Passive Measurements of Behavior

Andrew T. Campbell, Workshop on Precision Medicine Initiative, Santa Clara, July 27-28
what happens when life throws you a “googly”?
More College Freshmen Report Having Felt Depressed

By ALAN SCHWARZ  FEB. 5, 2015

High numbers of students are beginning college having felt depressed and overwhelmed during the previous year, according to an annual survey released on Thursday, reinforcing some experts’ concern about the emotional health of college freshmen.

The survey of more than 150,000 students nationwide, “The American Freshman: National Norms Fall 2014,” found that 9.5 percent of respondents had frequently “felt depressed” during the past year, a significant rise over the 6.1 percent reported five years ago. Those who “felt overwhelmed” by schoolwork and other commitments rose to 34.6 percent from 27.1 percent.

Conducted by the Cooperative Institutional Research Program at the
11% of Dartmouth students were diagnosed with depression in 2014.

12% reported depression has having an impact on academic performance.

28% have seen a mental health counselor in 2014.
most faculty are unaware that their students are struggling beyond grades
StudentLife study

48 students over 10 week Spring 2013 term
• 10 female, 38 male CS students
• 30 undergraduates, 18 graduates
• 8 seniors, 14 juniors, 6 sophomores, 2 freshmen, 3 Ph.D students, 1 second-year Masters student, and 13 first-year Masters students
• 23 Caucasians, 23 Asians and 2 African-Americans.
what behaviors can phones “passively infer” using sensors
activity

- sitting
- standing
- walking
- running
around conversation

face-to-to-face conservation: duration and frequency
Activity Feature
stationary duration

Sound Feature
silence duration

Light Feature
darkness duration

Phone Usage Features
Phone-lock, charging, phone-off duration

Linear regression model

\[ Sl = \sum_{i=1}^{6} \alpha_i \cdot F_i, \ \alpha_i \geq 0 \]

Minimize
\[ \min_{\alpha_i} \sum_{j=1}^{4} (Sl^j - \sum_{i=1}^{6} \alpha_i \cdot F^j_i)^2 \]
study areas

sound

activity

studying focus
partying
StudentLife

StudentLife is the first study that uses passive and automatic sensing data from the phones of a class of 48 Dartmouth students over one term to assess their mental health (e.g., depression, loneliness, stress), academic performance (grades across all the courses and cumulative GPA) and behavioral trends (e.g., how stress, sleep, visits to the gym, etc. change in response to college life).
behavioral trends
class attendance
sleep

The graph shows the number of deadlines and sleep over a period of 64 days, with a shaded area highlighting the mid-term. The x-axis represents the day, and the y-axis represents the number of deadlines. The graph indicates a fluctuation in both deadlines and sleep, with a notable dip during the mid-term.
face-to-face conversation

The graph shows the number of deadlines, conversation duration, and conversation frequency over time. The mid-term period is highlighted, indicating a peak in conversation frequency and a corresponding increase in deadlines. The graph suggests a pattern where deadlines and conversation duration rise and fall in parallel, with a notable increase towards the end of the period.
activity duration

mid-term
stress and affect

The figure shows the trend of deadlines, positive affect (PA), and stress over days. The mid-term is indicated by a shaded area. The x-axis represents the number of days, and the y-axis represents the number of deadlines. The graph illustrates how these factors change over time.
class attendance

- number of deadlines
- attendance

- mid-term
The graph shows the number of deadlines and gym visits over a period of days. The x-axis represents the day, ranging from 1 to 64. The y-axis on the left side represents the number of deadlines, ranging from 0 to 1.2. The y-axis on the right side represents the number of gym visits, ranging from 0 to 2.5.

The graph highlights a significant drop in gym visits around day 36, coinciding with the mid-term period, indicated by the gray shaded area. The line representing deadlines shows a slight increase around the same period, suggesting a possible correlation between increased deadlines and gym visits.

Legend:
- blue line: deadlines
- orange line: gym

Mid-term period:
- Day 22 to Day 36

Key points:
- Days 1 to 8: Stable number of gym visits.
- Days 9 to 15: Increase in gym visits.
- Days 16 to 21: Stable number of gym visits.
- Days 22 to 35: Drop in gym visits.
- Days 36 to 50: Increase in gym visits.
- Days 51 to 64: Decrease in gym visits.
when do students party?

when do students study?
mental health
depression

- Sleep duration *
- Conversation frequency (day) **
- Conversation frequency (evening) *
- Number of co-locations *

*R value

*p ≤ 0.05, **p ≤ 0.01
why are these results important?
24/7 passive sensing on smartphones is here at last!
because we find significant correlations between passive and objective sensor data from smartphones and outcomes from validated mental health “gold standard” surveys such as PHQ9
future of mobile
phone will predict
depression
relapse
intervention
so what happens when life throws you a “googly”?
Mobile will detect it.
And deflect it.