



Objective Surgical Skill Assessment of Computer-Aided Hysterectomy Procedures

Checkpoint Presentation

Group 12

Student

Elif Bilgin
ebilgin1@jhu.edu

Mentors

Anand Malpani, PhD
amalpan1@jhu.edu

Molly O'Brien, BS
mobrie38@jhu.edu

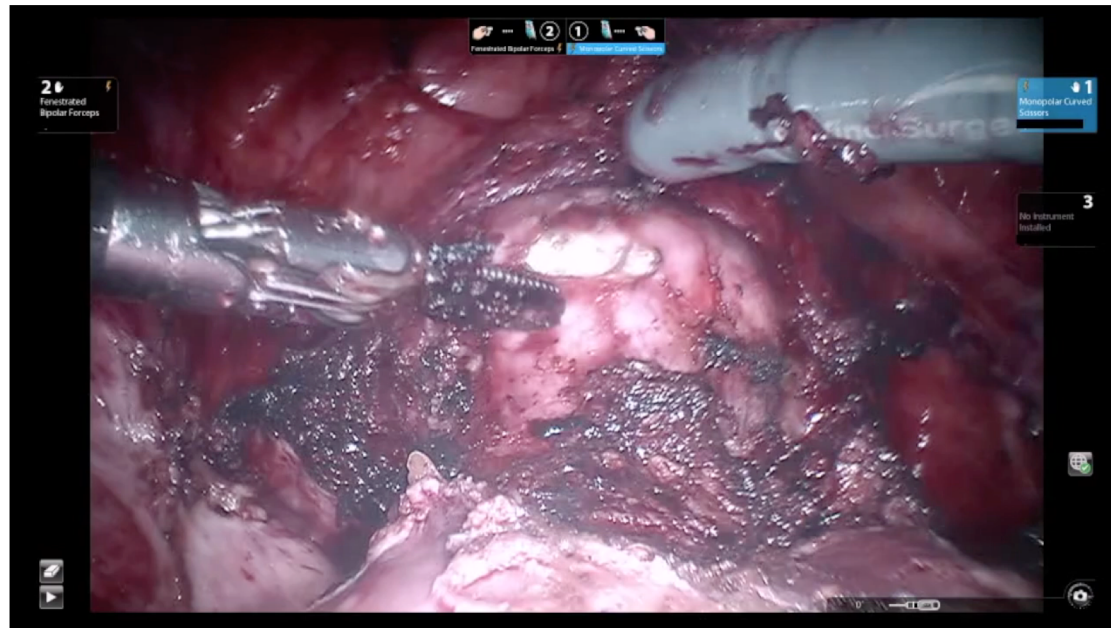
Clinical Collaborator

Chi Chiung Grace Chen, MD MHS
(Gynecology & Obstetrics)



Hysterectomy Procedure

- **Hysterectomy** is the process of the removal of the uterus
- **Colpotomy** is a particular step in the hysterectomy procedure where the connective tissue attaching the uterus to the vaginal opening is removed to release the uterus before removal



