Exploring Pediatric Appendicitis

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Introdution

In 2015, approximately 11.6 million cases of appendicitis were reported, resulting in around 50,100 deaths worldwide. Also appendicitis is one of the most common and significant causes of sudden abdominal pain, So diagnosing and treating this disease should be made as quickly as possible. There are many criteria to do so such as taking a history, physical examination, risk scores (e.g Alvarado Score) and imaging techiqies like ultra-sonography and CT.

The cost of the diagnosis could be improved for example using US instead of CT, accuracy could be also improved using Machine learning. One recent study built a model to predict appendicitis in pediatrics using Interpretable unsupervised machine learning method.

Since a lot of models has been built using just history and physical examinatin as predictors, we would use the same dataset to explore the disease for a bit then build models that focus on ultra-sonography as a way to diagnose appendicitis.

Methodology

- Taking a look at the data

Table 1: First Ten Rows of the Pediatric Appendicitis Dataset

Sex	US_Performed	Severity	Management	Diagnosis
female	yes	uncomplicated	conservative	appendicitis
male	yes	uncomplicated	conservative	appendicitis
male	yes	uncomplicated	conservative	appendicitis
male	yes	uncomplicated	conservative	no appendicitis
male	yes	uncomplicated	primary surgical	appendicitis
male	yes	uncomplicated	conservative	no appendicitis
male	yes	uncomplicated	conservative	no appendicitis
female	yes	uncomplicated	conservative	no appendicitis
male	no	complicated	primary surgical	appendicitis
female	yes	uncomplicated	secondary surgical	appendicitis

