Predictive User Modeling and Planning for Improving Self-efficacy and Goal Adherence in mHealth

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Introduction

mHealth applications provide a great opportunity for integrating behavior-change methods in everyday life. We are developing an artificially intelligent coach that provides support for health-related behavior change by personalizing behavior goals and tracking progress toward them.

Dynamic Planner

Designed to encourage users to increase their aerobic activity to AHA guidelines:

- low: 30 minutes of moderate activity 5 times a week
- high: 30 minutes of vigorous activity 5 times a week

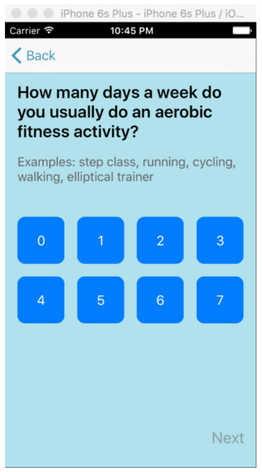
Designed using the F.I.T.T principles of exercise prescription and operates over:

- intensity: *i*, measured in MET level
- type: moderate walking, walking on inclines, interval walking, walking with exercises
- frequency: *f*, 3-5 times a week
- duration: *d*, 10 - 45 minutes of activity

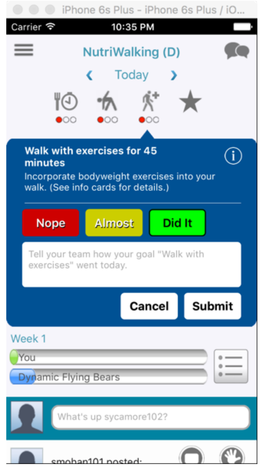
Weekly Planner

- assessor
  - interacts with users to measure their physical capability
    - *i*d*f* MET-minutes in a week
  - determines a long-term goal
  - recommends a first week goal
  - generates an initial trajectory to long-term goal
- evaluator
  - uses heuristics and data to evaluate if the current trajectory is appropriate
  - if easier proposes a progression, if harder proposes a regression, if user has been busy, proposes repeating the current goal (*shift*)
- reviser: revises the trajectory by
  - increasing step size, if a progression is recommended
  - moving it forward by a week, if a shift is recommended
  - decreasing step size and moving it by a week, if a regression is recommended
- presents user with a choice between the planner recommended goal and their previous goal.
- schedules selected weekly goal.

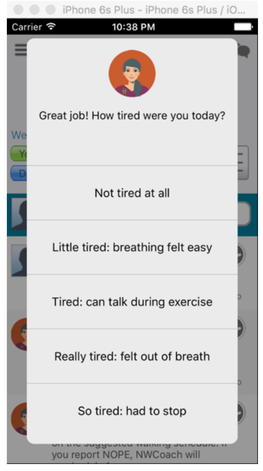
Assessing a User



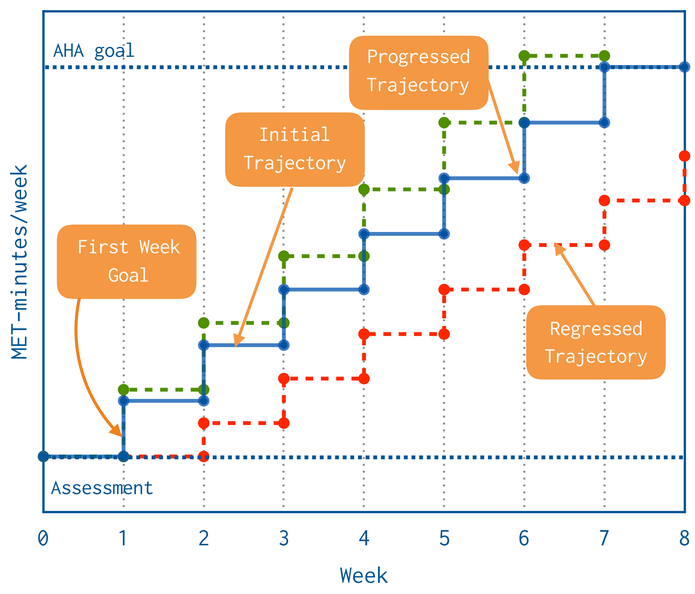
Compliance Report



Interactive Questions



User's Weekly Goal Trajectory



Daily Planner

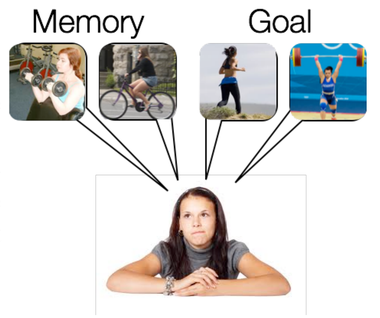
- tracks progress towards weekly goal
- maximizes opportunity to complete the weekly goal
- redistributes activities in the remaining days in the week after the user reports
- interacts with user to gather data for rate of perceived exertion, affective attitude, self-efficacy (feeds into evaluator's judgements)

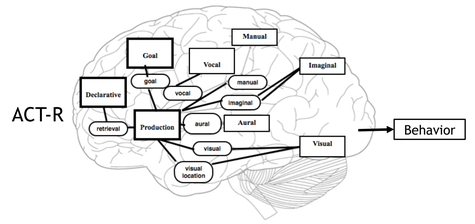
User Model of Self-Efficacy

Goal: To do a set of activities **A** that I believe have some difficulty δ_g.

Call upon memory: What have I done that is similar to **A**?

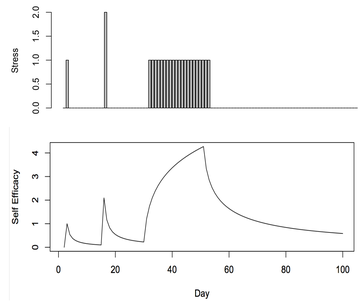
Blend memories to determine self-efficacy: Based on my memories of the difficulty δ_E of my successful past experiences, I believe my ability is θ_E.

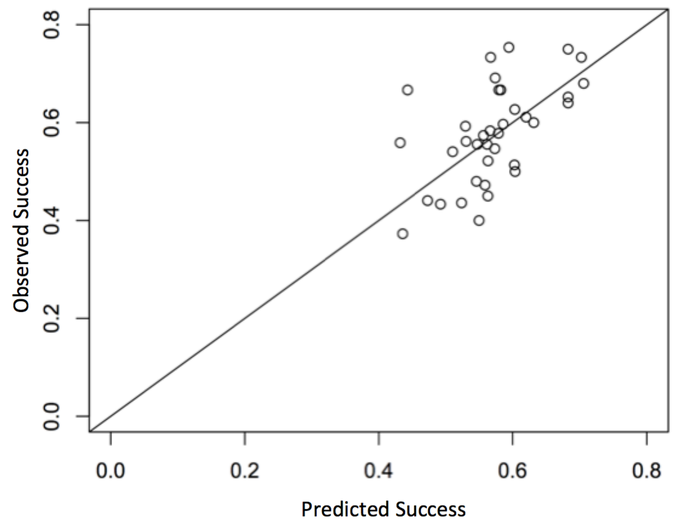




ACT-R Predictive Model

Self-efficacy builds based on frequency, recency, and difficulty of successful experiences.





Observed Exercise Adherence as a Function of ACT-R Prediction

For more details about the DStress study, and ACT-R Model see Konrad, A et al., CHI 2015; Pirolli, Translational Behavioral Medicine, 2016