20x Speed - Video provided by mentor

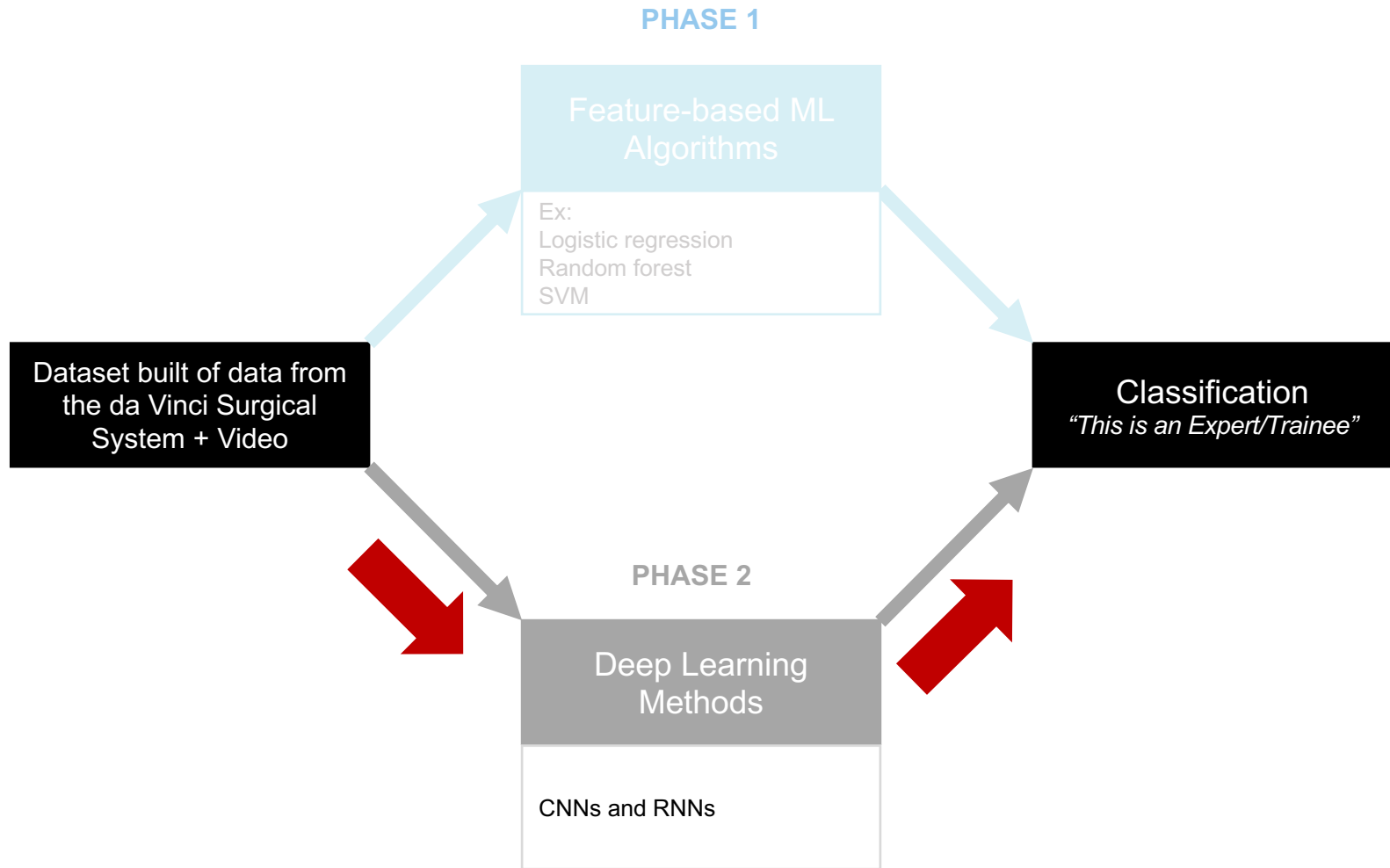
Objectives

- Automatically assess skill in robot assisted hysterectomy procedures, particularly the **colpotomy** step.
- Using video footage from procedures at Johns Hopkins Hospital, as well as motion data from the da Vinci Surgical System.



Image taken from official webpage of Intuitive Surgical

Technical Approach



Progress

1. Go through each surgery file to find the exact intervals of colpotomy (there are multiple)
2. Locate these intervals in user change files, and extract user change files for only the colpotomy step. Do the same for energy usage files.
3. Using these user change files, extract colpotomy motion data (per PSM) and energy usage data (per instrument), for each user change, in each surgery, during colpotomy.
4. Calculate duration, count and path length for each feature.