Some Plots

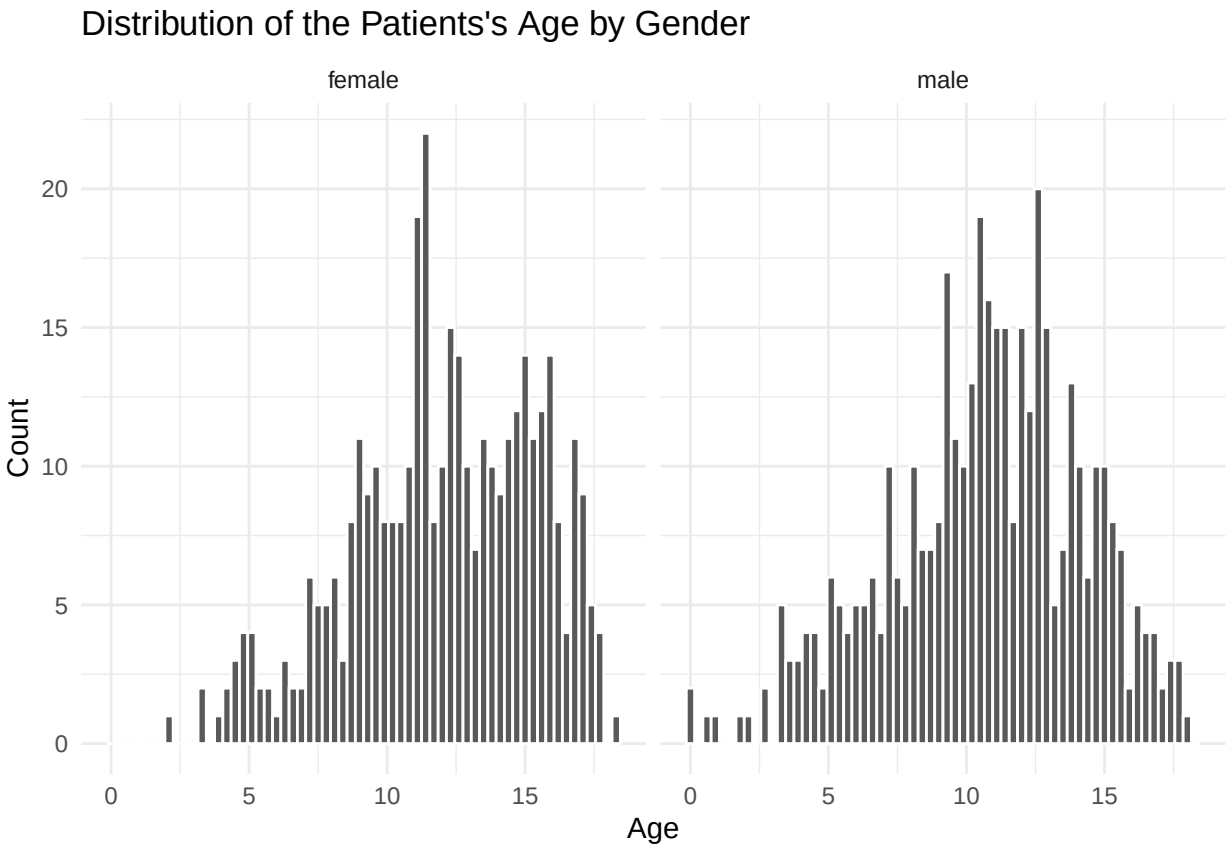


Figure 1: Distribution of the Patients's Age by Gender

Table 2: The Mean Age of Patients By Gender

Sex	Mean
female	12.06
male	10.68

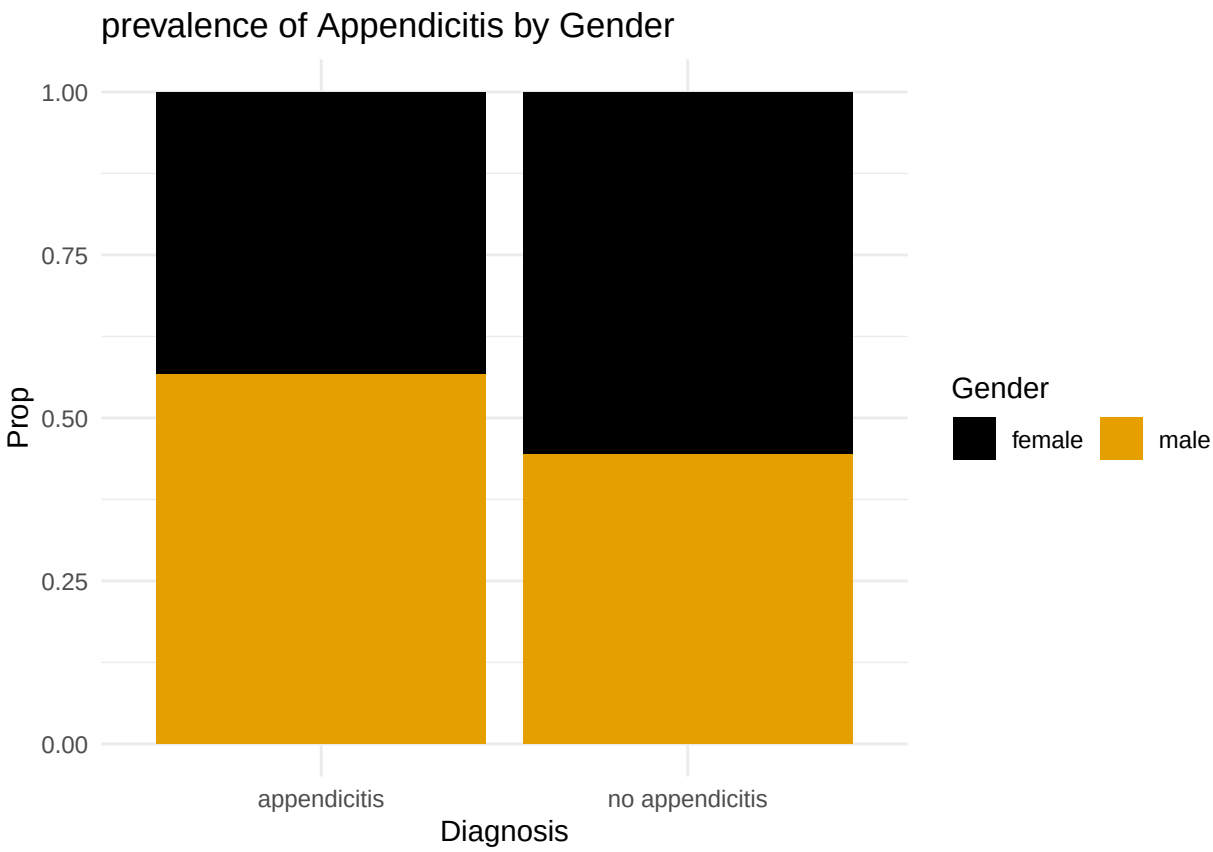


Figure 2: Prevalence of Appendicitis by Gender

Table 3: Prevalence of Appendicitis by Gender

Sex	Diagnosis	n	p
female	appendicitis	200	0.53
female	no appendicitis	176	0.47
male	appendicitis	262	0.65
male	no appendicitis	141	0.35

- Figure 2 shows that the prevalence in the appendicitis is more males than females which is consistent with existing finding, but it is not substantial.

