# CSC341 Lab 4A

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## 1 Pumps

### 1

- $p$ is chosen to be the pumping length guaranteed by the pumping lemma.
- $s$ is chosen to be the string $0^p1^p$.
- $x$, $y$, and $z$ are the specific strings that satisfy the conditions given in the pumping lemma.
- $i$ is an arbitrary nonnegative integer.

### 2

The string $y$ either contains no 1s, no 0s, or at least one 0 and at least one 1.

### 3

By condition 3 of the pumping lemma, we have $|xy| \leq p$, so $xy$, and therefore $y$, are composed entirely using the first $p$ characters of $s$. Because $s = 0^p1^p$, the first $p$ characters of $s$ are 0, so every character in $xy$ must be 0. Then, as in Sipser's proof, $xyyz$ contains more 0s than 1s and therefore is not in the language, which contradicts the initial assumption that the language is regular.

## 2 Nope, not regular

Suppose, for the sake of contradiction, that the language is regular. Let $p$ be the pumping length guaranteed by the pumping lemma, and let $s = 0^p1^p0^p1^p0^p1^p$. Then by the pumping lemma, we can fix $x, y, z$ such that $s = xyz$ with $|xy| \leq p, xyyz \in A$, and $|y| > 0$. By construction, the first $p$ characters of $s$ are 0, so $xy$ contains all 0s as it is constructed from at most the first $p$ characters of $s$. But then $xyyz \notin A$. To prove this, notice that the first third of $xyyz$ contains more than $p$ 0s, but the last third must contain exactly $p$ 0s. This is because, if it contains at least $p+1$ 0s, then it would contain the string $01^p0^p1^p$, which has length $3p+1$. Therefore, if $xyyz \in A$, then $|xyyz| \geq 9p+3$, but $|xyyz| = |xyz| + |y| = 6p + |y| \leq 7p$. This is a contradiction, so $xyyz \notin A$.