Dataset Features

- 19 features
- 29 surgeries

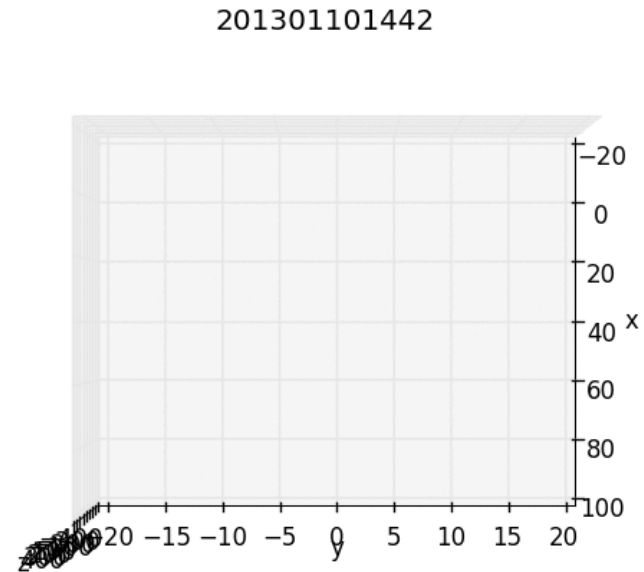
SURGERY_NAME	USER	COLPOTOMY_INTERVAL	TOTAL_DURATION	BIPO_COAG_DURATION	MONO_COAG_DURATION	MONO_CUT_DURATION	BIPO_CUT_DURATION	ENERGY_DURATION	TOTAL_PATH	BIPO_COAG_PATH	MONO_COAG_PATH	MONO_CUT_PATH	BIPO_CUT_PATH	ENERGY_PATH	TOT_INTERVAL_COUNT	BIPO_COAG_COUNT	MONO_COAG_COUNT	MONO_CUT_COUNT	BIPO_CUT_COUNT	ENERGY_COUNT
201307030858	R	1	293.3763	13.3988	0	99.315	0	112.7604	1542.3401	28.3094553	0	167.89718	0	196.264248	1	2	0	22	0	24
201307030858	A	1	108.2755	0	42.1079	2.7471	0	44.8555	853.337578	0	71.5903751	9.90069339	0	81.4910685	1	0	9	1	0	10

-
-
-



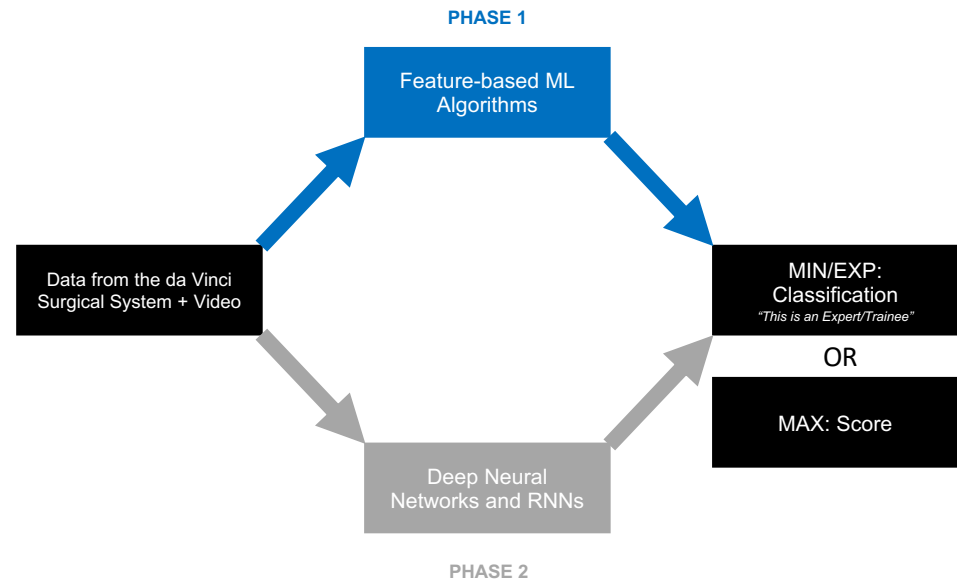
Problems

- Some work done for statistic collection and exploration of available data was not fruitful
- Creating the dataset and validation also took longer than expected



Updates

- Max deliverable needed to be updated:
 - Availability of surgeon time
 - Complexity of how we should acquire scoring from surgeons
- Decided to focus efforts on improving accuracy instead



Updated Deliverables

OLD

Minimum deliverables:

Gather statistics on video and motion data and apply feature-based ML methods to get an Expert/Trainee classification

Expected deliverables:

Use deep neural networks such as CNNs and RNNs to get an Expert/Trainee classification

Maximum deliverables:

~~Use the Phase 1 & 2 approaches and use regression to get a skill score~~

NEW

Minimum deliverables:

Gather statistics on video and motion data and build a training dataset

Expected deliverables:

Apply feature-based ML methods to get an Expert/Trainee classification

Maximum deliverables:

Use deep neural networks such as CNNs and RNNs to get an Expert/Trainee classification with an accuracy at or above 80%