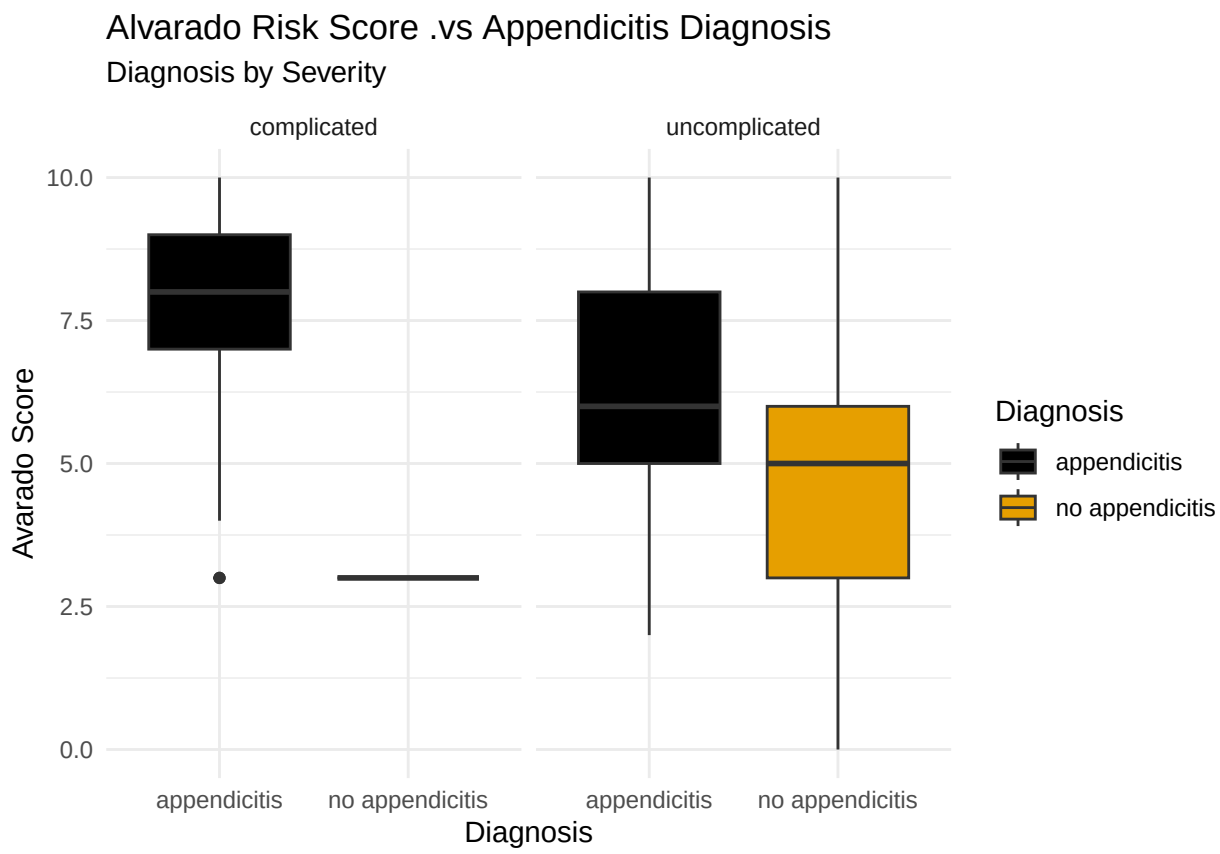


Figure 3: Alvarado Risk Score .vs Appendicitis Diagnosis

Table 4: Alvarado Risk Score .vs Appendicitis Diagnosis

Diagnosis	mean
appendicitis	6.669746
no appendicitis	4.831650

- Alvarado score is a system that have been developed to identify people who are likely to have appendicitis, like a score below 5 suggests against a diagnosis of appendicitis, whereas a score of 7 or more is predictive of acute appendicitis, but it is performance varies. Here added the severity diagnosis to see if the score differs also.

