Goals
- Prove facts 3 and 4

Questions
- If we know that diagonalization and simulation fail, does that mean the only way to prove $P \neq NP$ is to invent a new proof technique?

Announcements
- Pet photos
- Seniors: Fill out 701 form

Let $L_{EXP}^P$ be the set of all polynomial time TM $M$ s.t. $x \in L_M$. Let $M$ be a TM that takes in inputs $x$ and in $n$ steps on input $x$, where $x \in \{0,1\}^n$. Let $M_1$ be the machine that on input $x$ and output $\langle x, M_1 \rangle$, $M_1$ runs in exponential time. So $L_{EXP}$.

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Result: $P \neq \text{NP}$ can be used. Diagonalization to prove $P \neq \text{NP}$

Then $P \neq \text{NP}^P$. Create our oracle $B$.

- Enumerate all Turing Machines $M_0, M_1, M_2$... 
- Start at $i=1$ (and assuming for each $i=2,3,...$ pick a number $m_i$ (will tell how to pick later) and run $M_i$ on input 1.
- Pick $m_i$ to be the smallest number s.t.
  - $m_i < n$ 
  - No string of length $n_i$ has been assigned.
- Run $M_i^B(1^n)$ for $(m_i)^{th}$ steps.
- Query $y \in B$ 00 in B? No

Look at list, if $y$ is already assigned, be consistent.

- If $M_i^B(1^n)$ doesn't terminate in $(m_i)^{th}$ steps, or it outputs 1, then set all strings $y$ s.t. $y|1|y$, that haven't already been assigned to "No".
- If $M_i^B(1^n)$ outputs 0 in $(m_i)^{th}$ steps, then assign one string of length $n_i$ to be "Yes".

There are $2^n$ such strings: $M_i^B(1^n)$ only ran $(m_i)^{th}$ steps $2^n$.