

## 2) (10 pts) ANL (Algorithm Analysis)

For a certain known data structure a lookup takes  $O(\sqrt{n})$  time, where  $n$  is the number of stored items. For a data set of 8,000,000 items the runtime for a look up was approximately 10ms. On a different data set the look up took 40ms. About how many **items** do you expect to be stored in the second data set?

The runtime in milliseconds can be expressed as  $c\sqrt{n}$  where  $c$  is some constant. We can find the  $c$  by plugging in  $n=8,000,000$  10ms. We find that

$$\begin{aligned} 10ms &= c\sqrt{8,000,000} \\ \frac{10ms}{2000\sqrt{2}} &= c \\ c &= \frac{1}{200\sqrt{2}}ms \end{aligned}$$

Let  $m$  equal the size of the data set for which a search takes 40 ms. This gives us the following equation:

$$\begin{aligned} 40ms &= \frac{1}{200\sqrt{2}}\sqrt{m} \\ 40 \times 200 \times \sqrt{2} &= \sqrt{m} \end{aligned}$$

Square both sides

$$\begin{aligned} 40^2 200^2 2 &= m \\ 1600(40000)(2) &= m \\ \underline{128,000,000} &= \underline{m} \end{aligned}$$

It follows that the number of items expected is 128 million.

**Grading:**

**Find  $c$ , 4 pts.**

**Setting up a variable for the answer, 2 pts**

**Plugging in 40ms, 1 pt.**

**Square both side, 2 pts.**

**Correct answer, 1 pts.**