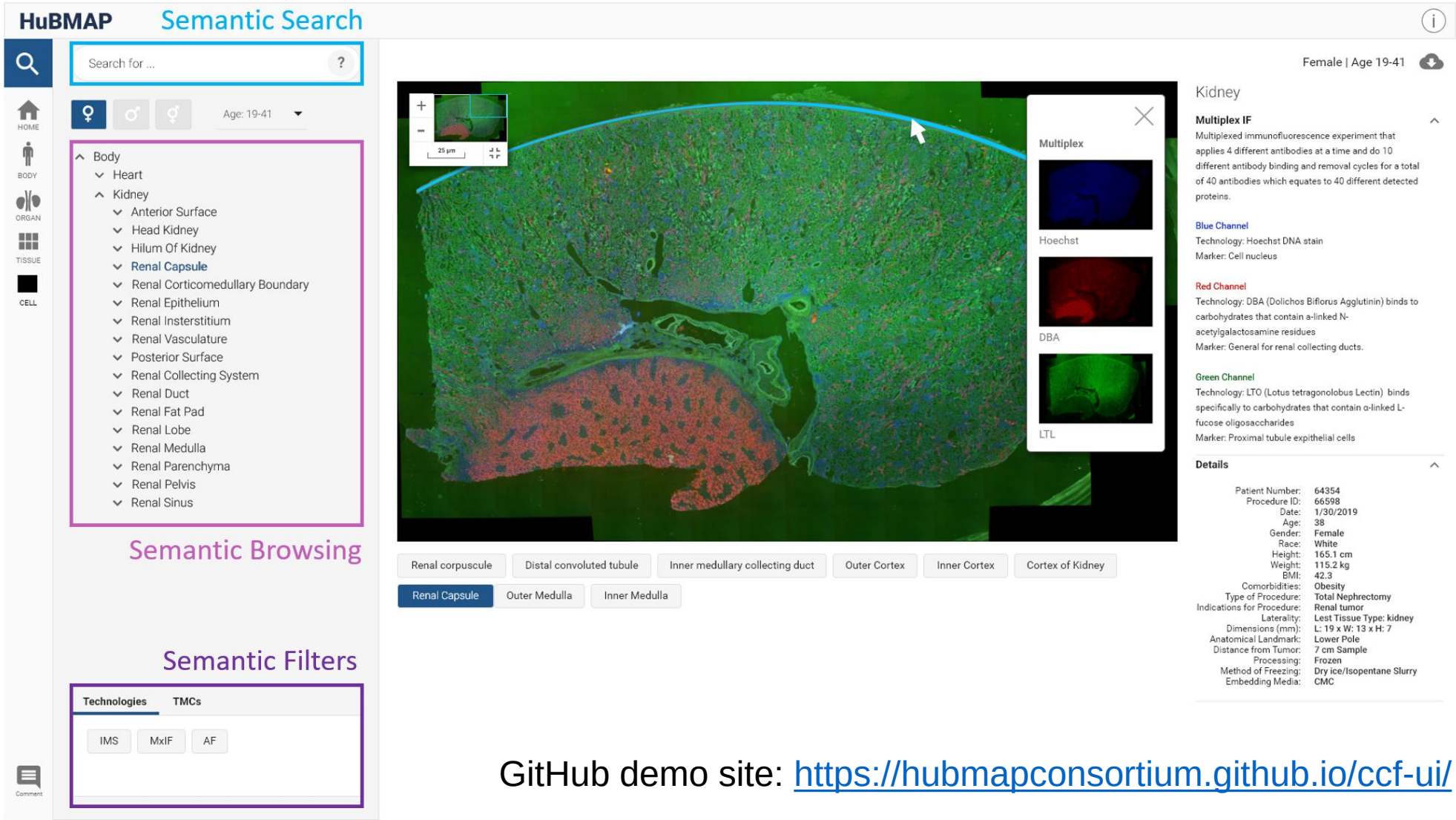
Introduction

Here we **focus on the CCF required SUBSET of all data and metadata**. We are primarily concerned with what data the CCF Registration User Interface (RUI) and the CCF Exploration UI (EUI) will need and what format that data will have. This specification is for the data and metadata formats for the EUI shown on the right side of the “CCF Data Store” **Figure 1** below. In addition, we specify the data returned by the registration user interface (RUI), shown in the upper left of **Figure 1**.

