**OPTIONAL PROJECT TO AVOID GETTING A D**
**THIS DOCUMENT IS TWO PAGES LONG**

If you do this project AND end up with an F or D in the course then I will grade it and MAY use your grade to BUMP your grade up (from an F to a D-, from a D to a C-). Throughout this document "prove" means "give a construction and discuss why it works." What you hand in must be TYPED or VERY GOOD HANDWRITING.

DUE the LAST DAY of class. Absolute Deadline.

HINT: START early. Feel free to get help from me or the TA.

CONVENTION; You can't say 'by theorem BLAH' For example, if I as you to show that

**If $L$ is regular than $LL$ is regular**

You CANNOT say

**Because regular langs are closed under concatenation**

1. (0 points but you have to answer) What is your name? Write it clearly.
2. Let $L$ be regular. Prove or Disprove or state that it is unknown to science. (You may use the equivalence of DFA,'s NFA's, and Regular Expressions).
   (a) $LL$ is regular.
   (b) $L^*$ is regular.
3. Let $L$ be in P. Prove or Disprove or state that it is unknown to science.
   (a) $LL$ is in P.
   (b) $L^*$ is in P.
4. Let $L$ be in NP. Prove or Disprove or state that it is unknown to science.
   (a) $LL$ is in NP.
   (b) $L^*$ is in NP.

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5. Let $L$ be decidable. Prove or Disprove or state that it is unknown to science.

   (a) $LL$ is decidable.

   (b) $L^*$ is decidable.

6. For this problem you may assume regular languages are closed under UNION, INTERSECTION, COMPLEMENTATION, and PROJECTION. Describe carefully an ALgorithm that will, on input a SENTENCE $\phi$ in WS1S, output (1) TRUE if $\phi$ is TRUE, and (2) FALSE if $\phi$ is FALSE. (Note that since $\phi$ is a sentence it is either true or false.)

7. (a) Describe the reduction of SAT to IND SET. That is, describe how you would take a formula $\phi$ (we can assume its in CNF form) and from it get a graph $G$ and a number $k$ such that

$$\phi \in SAT \text{ iff } (G, k) \in \text{IND SET}$$

   (b) Use the answer to part 1 to find a graph $G$ and a number $k$ such that

$$(x_1 \vee x_2) \wedge (\neg x_1 \vee x_3) \wedge (x_1 \vee x_2 \vee x_3) \in SAT$$

   iff

   $(G, k) \in$ IND SET.