Developing Web-based Applications for Health Intervention Research

Luyao Zhang
July 16, 2018
CHAI Core

• Connected Health Applications & Interventions

• A resource for investigators looking to add value to their researches

• Application development, user inquiry, graphic design
My Projects (Done & Ongoing)

- Charts Modification for IMPACT
- Modules Adaption & Email Notification for CHART
- Database Query Optimization for CHAMPs
- Metrics Implantation for NUDGE
IMPACT

- NIH funded 4-year study

- Increasing physical activity among young adult cancer survivors

- Responsive website developed by CHAI Core

- Pull data from remote scale and Fitbit trackers and send real time messages to participants
Dashboard of IMPACT

WEEKLY GOALS
Week 2
105 minutes this week
7,239 steps per day
Don't forget to check out this week's lesson!

ACTIVITY PROGRESS

DAYS FITBIT WORN THIS WEEK

ACTIVE MINUTES THIS WEEK
GOAL: 105 MINUTES
ACHIEVED: 177 MINUTES

STEPS THIS WEEK
GOAL: 7,239 STEPS PER DAY

7,212, 6,360, 12,483, 0
Charts Modification - IMPACT

• **Steps graph** (progress page)
  – Add Y axis label text
  – Add explanation text under X axis
  – Change title to “STEPS”
  – Display 7 when goal is met all 7 days
Charts Modification - IMPACT

• **Active minutes graph** (progress page)
  – Add legend
  – Color adjustment
Charts Modification - IMPACT

- **Progress bars** (dashboard and feedback pages)
  - Set horizontal axis tick value to be the fifth of the max value on the scale rounding up to a multiple of 5
  
  - Set the max value on the horizontal axis as step goal if goal is not met and as actual number of minutes achieved if goal is exceeded
  
  - Display number of active minutes achieved
Modified Progress Bar

**ACTIVE MINUTES THIS WEEK**
GOAL: 105 MINUTES
ACHIEVED: 177 MINUTES

**TOTAL ACTIVE MINUTES LAST WEEK**
GOAL: 95 MINUTES
ACHIEVED: 462 MINUTES
Solution

- Modified the functions in that used to calculate the max tick value
- Added helper function to calculate the tick value as requested
- Added variable in the feedback controller and progress controller for passing total active minutes data
- Added text and variable in D3 progress bar graph files for displaying text and receiving total active minutes data
The brain of an application

1. Submit User Request
2. Route to appropriate Laravel Controller
3. Interact with Data Model
4. Controller invokes results View
5. Render view in users browser
CHART

- The Carolina Health Assessment & Resource Tool

- Investigate the relationship of human behavior between cancer risk and other chronic conditions

- 10 core behavioral modules

- Accompanying evidence-based and theory-guided message libraries
Modules Adaption (Sisler)

- Clinical tobacco counseling program at the North Carolina Cancer Hospital
- An adaptation of the CHART My Tobacco Plan module and a customized follow-up module
- Test the feasibility to recruit social networks for a smoking cessation intervention
My Health Behaviors

This report shows your current health behaviors and whether or not you are meeting national health recommendations.

you meet recommendations

you can improve

My Emotional Health

GOAL: Minimize distress in your life.

You've been feeling a distress level of 1 of 10 in the past week.

My Sleep Habits

GOAL: Get 7-9 hours of sleep in a 24-hour period

You get 7 hours of sleep in a 24-hour period.
Tasks – CHART (Sisler)

- Program changes to the “My Tobacco Plan” baseline questionnaire

- Program changes to demographics questionnaire

- Send email notifications to admin when participant completes baseline module
Approach – CHART(Sisler)

- Edit the PHP associative array used to store the survey data (question content, type and skip logic)

- Mail API in Laravel (based on SwiftMailer library)

- UNC SMTP (Simple Mail Transfer Protocol) mail server: \textit{relay.unc.edu}

- Create new function in the participant controller for sending email
Adapted demographics module (showing one page)

Results – CHART(Sisler)
"My Tobacco Plan"

If I am tempted to use tobacco when I am very angry about something or someone
Then I will tell myself that if I try hard enough I can keep from using tobacco!

Adapted “My Tobacco Plan” module (showing one page)

Results – CHART (Sisler)
Challenging Part – blank survey page

- Participant will be identified as a smoker or a non-smoker based on the responses for the first page of the baseline survey.
- If he/she was identified as a non-smoker, the questions on the second page will be hidden.
Solution

- Controller contains the page jumping logic by tracking the behaviors of the next/back button elements on the survey page
- Located the functions in the file that determine the next/last page
- Created a new algorithm for generating next pages’ ID, which can take the ID of the nearest page that has at least one unhidden question as the ID for the next/last page
- Applied the new algorithm to the target functions and tested it on local server
CHAMPs

• Coach-Delivered Healthy Eating Activity Management Programs

• A web-based weight loss intervention for a study called Peer Support for Weight Loss Maintenance

• NIH funded 5-year study by the Weight Management Research Group at the University of Connecticut
Database Query Optimization for CHAMPs

- Data retrieval from the database in the admin controller and the report controller is slow.

- Optimize the data retrieval by using tables instead of views or by improving the performance of views.
Approach

- MySQL EXPLAIN statement
- Database index
- Reorganize queries
user_id, participant_id, first_name, cohort, baseline, intrv_week, last_week, avg_calories, calorie_days, sum_pa, pa_days, weight_days, weekly_first_weight, weekly_last_weight, weekly_weight_change, all_weight_change, change_goal, met_five_pct_goal
View - user_weeklyprogress

- user_id, participant_id, first_name, cohort, baseline, intrv_week, last_week, avg_calories, calorie_days, sum_pa, pa_days, weight_days, weekly_first_weight, weekly_last_weight, weekly_weight_change, all_weight_change, change_goal, met_five_pct_goal
View - user_weeklyprogress

- **User Info** (users, participants)
  - `user_id`, `participant_id`, `first_name`
  - `cohort`, `baseline`, `inrv_week`, `change_goal`

- **Calorie & Physical Activity** (selfreports)
  - `avg_calories`, `calorie_days`, `sum_pa`, `pa_days`

- **Weight Info** (selfreports, participants)
  - `Weekly_first_weight`, `Weekly_last_weight`
  - `Weight_days`, `met_five_pct_goal`
Solution

- Analyze the original queries that extracted from the view creating PHP files in migration folder with EXPLAIN statement

- Based on the idea of joining separated temporary derived tables containing target values which can be obtained with low cost, rewrote the SQL queries

- Create indexes and test whether the indexes work using the EXPLAIN statement

- Create fake records and test the performance of the new queries
Divide and Conquer

- Select **part of target data/value** cheaply
- Group by the final primary keys (user_id, intrv_week)
- Join derived temporary tables at low cost
Comparison of Execution Time

Query Execution Time (Improved vs. Original)

- **user_ondemand**: Original Query 26200, Original Query with Indexes 26900, New Query 25.1, New Query with Indexes 20.9
- **user_engagement**: Original Query 2580, Original Query with Indexes 51.2, New Query 13.8, New Query with Indexes 13.2
- **user_weeklyprogress**: Original Query 70900, Original Query with Indexes 27700, New Query 8710, New Query with Indexes 75.7
- **concat_intrvweeks**: Original Query 70400, Original Query with Indexes 31400, New Query 15.6, New Query with Indexes 12.4
Questions?