CCF Registration & Exploration UIs

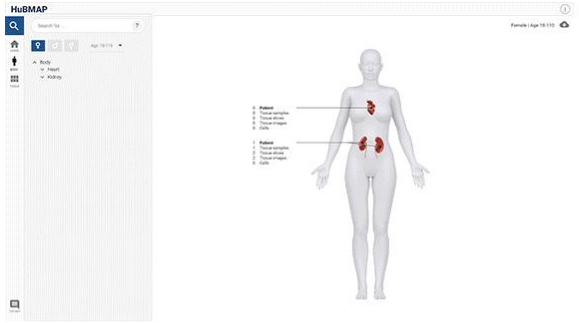


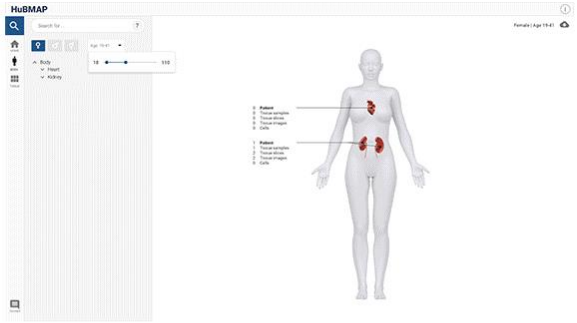
Y1 Q3 Result - CCF **Exploration** User Interface

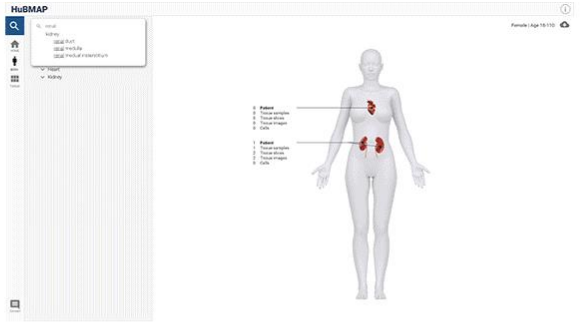


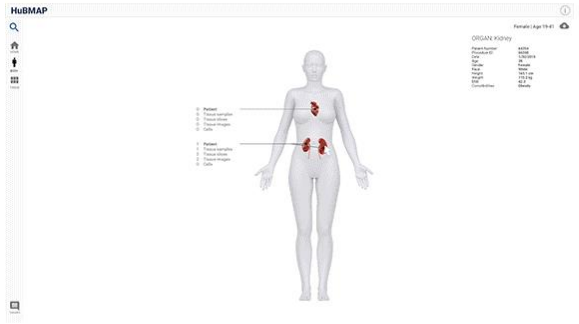
GitHub demo site: https://hubmapconsortium.github.io/ccf-ui/

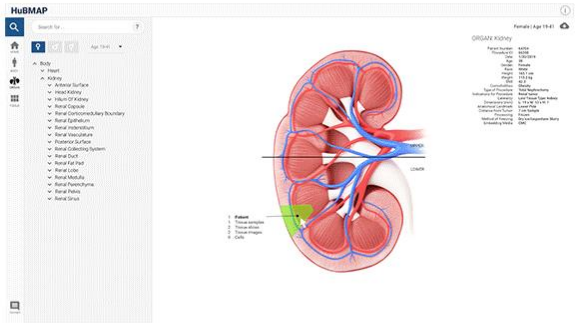
Y1 Q3 Result - CCF **Exploration** User Interface