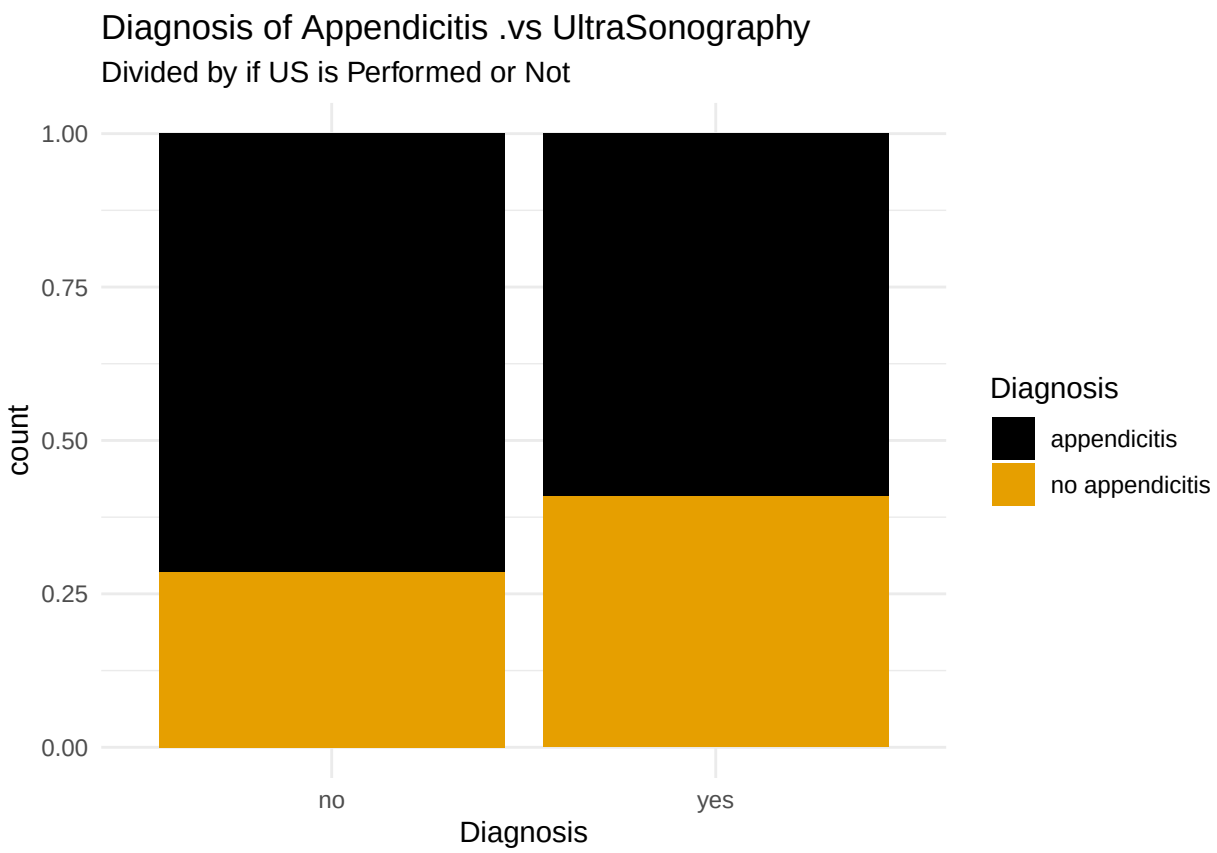


Figure 4: Diagnosis of Appendicitis .vs UltraSonography

- In cases where the diagnosis is unclear, other methods are preferred like medical imaging for example (CT, US), CT is more accurate but it is expensive and has some side effects, US may be preferred as the first imaging test in children and pregnant women because of the risks associated with radiation exposure from CT scans.