Preliminary Results

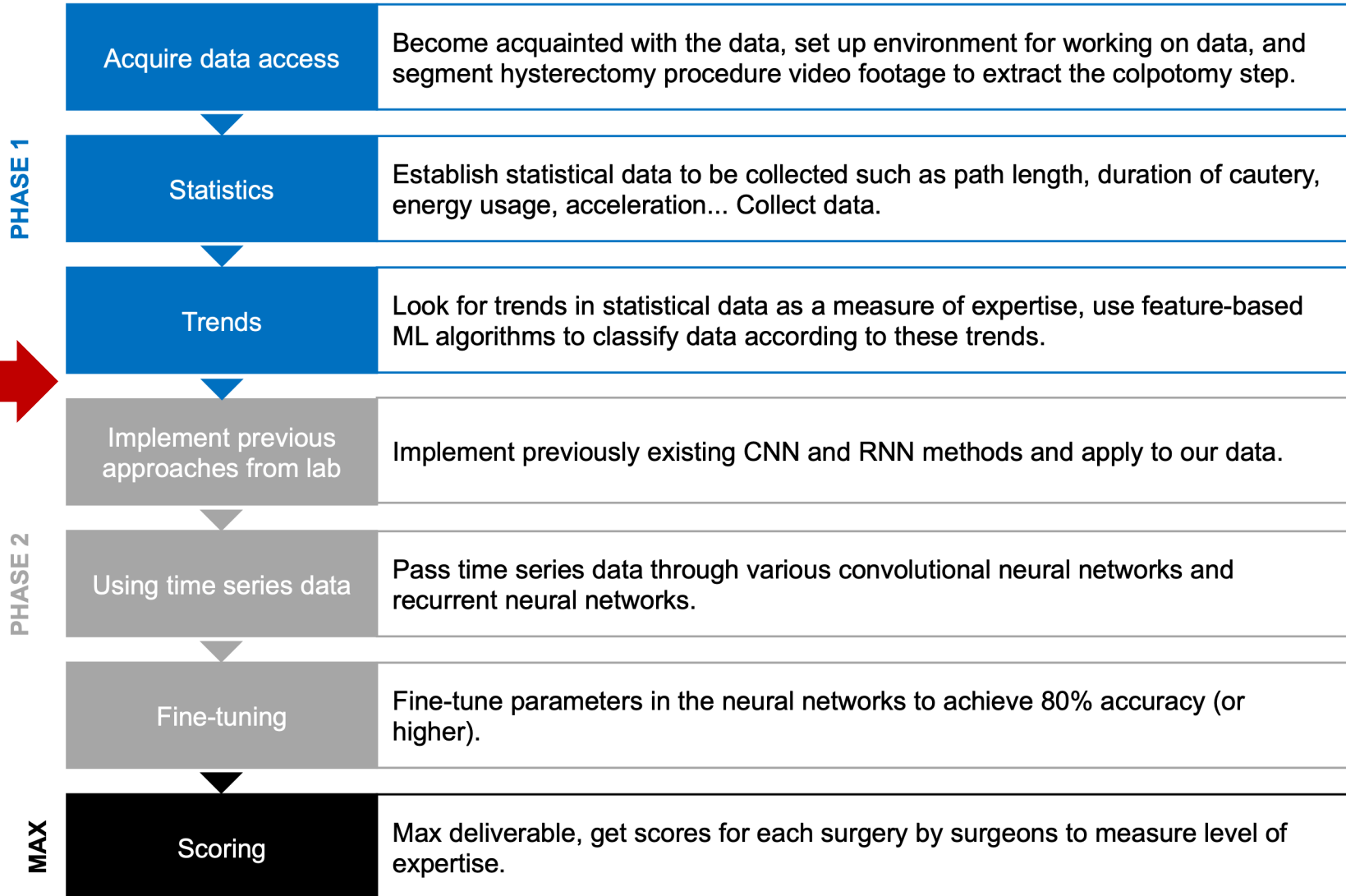
- Used K-fold cross-validator to split dataset into train/test sets (N-Splits = 10)
- Using all features to make prediction using scikit-learn libraries in Python

Binary Classifier	% Correct Prediction
Logistic Regression	39.1
K-Nearest Neighbor	50.0
Decision Tree	60.9
2-Class Adaboost	56.5
Linear SVM	47.8