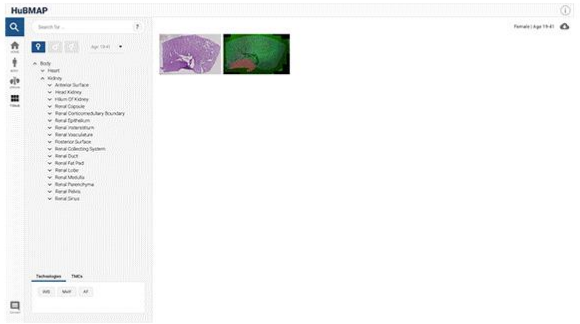


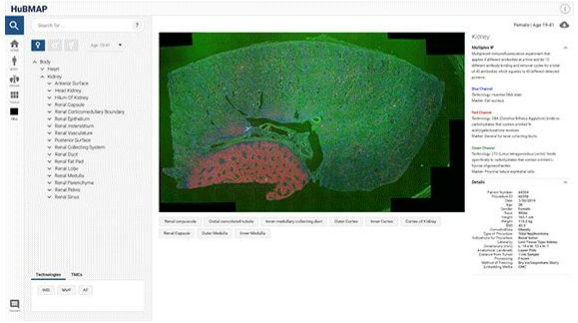


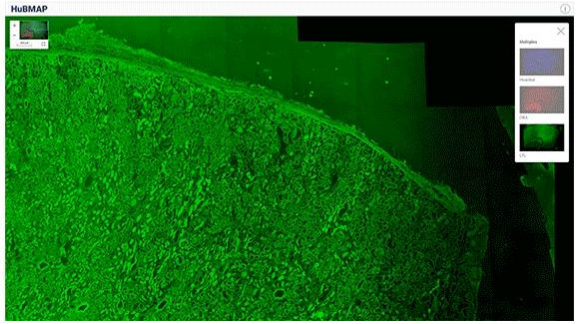


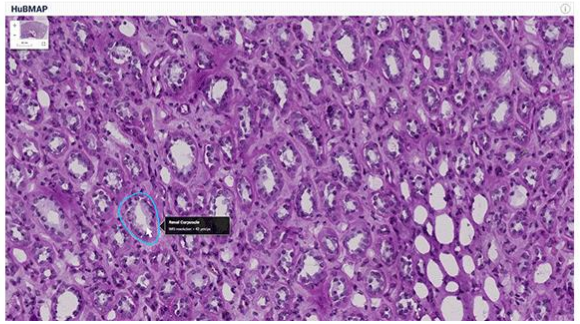












Y1 Q3 Result - CCF **Exploration** User Interface

MC-IU has released CCF user interface v0.5.0, a proof-of-concept version of the CCF UI.
The user interface supports:

- Visual browsing of tissue samples and metadata at the whole body, organ, tissue, and cell level.
- Filtering by metadata (age, gender, TMC, and technology), results are presented at all views.
- Submission of questions and comments on the CCF UI.
- Semantic search by ontology, results are presented at all levels.
- Data download at the whole body, organ, tissue, and cell level, i.e., link to https://sampledata.hubmapconsortium.org.

See also:

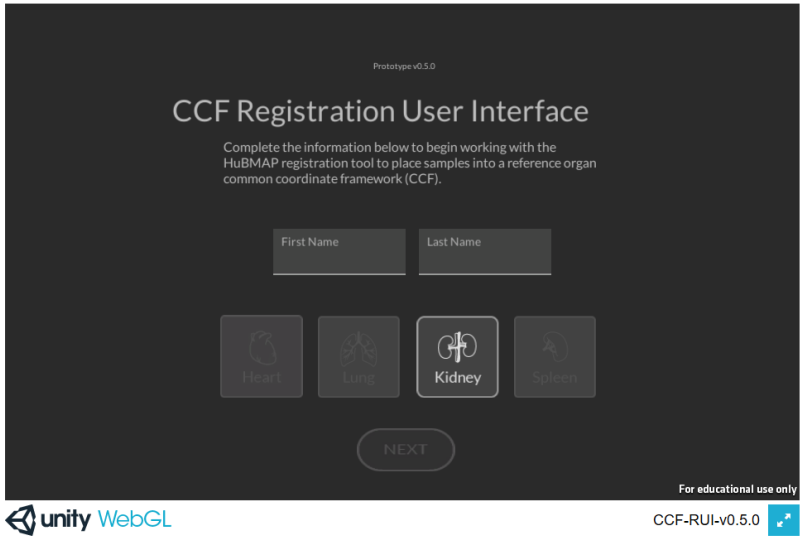
Recorded demo: https://www.youtube.com/watch?v=rWMqKQc_00w&feature=youtu.be
GitHub link to code: https://github.com/hubmapconsortium/ccf-ui
GitHub demo site: https://hubmapconsortium.github.io/ccf-ui/
Original specs: https://drive.google.com/open?id=1tqUzmVLxwqcGprtRIevfY86YvHHPEsDR

Y2 Q1 Result - CCF **Registration** User Interface

MC-IU has released the CCF Registration User Interface (RUI) v0.5.0 prototype

The user interface supports:

