Example 2: A patient enters the hospital with severe abdominal pains. Based on past experience, Doctor Craig believes there is a 28% chance that the patient has appendicitis and a 72% chance that the patient has nonspecific abdominal pains. Dr. Craig may operate on the patient now or wait 12 hours to gain a more accurate diagnosis. In 12 hours, Dr. Craig will surely know whether the patient has appendicitis. The problem is that in the meantime, the patient's appendix may perforate (if he has appendicitis), thereby making the operation much more dangerous. For each option Dr. Craig has these information:

If Dr. Craig performs surgery now and he finds out that the patient has nonspecific abdominal pains, the patient may recover fully with a probability of 85% or may have the abdominal pain, with the same severity as before, after the operation. If Dr. Craig finds out that the patient indeed has appendicitis, the operative mortality for the surgery is 8%. If the patient survives the operation, the patient may recover fully with a probability of 70% or may have the abdominal pain, with the same severity as before, after the operation.

If Dr. Craig waits for 12 hours, with a probability of 60%, he might find out that the patient surely has nonspecific abdominal pain and does not require surgery. If the patient indeed has appendicitis, after 12 hours of wait, with a probability of 60% he may suffer from perforated appendix. If the patient's appendix perforates, the operative mortality for the surgery becomes as high as 25%, or he may survive with more severe abdominal pain than before. If the patient's appendix is not perforated, the operative mortality for the surgery is 20%. If the patient survives the operation, he may recover fully with a probability of 80% or may have the abdominal pain, with the same severity as before, after the operation.

Using the utilities in the table below, draw the decision tree and calculate expected utilities. Which procedure should Dr. Craig follow?

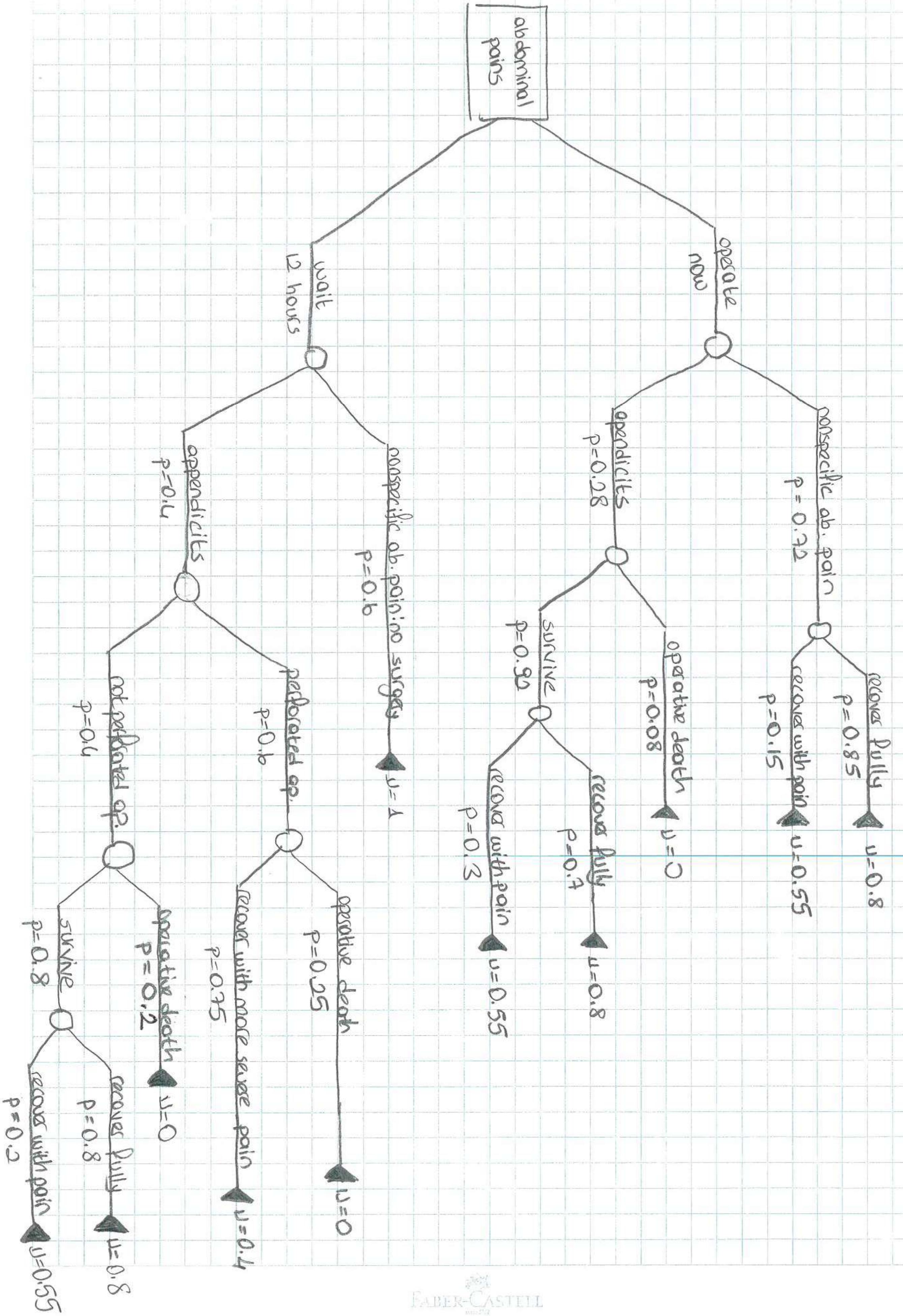
Perform one-way sensitivity analysis on the utility of "recovery with pain". Answer the questions below. Also provide a graphical solution as in the lecture notes.