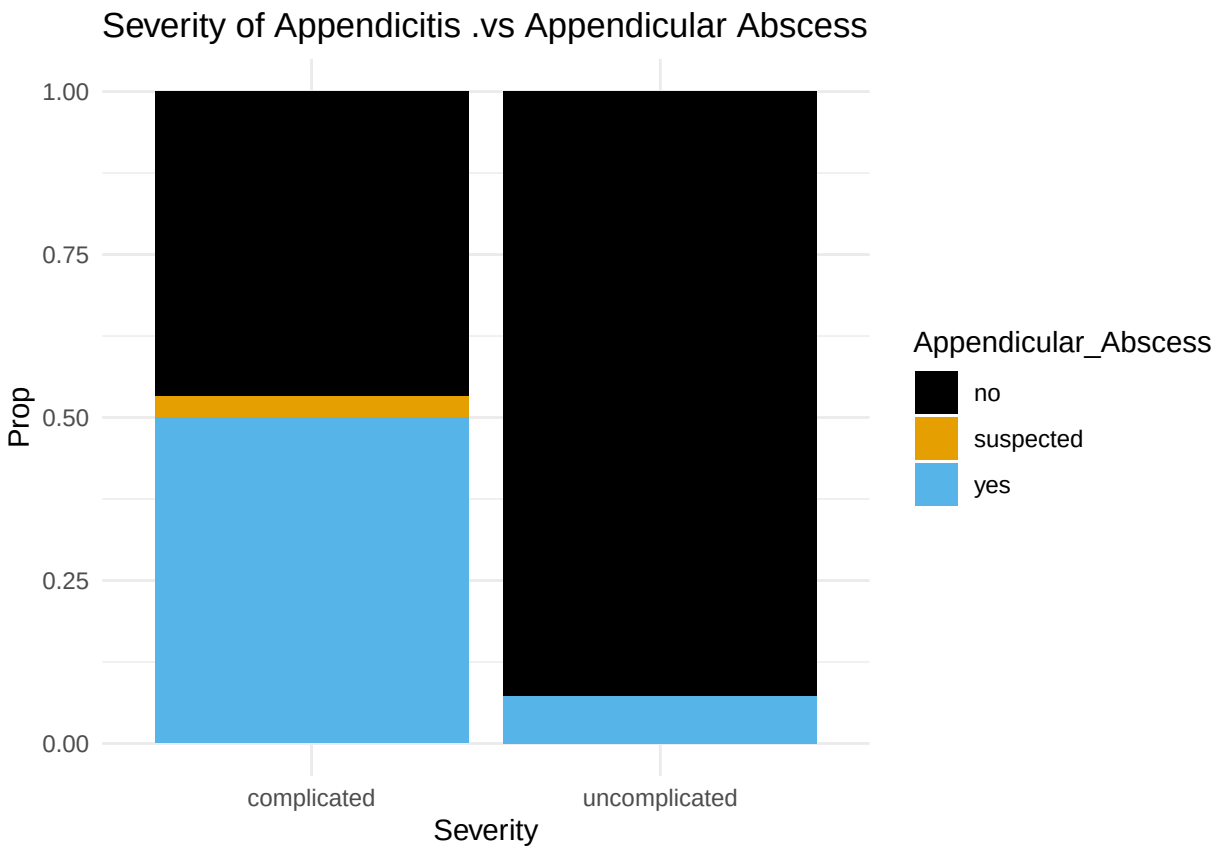


Figure 5: Severity of Appendicitis .vs Appendicular Abscess

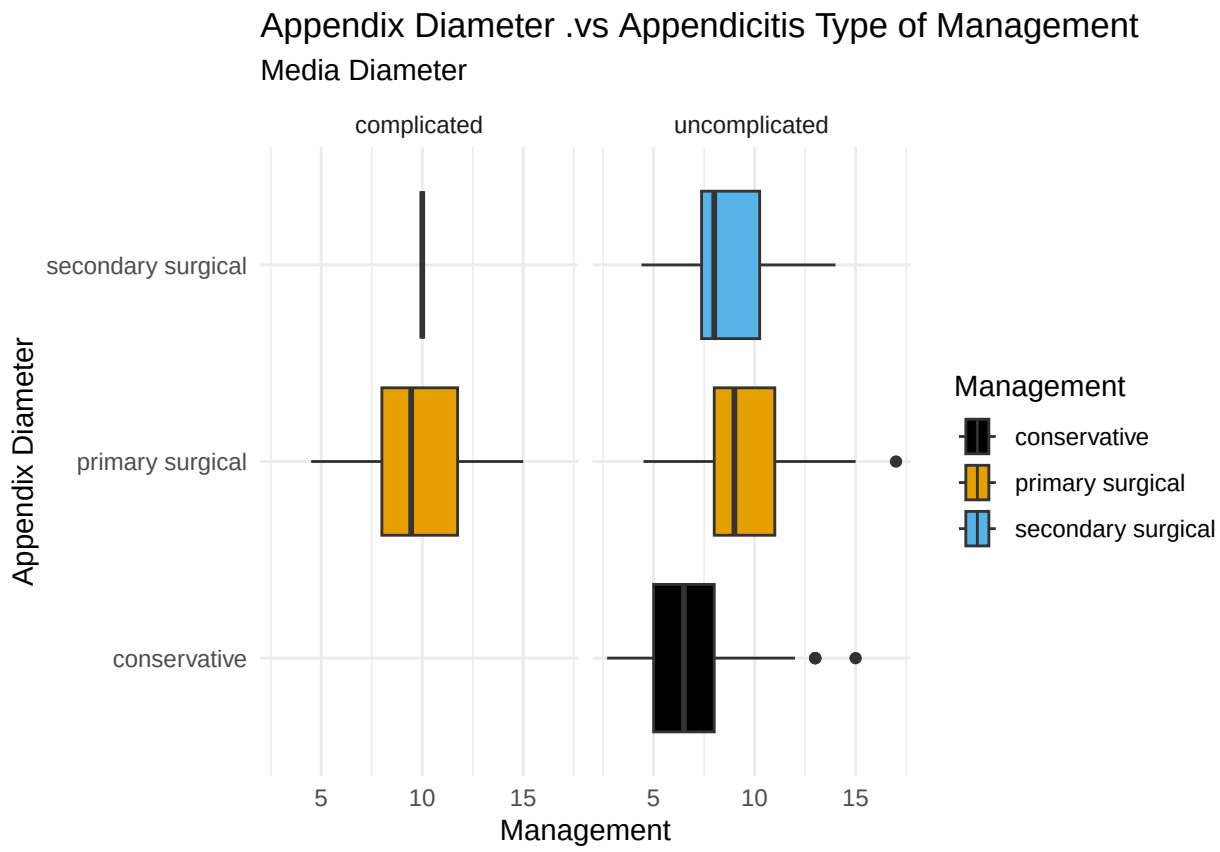


Figure 6: Appendix Diameter .vs Appendicitis Type of Management

Table 5: Mean of Appendix Diameter By Appendicitis Management

Management	mean
conservative	6.72
primary surgical	9.33
secondary surgical	8.80

Statistical Analysis

Hypothesis testing

Since the use of ultrasound is less expensive and less harmful than CT, we would test if only the introduction of US in the diagnostic process will have a discernible (i.e. significant) difference on the outcome of the diagnosis.

- To do this, we will use a hypothesis testing framework and set our level of rejection to be 0.05.

1. *Null hypothesis*

   There is no difference in the proportion of the outcome if only the US has been used.

2. *Alternative hypothesis*

   There is a difference in the proportion of the outcome if only the US has been used.

- Since is p-value is 0.52 which bigger than 0.05, we fail to reject null hypothesis. So the data does not provide a convincing evidence that only the introduction of US will have a have a discernible difference on the outcome of the diagnosis.

Table 6: 95% Confidence interval for difference in appendicitis diagnosis when ultrasonography is performed

lower_ci	upper_ci
-0.36	0.15

- What if we use the results that came from the US, we check if adding **Appendix Diameter** will have a discernible difference on the outcome of the diagnosis.
- So our hypotheses are

1. *Null hypothesis*

   There is no difference in the proportion of results when appendix diameter results from US are added.

