Questions?

- Project #3
- HW #7 due April 24
Today

- Introduction to evaluation
Practicing CS as Science

By Adam Porter
Success!

176 C KA 03 33 Paid. Via Norfolk Va
Kitty Hawk N C Dec 17
Bishop M Wright
7 Hawthorne St

success four flights thursday morning all against twenty one mile
wind started from Level with engine power alone average speed
through air thirty one miles longest 57 seconds inform Press
home # # # Christmas.

Orevelle Wright 525P
The Wright Flyer 1’s maiden flight
The rest of the story

- Samuel P. Langley
  - Background
    - Renowned astrophysicist & astronomer
  - Institution
    - Secretary of the Smithsonian Institution
  - Research funding
    - $50,000 from the US War Department
  - Prior work
    - An unmanned steam-powered model flew 3/4 of a mile in 1891.

- Orville & Wilbur Wright
  - Background
    - Neither finished high school
  - Institution
    - The Wright Cycle Company
  - Research funding
    - Piggy bank
  - Prior work
    - None before 1899
Langley’s Aerodrome “A”

- Innovative design
- Several successful unmanned flights
What did the Wright’s do right?

- They got lucky! :-)
- They worked their tails off
Reviewed what was already known
Wilbur’s letter

• “… I wish to obtain such papers as the Smithsonian Institution has published on this subject, and if possible a list of other works in print in the English language. I am an enthusiast, but not a crank in the sense that I have some pet theories as to the proper construction of a flying machine. I wish to avail myself of all that is already known and then if possible add my mite to help on the future worker who will attain final success.”
The Smithsonian answers

- Assistant Secretary Richard Rathbun answered Wilbur on June 22, enclosing a list of publications including works by
  - Octave Chanute, Samuel Langley, and James Means.
- Basically all that was known on the subject at that time
- Wilbur commented that "at that time there was no flying art in the proper sense of the word, but only a flying problem."
Developed hypotheses & experimented

• Otto Lilienthal, a famous pilot, died when a gust of wind pushed the nose of his craft up. Since he could not bring it back down quickly enough he stalled and then plunged to his death.

• The Wright’s focused on the lack of controls for aircraft. (e.g., Lilienthal hung beneath his plane kicking his legs to balance)

• Also surmised that birds must have a better method for balance and control, so began to study bird’s wing structures as
Built prototypes
Corresponded with other researchers

- They wrote to Octave Chanute (one of the researchers whose book was sent to them by the Smithsonian) for advice on where to conduct their test flights
- He advised them to find a location over water or sand to cushion the impact of a crash
- And that’s exactly what they did. Kitty Hawk, NC has a long sandy beach to the ocean (They also contacted the weather bureau to get wind informations)
Paid attention to inconsistencies &
published intermediate results

- The Wrights had obtained data tables from Lilienthal to calculate expected lift and drag
- Their planes did not exhibit the expected lift

SOME AERONAUTICAL EXPERIMENTS.

Mr. WILBUR WRIGHT, Dayton, Ohio.

[Presented to the Western Society of Engineers September 18, 1901.]

“This deficiency we supposed might be due to one or more of the following causes: (1) That the depth of the curvature of our surfaces was insufficient, being only about 1 in 22 instead of 1 in 12. (2) That the cloth used in our wings was not sufficiently air tight. (3) That the Lilienthal tables might themselves be somewhat in error. We decided to arrange our machine for the following year so that the depth of curvature of its surfaces could be varied at will and its covering air-proofed.
Built Experimental Apparatus
Gathered and analyzed exper. results

- Found that lillenthal’s data was correct, but that another constant was incorrect (and had been for over 150 years)
- Now they were able to test 100’s of wing shapes & wind angles and determined that existing wing shapes were inefficient
- Iterated to fix remaining problems (finally adding a tail rudder to control turn instability)
Overall approach

1. Identify key technical challenges that were on the critical path to constructing the desired technology (e.g., control)
2. Systematically investigate the underlying principles necessary to address those challenges
3. Apply those principles to construct prototypes
4. Systematically evaluate those prototypes
5. Iterate
Science is about discovery
So how can we increase the odds of discovering something important?
  – It helps to know something
  – There is a lot to discover in the unknown
  – If it were food you’d figure out how to find it
  – Paradigms, not puzzles
  – Practice big thoughts Fridays

In Oliver’s words
  – Identify an important frontier
  – Explore that frontier
  – Observe the unknown thoroughly.
A project check list

• Does anyone beside your mother care about this?
  – Is it an unexplored (or underexplored) question?
  – Do different points of views exist?
• Do you have testable hypotheses?
• Can you identify possible independent and dependent variables
• Do your experiments study behavior? As opposed to design?
• Some practical issues
  – Existing implemented algorithm, protocol, or system; or well-described algorithm with low reimplementation cost
  – Existing experimental infrastructure
Setting the stage for discovery
What does evaluation mean?
Predictions and measurements?

• Type of prediction
  – Point
  – Interval
  – Ordinal
  – Categorical

• Construct and measurement methods
  – Reliability
  – Convergent validity
  – Discriminant validity
Questioning measurements

• Are they reliable?
  – Does the experiment take into account variations between subjects?
    • Need for testing a sample of subjects

• Are they valid?
  – Does the experiment reflects target use?
    • Were users typical?
    • Were tasks typical?
    • Was the setting realistic?
    • Was the experience biased?

• Do they make sense?
  – Setting the stage for discovery!
The participant standpoint

- Testing is a distressing experience
  - Pressure to perform
  - Feeling of inadequacy
  - Looking like a fool in front of your peers, your boss,…

(from “Paper Prototyping” by Snyder)
Ethics: The Stanford prison experiment

• Was it useful?
  “…that’s the most valuable kind of information that you can have - and that certainly a society needs it” (Zimbardo)

• Was it ethical?
  – Could we have gather this knowledge by other means?