a) What is the threshold value of the utility of "recovery with pain"?
b) What is the expected utility of the corresponding threshold value of the utility of "recovery with pain"?
c) When Dr. Craig should prefer waiting over acting immediately?

Possible Outcome	Utility
No surgery	1
Full recovery after surgery	0.8
Recovery with pain	0.55
Recovery with more severe pain	0.4
Operative death	0

Example 2: Solution

Decision Tree:



- Expected utility for performing surgery immediately:

$$=(0.72)((0.85\times0.8)+(0.15\times0.55))+(0.28)((0.08\times0)+(0.92)(0.7\times0.8+0.3\times0.55))$$

$$=0.736$$

- Expected utility for waiting 12 hours:

$$=(0.6)\times1+((0.4)\times[(0.6)\times(0.25\times0+0.75\times0.4)+(0.4)\times(0.2\times0+0.8(0.8\times0.8+0.2\times0.55)])$$

$$=0.768$$

→ So in the base case, Dr. Craig should prefer waiting for 12 hours and then perform surgery if needed.

Perform one-way sensitivity analysis on the utility of "recovery with pain".

a) Threshold value of the utility of "recovery with pain"?

Let's denote "recovery of pain" as u_p.

- Then, the expected utility for performing surgery immediately:

$$=(0.72)((0.85)\times(0.8)+(0.15\times u_p))+(0.28)((0.08\times0)+(0.92)(0.7\times0.8+0.3\times u_p))$$

$$=0.634+0.185u_p \quad (*)$$

- The expected utility for waiting 12 hours:

$$=(0.6)\times1+(0.4)\times[(0.6)\times(0.25\times0+0.75\times0.4)+(0.4)\times(0.2\cdot0+0.8(0.8\times0.8+0.2\times u_p)]$$

$$=0.754+0.0256u_p \quad (**)$$

→ Equate two functions ((*) and (**)) and solve for u_p

$$0.634+0.185u_p=0.754+0.0256u_p$$

$u_p=0.752$ → threshold utility value for "recovery with pain"

b) Expected utility of the corresponding threshold value of the utility of "recovery with pain".

Expected utility for performing surgery $=(0.72)(0.85\times0.8+0.15\times0.752)$
$+(0.28)(0.08\times0+0.92\times(0.7\times0.8+0.3\times0.752)$

$=0.773$

Expected utility for wating 12 hours:

$= (0.6)\times 1 + (0.4)\times[(0.6)\times(0.25\times 0 + 0.75\times 0.4) + (0.4)\times(0.2\times 0 + 0.8\times(0.8\times 0.8 + 0.2\times 0.752))]$

$= 0.773$

- Expected utility for performing surgery and waiting 12 hours are same, as expected.

c) Dr. Craig should prefer waiting for 12 hours over acting immediately when utility of "recovery with pain" is smaller than 0.752

We need to have (**) > (*)

$$0.754 + 0.0256 u_p > 0.634 + 0.185 u_p$$

$$0.12 > 0.1594 u_p$$

$$u_p < 0.752$$