Outline for May 7, 1997

1. Greetings and Felicitations
2. HRU result and proof
   a. General result (HRU Theorem): Whether a given state of a given protection system is safe for a given generic right is undecidable
   b. Proof approach: reduce halting problem to safety problem
   c. Proof: *T* is an arbitrary Turing machine; encode *T*'s state as an ACM and the head moves as commands of the protection system

      T in state *q* has scanned *k* cells; cells *k*+1, ... are blank. Represent *q* as an ACM with *k* subjects and objects meeting the following:

      1. If cell *s* of tape contains symbol *X*, then *A*[*s*, *s*] contains the right *X*
      2. *A*[*s*, *s*+1] contains the right *Own*; this induces an ordering on the subjects according to the symbols on the tape; note *Own* is above main diagonal
      3. *A*[*k*, *k*] contains the right *End* (signalling the farthest right the head has moved)
      4. If tape head at cell *s*, *A*[*s*, *s*] contains the right *q*

      Initially, *q*0 is an ACM with one subject and one object corresponding to the first tape cell.

      Move: d(q, X) = (p, Y, L) means in state q and head scanning symbol X, changes state to p, overwrites X with Y, and moves head left (R would be right). Movesrepresented as commands; example: above move is:

      command $c_{qX}(s, s')$
      if *Own* **in** *A*[*s*, *s'*] **and**
      q **in** *A*[*s'*, *s'*] **and**
      X **in** *A*[*s'*, *s'*]
      then
      delete *q* **from** *A*[*s'*, *s'*]
      delete *X* **from** *A*[*s'*, *s'*]
      enter *Y* **into** *A*[*s'*, *s'*]
      enter *p* **into** *A*[*s'*, *s'*]
      end.

      where *s'* is current position of tape head and *s* is square to left. A move to the right has to handle the *End* case; 2 different commands, appropriately conditioned

      Now, if *T* reaches its final state q_f, then right *qf* leaked into some position of ACM; equivalently, if TM halts, the right q_f is leaked. So if the safety question is decideable, so is the halting problem, which is false; so the safety problem is undecidable.
3. Take-Grant: rules, initial and terminal spans, bidirectionality of t and g given subject-only graph