Tutorial 12

- You may benefit from solving the problems on your own or in collaboration with others rather than reading solutions given in books or sources online.
- For the sake of getting better at solving problems, start writing down your thoughts and go over them repeatedly, even if you do not get the full solution.
- No credit is attached to solving this tutorial. However, solving these problems may help in being able to perform better in quizzes and exams which count towards the overall credits.

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1. Give a $O(n \log n)$ time TM for the following problem. (2)

   Given: 1^n
   Output: binary representation of n

2. Give a $O(n^2)$ time TM for the following problem. (2)

   Given: 1^n
   Output: binary representation of n^2

3. Show that SAT, 3Color are in NP.

4. Show that Min, Verify-SAT are in L. (From Lecture 35)

5. Show that given a directed graph G, whether it has a cycle or not is in NL.

6. Specify the relationships between the following complexity classes: (containment, strict containment, incomparable)

   (a) P. NP, EXP, NEXP, NL
   (b) SPACE(n), TIME(n), TIME(2^n), SPACE(2^n), SPACE($\log n$)

7. State true or false with justification: Either P is strictly contained in NP or EXP properly contains NP.