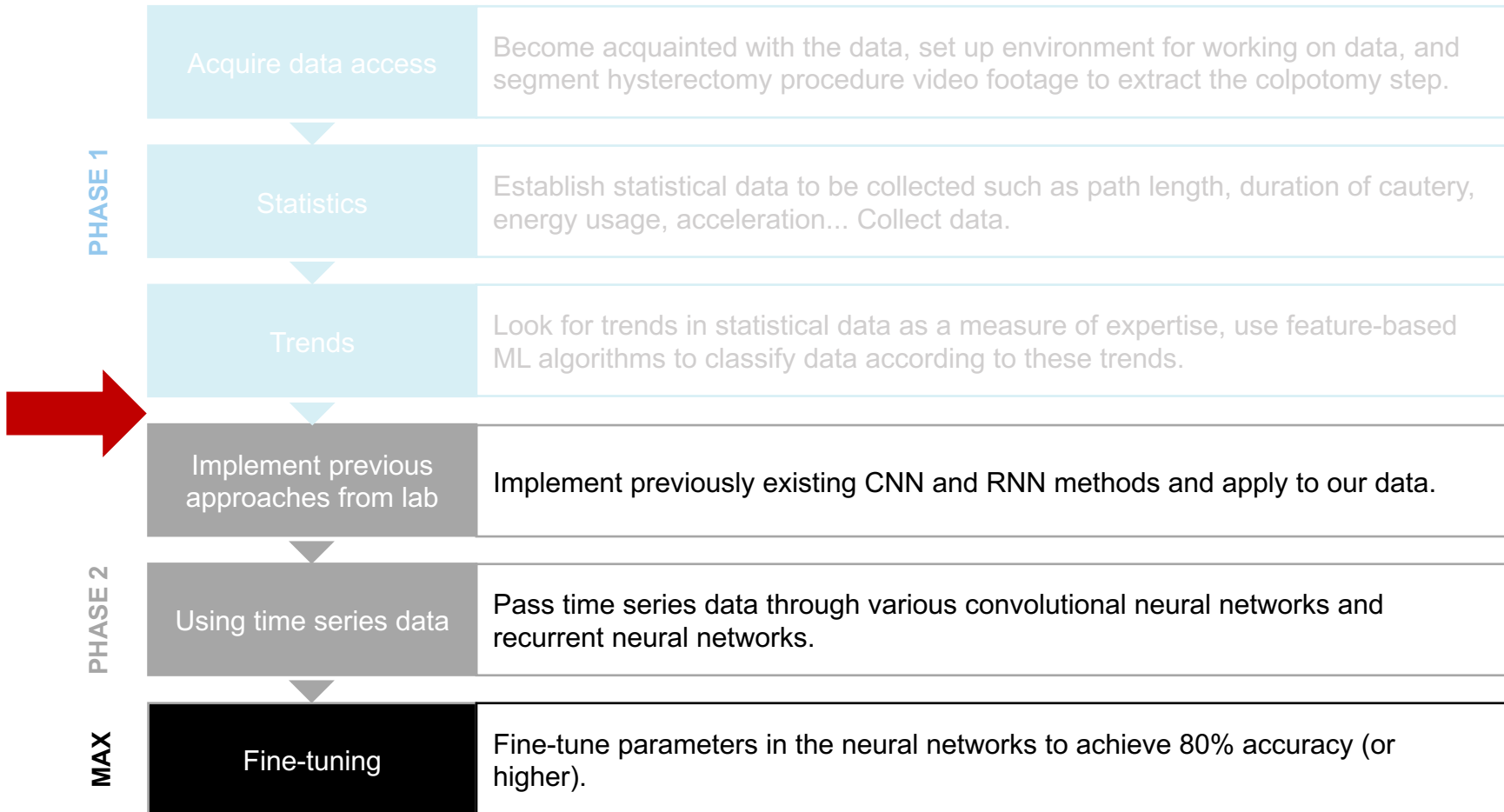
- Next step is to apply RBF Kernel, and also try these methods by selecting specific features only



Workflow



Workflow (Updated)



Dependencies

Dependency	Status	Explanation
IRB data access	Resolved	Have completed the proper training modules, have been added to the IRB study
Access to the motion data which is under Intuitive NDA	Resolved	Signed the NDA
Access to the Johns Hopkins University compute server	Resolved	Given proper credentials by mentors
Obtain existing code for neural network methods from graduate student researchers	Resolved	Molly has agreed to sharing her implementation
Getting surgeon time to get a scoring of each procedure*	In progress	Anand Malpani will be contacting physicians