2. *Alternative hypothesis*

   There is a difference in the proportion of the outcome when the appendix diameter results from US is added.

- Since the p-value is 0, which is less than 0.05, then we reject the null hypothesis, so the data provide convincing evidence that adding **Appendix diameter** will have a discernible difference on the outcome of the diagnosis.

Table 7: 95% confidence interval for the difference in mean between patients diagnosed with appendicitis or no appendicitis.

lower_ci	upper_ci
3.37	3.94

Modeling

- To help the health workers make more informed decisions (i.e, Accurately diagnosing the appendicitis) we would use machine learning.

We will build Supervised explainable models like logistic regression then test and validate the model.

So we will use **cross validation** as way to build the model then we would use **ROC** to check the models precision and accuracy.

Table 8: A Model to Diagnose Appendicitis With Avarado Score

pred_class	pred_appendicitis	pred_no_appendicitis	alvarado_score
appendicitis	0.78	0.22	6
appendicitis	0.95	0.05	9
appendicitis	0.68	0.32	5
appendicitis	0.86	0.14	7
appendicitis	0.56	0.44	4
appendicitis	0.56	0.44	4
appendicitis	0.78	0.22	6
no appendicitis	0.30	0.70	2
appendicitis	0.86	0.14	7
appendicitis	0.86	0.14	7

Table 9: Precision and Accuracy of Model to Diagnose Appendicitis With Avarado Score

.pred_class	Diagnosis	n	p	decision
appendicitis	appendicitis	67	0.96	True positive
no appendicitis	appendicitis	3	0.04	False negative
appendicitis	no appendicitis	14	0.61	False positive
no appendicitis	no appendicitis	9	0.39	True negative

