NOTES AND QUOTES
PHY307 Sept. 3, 2002 - LECTURE #2 (3rd meeting)

OUTLINE:

1. Computers – what are they?
    a. Analog vs. Digital
    b. Babbage & Lovelace
    c. Universal Computers
    d. Universe as a computer
2. Pieces of Python
    a. Types of objects
    b. Expressions
    c. Block statements
    d. **for** loops
3. Commands in Python.

Analog machines: more or less a direct representation of the problem (models, electrical circuits with the same dynamics as a pendulum, model planes or dams.) Most often work with "continuous" variables (for example, the angle or shape of an object or duration of time as measured by a clock.) Program for an analog computer: initial conditions, configuration (example with pendulum.) [Increased precision is very expensive.]

Catenary: shape formed by a hanging chain or string. When "inverted", makes shape of strong uniform weight arches. [Used as an example of an analog computer.]

Digital computers: discrete states; more general and easier to program. [Can be misleadingly precise!]

> (From Andrew Hodges's pages): The idea of one machine for every kind of task was very foreign to the world of 1945. Even ten years later, in 1956, the big chief of the electromagnetic relay calculator at Harvard, Howard Aiken, could write:
>
> > If it should turn out that the basic logics of a machine designed for the numerical solution of differential equations coincide with the logics of a machine intended to make bills for a department store, I would regard this as the most amazing coincidence that I have ever encountered.

Charles Babbage

> Held the Lucasian Chair 1828-1839 at Cambridge University
>
> [this is the chair held by Isaac Newton (past) and Steven Hawking (recently).]
>
> Designed and started to build the Difference Engine and thought about the Analytical Engine.
>
> Left Cambridge to start work on these machines.

Augusta Ada Byron King, Lady of Lovelace

> Born 1815

Mother separated from the poet Lord Byron ("mad – bad - and dangerous to know") when daughter was 5 weeks old.
(Byron spent Summer of 1816 in Switzerland with friends, including Poet Shelley and Mary Shelley, author of Frankenstein.)
Mother fostered math and science and forbid poetry.
Met Babbage in 1832.
Wrote up Menabrea's analysis of Babbage in 1842 and added her own thoughts.
This was important guide for others.
(Gambling, drugs, died at age of 36.)

From AAL's writings:

"… the Analytical Engine does not occupy common ground with mere 'calculating machines.' It holds a position wholly its own; and the considerations it suggests are most interesting in their nature. In enabling mechanism to combine together *general* symbols in successions of unlimited variety and extent, a uniting link is established between the operations of matter and the abstract mental processes of the *most abstract* branch of mathematical science."

"Again, it [the Analytical Engine] might act upon other things besides number, were objects found whose mutual fundamental relations could be expressed by those of the abstract science of operations, and which should be also susceptible of adaptations to the action of the operating notation and mechanism of the engine . . . Supposing, for instance, that the fundamental relations of pitched sounds in the science of harmony and of musical composition were susceptible of such expression and adaptations, the engine might compose elaborate and scientific pieces of music of any degree of complexity or extent."

"We might even invent laws for series or formulae in an arbitrary manner and set the machine to work on them, and thus deduce numerical results which we might not otherwise have thought of obtaining.."

From Babbage's Autobiography:

"The circular arrangement of the axes of the Difference Engine round large central wheels led to the most extended prospects. The whole of arithmetic now appeared within the grasp of mechanism. A vague glimpse even of an Analytical Engine at length opened out, and I pursued with enthusiasm the shadowy vision. The drawings and the experiments were of the most costly kind. Draftsmen of the highest order were necessary to economize the labour of my own head; whilst skilled workmen were required to execute the experimental machinery to which I was obliged constantly to have recourse.

In order to carry out my pursuits successfully, I had purchased a house with above a quarter of an acre of ground in a very quiet locality. My coach-house was now converted into a forge and a foundry, whilst my stables were transformed into a workshop. I built other extensive workshops myself, and had a fire-proof building for my drawings and draftsmen. Having myself worked with a variety of tools, and having studied the art of

constructing each of them, I at length laid it down as a principle--that, except in rare cases, I would never do anything myself if I could afford to hire another person who could do it for me.

The complicated relations which then arose amongst the various parts of the machinery would have baffled the most tenacious memory. I overcame that difficulty by improving and extending a language of signs, the Mechanical Notation, which in 1826 I had explained in a paper printed in the "Phil. Trans." By such means I succeeded in mastering trains of investigation so vast in extent that no length of years ever allotted to one individual could otherwise have enabled me to control. By the aid of the Mechanical Notation, the Analytical Engine became a reality: for it became susceptible of demonstration."

"Some time after the appearance of his memoir on the subject in the "Bibliothèque Universelle de Genève," the late Countess of Lovelace informed me that she had translated the memoir of Menabrea. I asked why she had not herself written an original paper on a subject with which she was so intimately acquainted? To this Lady Lovelace replied that the thought had not occurred to her. I then suggested that she should add some notes to Menabrea's memoir; an idea which was immediately adopted.

We discussed together the various illustrations that might be introduced: I suggested several, but the selection was entirely her own. So also was the algebraic working out of the different problems, except, indeed, that relating to the numbers of Bernoulli, which I had offered to do to save Lady Lovelace the trouble. This she sent back to me for an amendment, having detected a grave mistake which I had made in the process.

The notes of the Countess of Lovelace extend to about three times the length of the original memoir. Their author has entered fully into almost all the very difficult and abstract questions connected with the subject.

These two memoirs taken together furnish, to those who are capable of understanding the reasoning, a complete demonstration--*That the whole of the developments and operations of analysis are now capable of being executed by machinery*."

Turing (Church) thesis (around 1936): Any effective computation (finite set of rules, pencil and paper using symbols) can be carried out by a Turing machine (Church: recursive functions can carry out effective computations.)

The Church-Turing thesis is unproven (what is working without "ingenuity"?) but widely believed.

Turing machines are equivalent to the digital machines we think of as computers.

Extended CT thesis: any mechanism can be emulated by a Turing machine.

RESOURCES

Turing

Scientific American, volume 280, p. 76.
www.turing.org.uk/turing/
www.alanturing.net
www.turingarchive.org

Babbage and Lovelace

Books in S.U. library (look up Charles Babbage or Ada Lovelace)
www.fourmilab.ch/babbage/contents.html

Python

Learning to program using Python will be on reserve starting this afternoon (Physics & Bird.)

See attached notes – from LiveWires course on Python (see Web – link from python.org)

You should read A, S, J, and L – you don't need to know all of A, S and J, yet, but look them over!