***Max-Deliverable-Dependency**



Schedule

	31-Jan	7-Feb	14-Feb	21-Feb	28-Feb	7-Mar	14-Mar	21-Mar	28-Mar	4-Apr	11-Apr	18-Apr	25-Apr	2-May
Become familiarized with the data														
Segment colpotomy step from procedure videos														
Plot motion data in 3D from endoscope angle,														
Create video of 3D plot														
Go through user change data to collect statistics on duration of surgery per user (Attending, Trainee)														
Verification of user change data														
Decide on metrics to use and build dataset accordingly, verify data in dataset														
Implement and apply ML algorithms on data														
Acquire code for neural networks, fine-tune for colpotomy data														
Collect skill ratings from surgeons using GEARS and RHAS														
Report wrap-up and poster preparation														

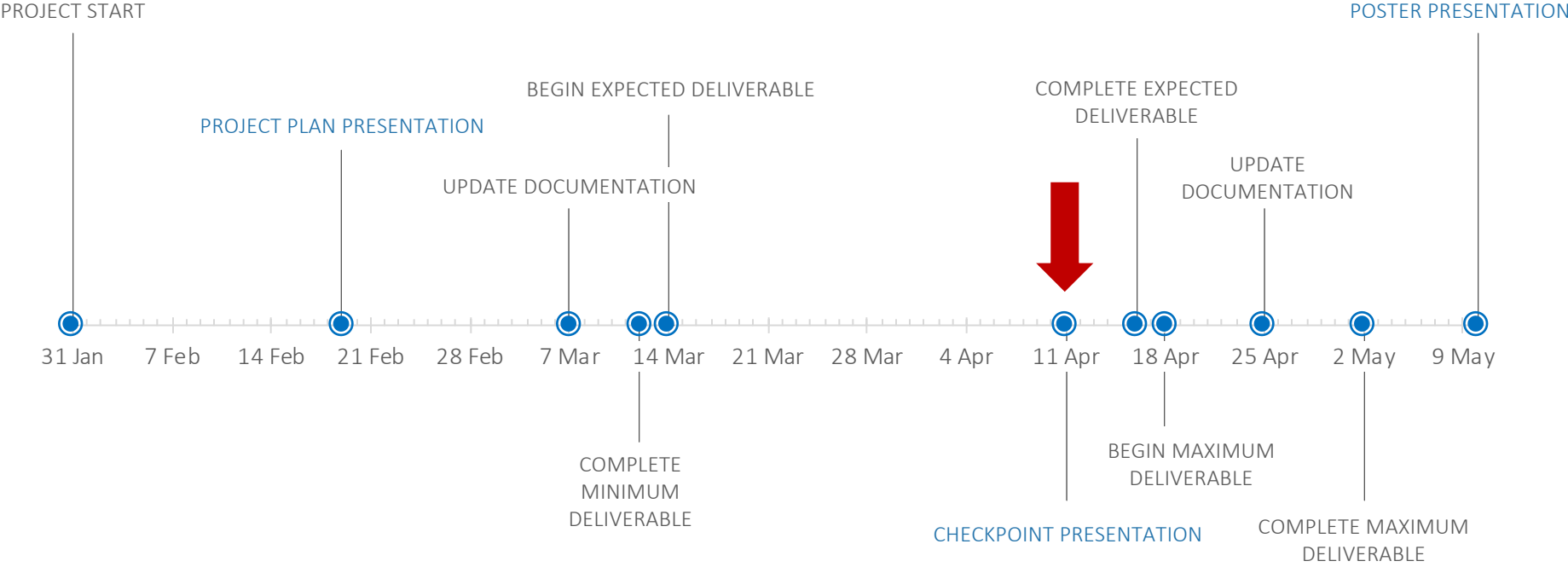


Schedule (Updated)

	31-Jan	7-Feb	14-Feb	21-Feb	28-Feb	7-Mar	14-Mar	21-Mar	28-Mar	4-Apr	11-Apr	18-Apr	25-Apr	2-May
Become familiarized with the data														
Segment colpotomy step from procedure videos														
Plot motion data in 3D from endoscope angle,														
Create video of 3D plot														
Go through user change data to collect statistics on duration of surgery per user (Attending, Trainee)														
Verification of user change data														
Decide on metrics to use and build dataset accordingly, verify data in dataset														
Implement and apply ML algorithms on data														
Set up environment for deep learning and tuning existing code for dataset														
Hyperparameter tuning, achieve accuracy at or above 70%														
Report wrap-up and poster preparation														



Key Dates and Milestones



Questions?