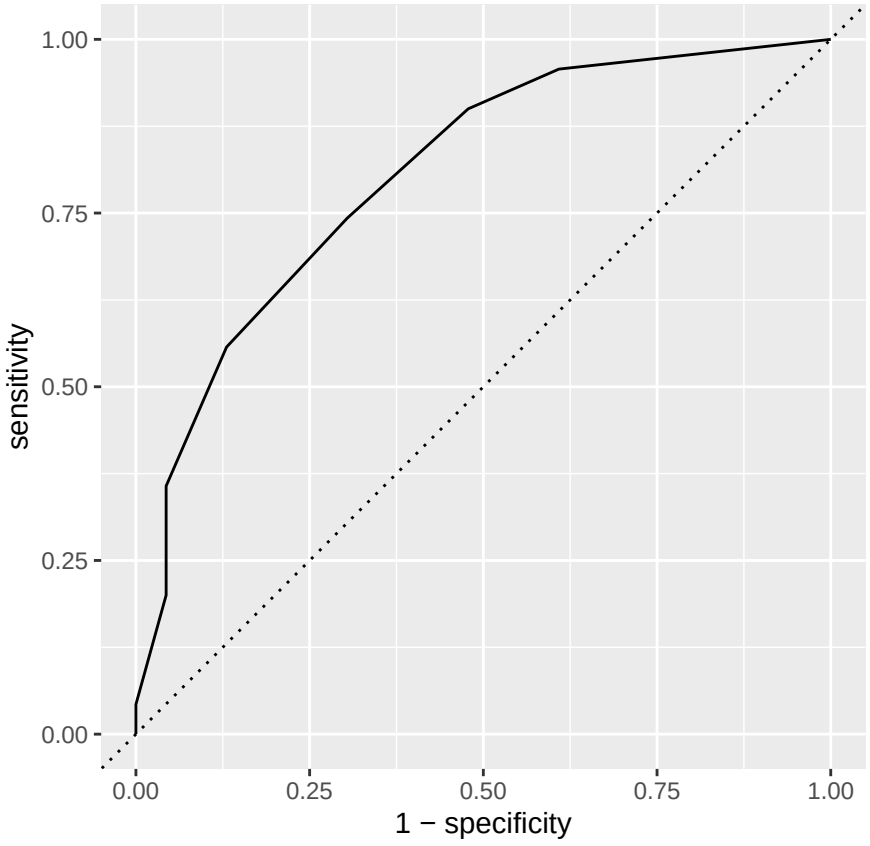
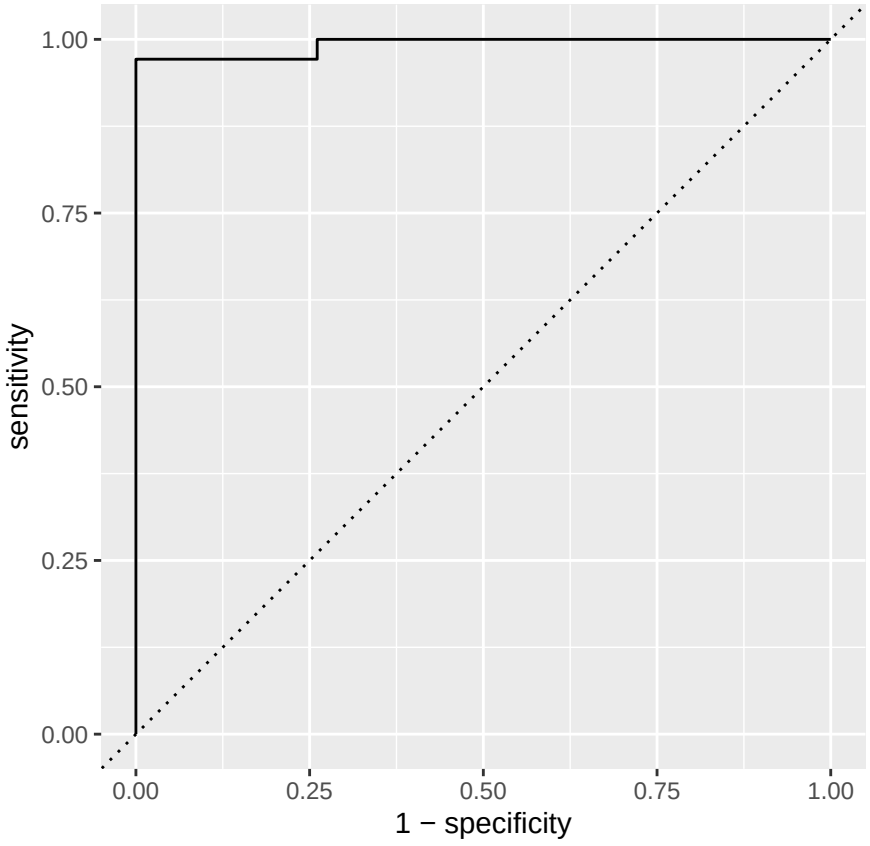