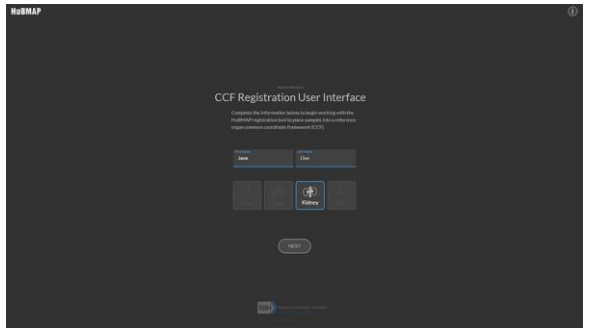
- Registration of tissue samples in human kidney
- Collection of alignment operator name, date, UUID, etc.
- Tissue slice dimensions
- Copy + paste of JSON file
- Usage via web browser

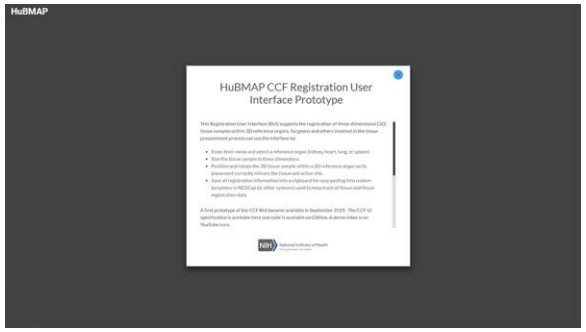


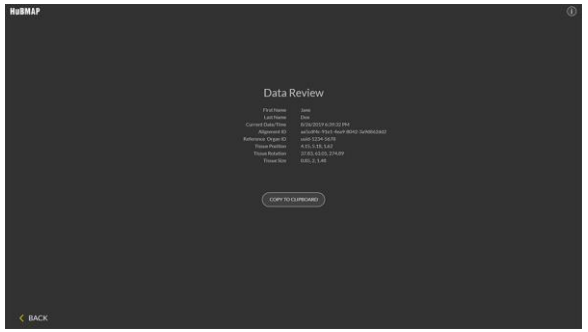
RUI Intro Page. Prototype built using Unity 3D.

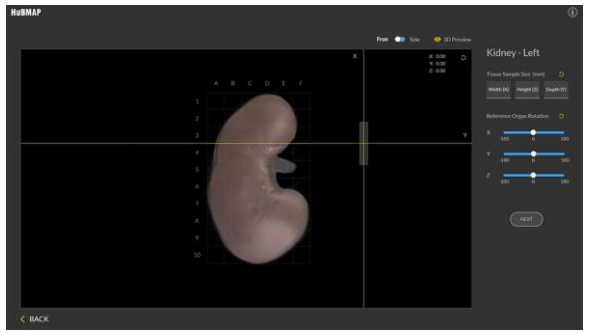
Y2 Q1 Result - CCF **Registration** User Interface

