CS 6002: Selected Areas of Mechanism Design **Jan-Apr 2025**

Lecture 1: The Basics of Optimization

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Disclaimer: *These notes aggregate content from several texts and have not been subjected to the usual scrutiny deserved by formal publications. If you find errors, please bring to the notice of the Instructor.*

This lecture's notes illustrate some uses of various LaTeX macros. Take a look at this and imitate.

1.1 Some theorems and stuff

We now delve right into the proof.

Lemma 1.1 *This is the first lemma of the lecture.*

Proof: The proof is by induction on .... For fun, we throw in a figure.

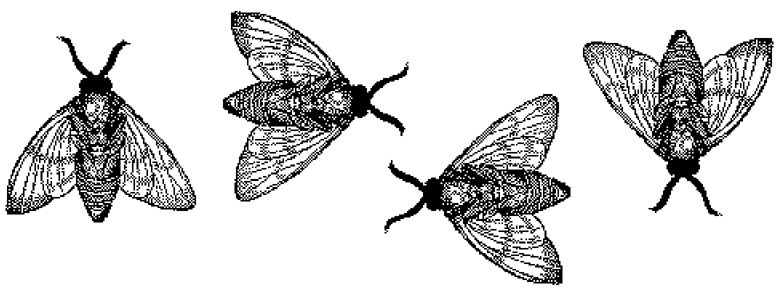

Figure 1.1: A Fun Figure

This is the end of the proof, which is marked with a little box. ■

1.1.1 A few items of note

Here is an itemized list:

- this is the first item;
- this is the second item.

Here is an enumerated list:

1. this is the first item;
2. this is the second item.

Here is an exercise:

Exercise: Show that P $\neq$ NP.

Here is how to define things in the proper mathematical style. Let f_k be the $AND - OR$ function, defined by

$$f_k(x_1, x_2, \ldots, x_{2^k}) = \begin{cases} x_1 & \text{if } k = 0; \\ AND(f_{k-1}(x_1, \ldots, x_{2^{k-1}}), f_{k-1}(x_{2^{k-1}+1}, \ldots, x_{2^k})) & \text{if } k \text{ is even;} \\ OR(f_{k-1}(x_1, \ldots, x_{2^{k-1}}), f_{k-1}(x_{2^{k-1}+1}, \ldots, x_{2^k})) & \text{otherwise.} \end{cases}$$

Theorem 1.2 *This is the first theorem.*

Proof: This is the proof of the first theorem. We show how to write pseudo-code now.

Consider a comparison between x and y:

if x or y or both are in S **then**
    answer accordingly
else
    Make the element with the larger score (say x) win the comparison
    if $F(x) + F(y) < \frac{n}{t-1}$ **then**
        $F(x) \leftarrow F(x) + F(y)$
        $F(y) \leftarrow 0$
    else
        $S \leftarrow S \cup \{x\}$
        $r \leftarrow r + 1$
    endif
endif

This concludes the proof. ■

1.2 Next topic

Here is a citation, just for fun [CW87].

References

[CW87] D. Coppersmith and S. Winograd, "Matrix multiplication via arithmetic progressions," *Proceedings of the 19th ACM Symposium on Theory of Computing*, 1987, pp. 1–6.