Table 10: A Model to Diagnose Appendicitis With Avarado Score, Appendix_Diameter, Weight and BMI

pred_class	pred_appendicitis	pred_no_appendicitis
no appendicitis	0.01	0.99
no appendicitis	0.10	0.90
no appendicitis	0.29	0.71
appendicitis	0.80	0.20
appendicitis	0.96	0.04
no appendicitis	0.46	0.54
appendicitis	1.00	0.00
no appendicitis	0.03	0.97
appendicitis	0.85	0.15
appendicitis	1.00	0.00

Table 11: Precision and Accuracy of Model to Diagnose Appendicitis With Avarado Score, Appendix_Diameter, Weight and BMI

.pred_class	Diagnosis	n	p	decision
appendicitis	appendicitis	67	0.96	True positive
no appendicitis	appendicitis	3	0.04	False negative
no appendicitis	no appendicitis	23	1.00	True negative



- The second model that used **Ultra-sonography** results showed lower **False positives and negatives**. per table above.

Diagnosing

```
## # A tibble: 1 x 2
##   .pred_appendicitis `.pred_no appendicitis`
##                <dbl>                   <dbl>
## 1               1.00                0.000358
```

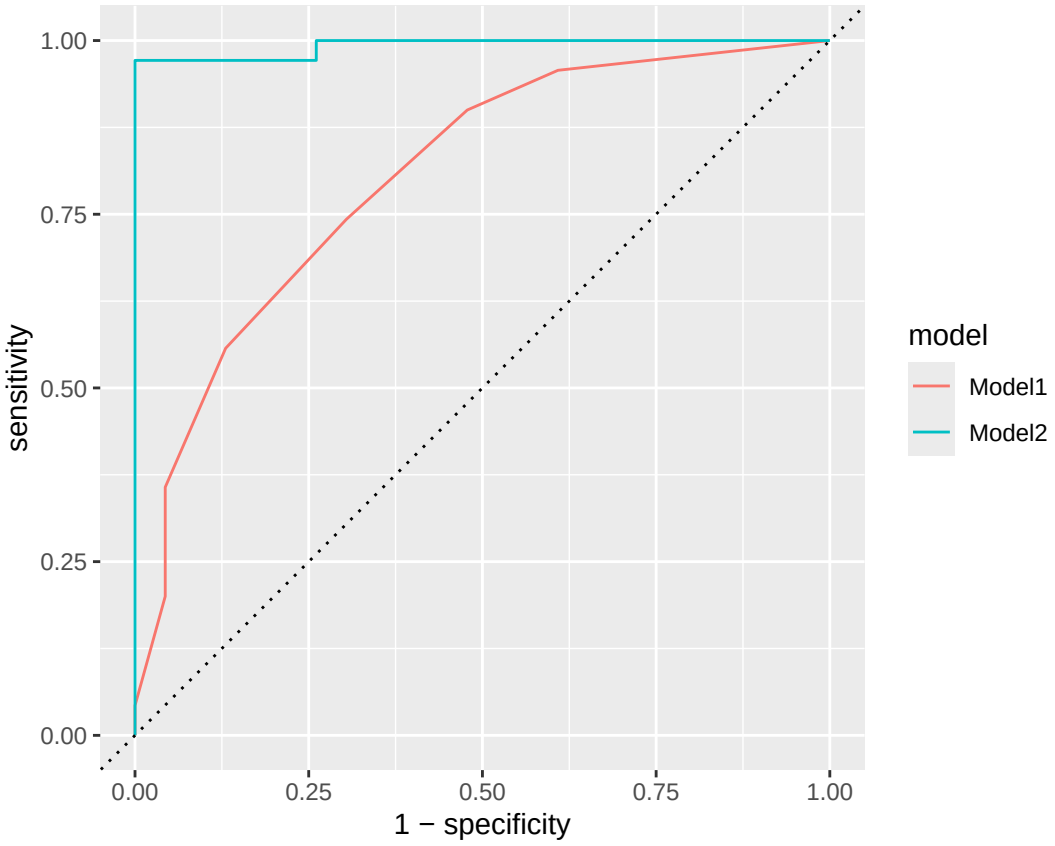


Figure 7: Comparing the Accuracy and Precision of both Models