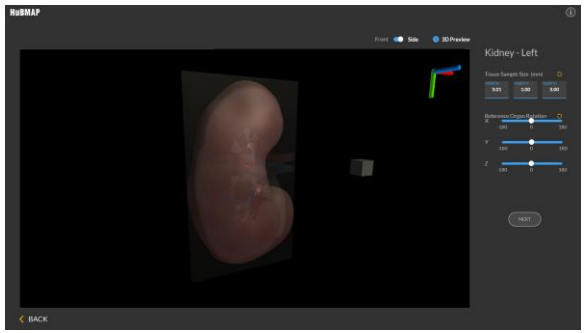
RUI SCREENS

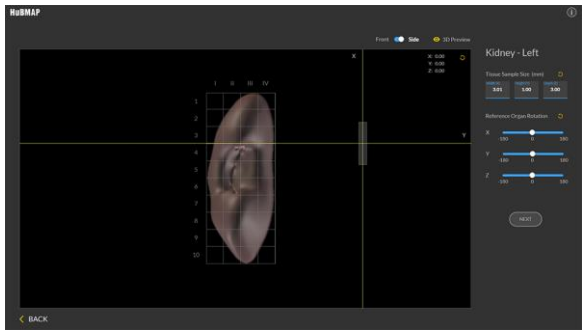










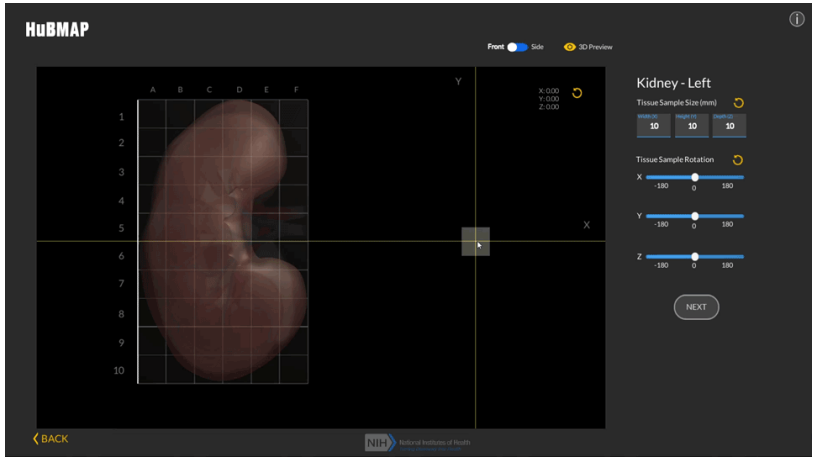


Link to RUI Prototype v0.5.0: https://hubmapconsortium.github.io/ccf-3d-registration/

Y2 Q1 Result - CCF **Registration** User Interface

USER STUDIES

Working with HuBMAP partners to gather UX insights we registered five (5) samples through the RUI prototype. Insights from the recorded Zoom sessions are helping us produce future refinements.



Participants:

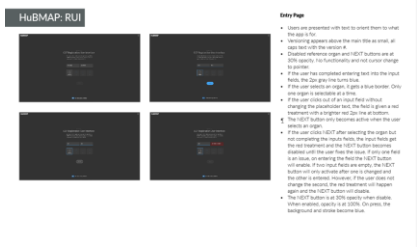
- Jeff Spraggins, Research Assistant Professor (TMC-Vanderbilt)
- Elizabeth Neumann, Postdoctoral Researcher (Vanderbilt)
- Sanjay Jain, Associate Professor of Medicine (TMC-WUSTL)
- Bernard de Bono, MD PhD (SPARC) and Susan Tappan, Scientific Director (MBF Bioscience)

Y2 Q1 Result - CCF **Registration** User Interface

RESOURCES

Recorded Unity Tech Demo
https://www.youtube.com/watch?v=E8GGcpPsohc

GitHub Prototype
https://hubmapconsortium.github.io/ccf-3d-registration/



Original Specs
https://iu.box.com/s/zcgvlfbxbo9co0dxozeiye70qtx8uqzq

Visible Human MOOC Topics and Timeline

Topics

1. Introduction to HuBMAP with interviews of lead PIs at Stanford U
2. New single-cell technologies and data processing pipelines
3. CCF ontologies and the CCF registration and exploration user interfaces
4. Biomolecular data harmonization and Seurat
5. HuBMAP Portal design and usage

Timeline

- Sept 30: Identify VHMOOC topics (see above 5) and develop a recording timeline
- Dec 31: Use Stanford U event to interview key experts
- March 31: Record other VHMOOC content
- June 20: Deploy initial 5 videos in Visible Human MOOC as part of first HuBMAP Portal release

Next Year's Deliverable in 1 slide

CCF Ontology

- V1.0.0 Data format specifications for image data including specification of identified regions
- Patient, sample and technology metadata ontologies for kidney, heart, lung, and spleen in collaboration with TMCs

CCF User Interfaces

- Go from Proof of Concept to fully-realized application
  - Support kidney, lung, heart and spleen data (need adequate standard organ models)
  - Integrate Tissue Registration UI data
  - Integrate expanded CCF Ontology
  - Connect to data/queries via IEC APIs and infrastructure
- Collaborate on a common Tissue Viewer with Nils' team at Harvard U
- Four 3-week sprints are scheduled starting Oct 21, 2019, Feb 17, Apr 21, and May 12, 2020.

