For this NIH project, we have modeled two common cardiac surgeries:

- AVR (Aortic Valve Replacement)

- CABG (Coronary Artery Bypass Grafting)

Each cardiac surgery model consists of the following phases:

00. Patient Arrival

01. Pre-induction

02. Anesthesia induction

03. Sterile prepping

04. Pre-incision timeout

05. Sternotomy

06. Vessel harvesting (only for CABG)

07. Heparinization

08. Aortic cannulation

09. Initiate CPB

10. Clamp aorta and deliver cardioplegia

11. Aortomy (for AVR) or Anastomoses (for CABG)

12. Separate from bypass

13. Sternal closure

14. Patient departure

For all of the OR cases, we have the high-level process execution events (manual annotations in the OR videos) corresponding to the above phases.

Additionally, we have the abstracted phases from SterileCockpitForCardiacSurgery.pdf (in the Validation directory):

01. Preparation and induction // Pre-induction, Anesthesia Induction

02. Opening // Pre-incision Time-out, Vessel Harvesting, Sternotomy

03. Pre-bypass preparation // Heparinization, Aortic Cannulation

04. Initiate CPB and arrest heart // Initiate CPB, Clamp Aorta and Deliver

Cardioplegia

05. Surgical repair // Anastomoses - Aortotomy

06. Wean from bypass // Separate from Bypass

07. Closure // Sternal Closure

08. Post-operative // End of Sternal Closure or end of Patient Departure

(NOTE: The Sterile prepping high-level step was not mapped to an abstracted phase. This leads to a gap.)

For now, we have been focusing on the Separate from bypass (Phase 12) consisting of the following substeps:

12.1. Restart ventilation

12.2. Prepare to start coming off bypass

12.3. Reduce CPB pump flow to half

12.4. Assess heart function then consider inotropic/vasoactive support

12.5. Consider reducing CPB pump flow to 1 L/min

12.6. Consider terminating bypass

For four of the OR cases, we also have the lower-level process execution events corresponding to the above substeps.

For the cardiac surgeries, the 4 specialty teams are:

- Anes: Anesthesia

- Nurs: Nursing

- Perf: Perfusion (operates the heart-lung machine)

- Surg: Surgery

The HRV parameters of interest are:

- LF/HF ratio // Higher values correspond to higher cognitive load

- Mean RR // Lower values correspond to higher cognitive load

- PNS index (<https://www.kubios.com/hrv-ans-function/>) // Lower values correspond to higher cognitive load

- RMSSD // Lower values correspond to higher cognitive load

- SNS index (<https://www.kubios.com/hrv-ans-function/>) // Higher values correspond to higher cognitive load

For each HRV parameter, we computed the following:

- the raw value within a particular time period (e.g., phase, substep)

- the maximum raw value in the phase or entire surgery

- the minimum raw value in the phase or entire surgery

- the normalized value defined to be ((the raw value - the minimum value) / (the maximum value - the minimum value))

For each OR case, there are the following directories and files:

- \*-abstractedPhases.csv: These abstracted phases are adopted from:

SterileCockpitForCardiacSurgery.pdf (in the Validation directory).

- \*-events.csv: All of the process annotations

- cognitiveLoad-phases-1min: The entire surgery is decomposed into the phases where the HRV analysis time window is 1 minute.

- cognitiveLoad-phases-5min: The entire surgery is decomposed into the phases where the time window is 5 minutes.

For a few of the OR cases, there are also the following directories:

- cognitiveLoad-phase12-substeps-abstracted-1min: Separate from bypass (phase 12) is decomposed into the abstracted steps where the time window is 1 minute.

- cognitiveLoad-phase12-substeps-abstracted-5min: Separate from bypass (phase 12) is decomposed into the abstracted steps where the time windon is 5 minutes.

For each directory, there are the following files:

- \*-hlSteps-only.csv: This is a listing of the high-level process execution events.

- \*-output\_table.csv: The first table has rows for the 4 specialty teams and columns for the minimum and maximum values of the 4 HRV parameters. The second table has rows for the events and columns for each team for each HRV parameter for both the raw value of that parameter and the normalized value of the parameter.

The Validation directory contains two papers:

- SterileCockpitForCardiacSurgery.pdf: Figure 1 contains the cognitive loads for the teams.

- CognitiveTaskAnalysis.pdf: Figure 2 contains the cognitive loads for the teams.

For each case directory, there are additionally the following files for validation purposes:

- \*-cognitiveLoad-\*.csv: For each HRV parameter, the rows are the teams and the columns are the events. The cells contain the normalized HRV parameter values.

- \*-processEventRank-\*.csv: For each HRV parameter, the rows are the teams and the columns are the events. The cells contain the ranks (i.e. indices in the sorted list of normalized HRV parameter values)