Order from Chaos

Exploring An Architecture to Bring Order from the Chaos of Mobile Sensor Data

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Why Collect Mobile Health Data?

- Acquire observed data, not just reported data
- Understand lives in greater detail
- Improve health outcomes
- Case study: bipolar research

Bipolar Disorder

- Chronic, severe mental illness
- Characterized by repeated episodes of
  - Depression
  - Mania, hypomania
  - Mixed states
- Affects ~ 2% of US population
- Median age of onset = 25 years

Major Depressive Episode

- 2 week period, change in functioning
- ≥ 5 symptoms with depressed or ↓ interest

Mood/Cognition

- Depressed mood
- ↓ Interest/pleasure
- Worthless/guilty
- ↓Concentration
- Suicidal thoughts

Behavior

- Change weight/appetite
- **Insomnia/hypersomnia**
- **Psychomotor ↑ or ↓**
- Fatigue/loss of energy

Manic Episode

- 1 week period or hospitalized
- If elevated ≥ 3, irritable ≥ 4 symptoms

Mood/Cognition

- ↑ Self-esteem
- Racing thoughts
- Distractability

Behavior

- **↓ Need for sleep**
- ↑ Talkative, pressured
- ↑ Goal, **↑ psychomotor**
- ↑ Pleasurable risks

Impact

- **Despite effective medications**

  Episodes long = 3 mos

  Multiple episodes

  Symptoms between episodes common

- **Disabling** - symptomatic 50% of time
- **Deadly**- relative risk mortality = 2.6

Psychosocial Treatment

- **Effective in controlled trials**
  - ↑ Quality of life
  - ↓ Symptoms
  - ↓ Time to relapse
  - ↓ Hospitalization
- **Not routinely utilized**
  - ~ 50% Receive psychosocial treatment
  - ~11 Mental health visits/yr

Treatment Components

- ↑ Knowledge about bipolar disorder
- ↑ Medication adherence
- ↑ Communication with family + supports
- **Emphasize stabilizing patterns of**
  - – Sleep/activity
  - – Social interactions
- **Teach relapse prevention plan**
  - – Monitor/recognize early warning signs
  - – Have a plan to intervene early

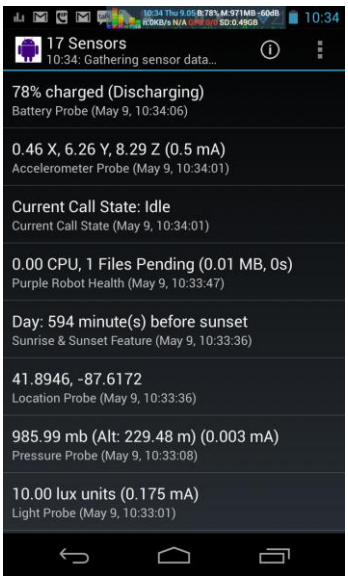
Smartphones and Bipolar

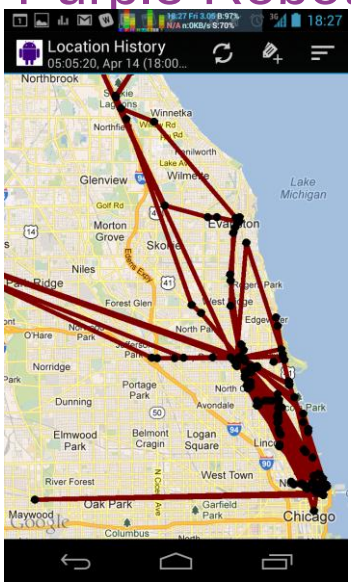
- ↑ Accessibility: lessons, skills training
- ↑ Engagement: self-monitoring, feedback
- ↑ Communication: provider alerts
- **Measure daily patterns of behavior**
  - Sleep and activity: accelerometer, gyroscope
  - Location: gps, tower ids
  - Social interaction: gps, tower ids

Data Acquisition Steps

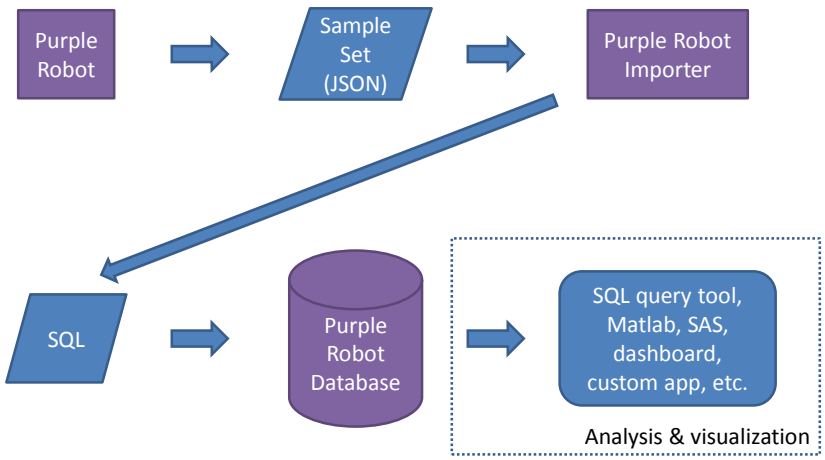
- Data Collection
  - **Purple Robot**
- Database Import
  - **Purple Robot Importer**
- Data Storage
  - **Purple Robot Database**

Data Collection: Purple Robot

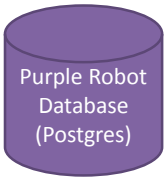




Data-Flow Architecture



Purple Robot Database



- *Database:* **De-identified user A**
  - *Table (sensor):* Accelerometer
  - *Table (sensor):* Current Call State
  - *Table (sensor):* Location
  - …etc…
  - *Table (feature):* survey_responses
  - *Table (feature):* nearby_locations
  - *Table (feature):* current_weather
  - …etc…
- *Database:* **De-identified user B**
  - *Tables…*
- *Database:* **De-identified user C**
  - *Tables…*
- …etc…

Accumulated Experiences

Challenges

- Data gaps; battery-related?
- Joining disjoint time-series.
- Occasional SQL user training.

Successes

- Multiple clinical trials.
- High-freq. data research.
- Matlab and SAS integration.
- Fast.
- Reliable.
- Flexible.

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