Collaborations

- Tissue viewer development with Nils' TC-Harvard (HuBMAP supplement)
- ImageVu large number of CT scans needed for the CCF (Vanderbilt supplement)
- Stage 2 biomolecular registration in RUI (KPMP GLUE grant pending)

- Jim Sluka is interacting with NIH projects: GenitoUrinary Development Molecular Anatomy Project (GUDMAP), Rebuilding a Kidney (RBK) and Kidney Precision Medicine Project (KPMP)
- Kristen Brown (Oliver Bodenreider) NLM, NIH: Segmented and annotated CT scans of VH organs
- Bernard deBono (SPARC): ApiNATOMY ontology & extending Registration UI to biopsy data
- Multiple experts at Allen: Adding a brain to the Exploration UI
- KitWare: Develops and distributes several software packages funded by the NIH and other US government entities, develops UIs for Allen Human Brain Atlas.

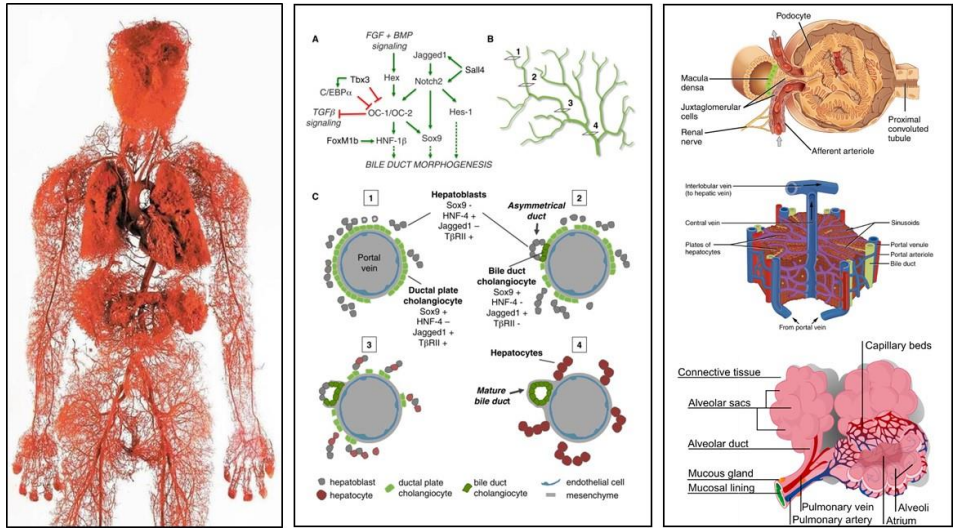
Barriers to collaboration:
Need an official means to share data, documents, discussions with teams outside of HuBMAP.

What should HuBMAP Do ?

- TMC-Vanderbilt uploaded new data with imaging MS, AF microscopy, PAS stained microscopy, Multiplexed IF microscopy, instrument metadata, CCF spatial metadata (via RUI), all spatial transform metadata files, all protocols (protocols.io), and clinical metadata. Let's use this data to test the entire pipeline—from **CCF Registration UI** to **CCF Exploration UI**.
- Sanjay Jain and Blue Lake recently shared single-cell data of different origin and representing two 2 different technologies (SPLIT-Seq and 10X). Rahul Satija use Seurat to harmonize the data. IEC should review data and harmonization workflow and consider supporting code like Seurat and alternatives.
- ASAP: Decide what will be in the 2020 HuBMAP Release.

One Alternative CCF: Vascular CCF

- Instead of a 3D Cartesian coordinate system, one alternative is a "Vascular CCF", where the position of cells are described relative to the nearest blood vessel.
- This isn't a CCF of the vascular system. It is a CCF of the tissue surrounding vessels, using the vascular pathways as an axis of a coordinate system.
- Vessels are unique in that they:
  - reach with ~100 micrometers of every living cell to deliver oxygen
  - scale seamlessly from macro- to meso- to micro- levels
  - form the scaffolding of functional units in organs
  - can be identified histologically, gene expression, hypoxia levels, etc.
  - adapt to different body sizes and shapes
  - drive organogenesis (development of organs around vasculature)
  - used clinically to localize tissue, plan surgery, diagnose disease, etc.
- Next step: experiments to test whether it is possible to register cell location using a vascular CCF
- Thinking through a biological-based coordinate system helps us understand the benefits and limitations of a 3D Cartesian system.



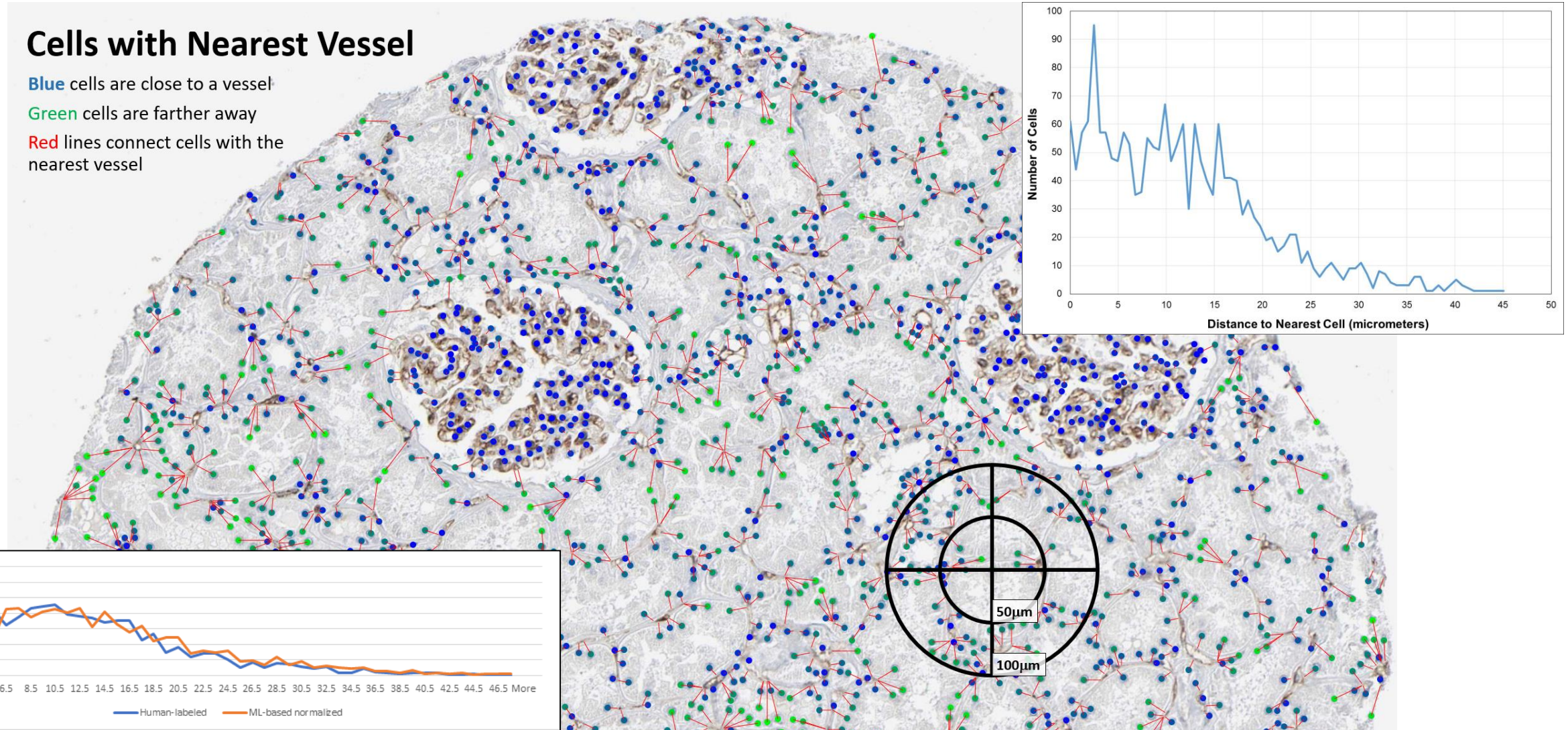
- https://www.pinterest.jp/pin/522699100479032485/
- Si-Tayeb et al, Developmental Cell 2010
- Anatomy & Physiology, Connexions Web site. http://cnx.org/content/col11496/1.6/
- https://en.wikipedia.org/wiki/Pulmonary_alveolus#/media/File:Alveolus_diagram.svg

Vascular CCF

Griffin Weber, Zorina Galis, Yingnan Ju

Using data from the Human Protein Atlas

WANTED: Tissue Data



Acknowledgments

Jeffrey Spraggins

TMC-Vanderbilt

Vanderbilt University

Sanjay Jain

TMC-UCSD

Washington University, St. Louis

https://hubmapconsortium.org

MC-IU HIVE Team at IU

Plus, **patients** that agreed to volunteer healthy tissue and to use their data openly.