PEBBLE DEVELOPMENT

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Why Should You Care?

- Tuesday’s lab in on Pebble Development
- You have a homework on Pebble Development
    - Must include a Pebble Watch App and Android Companion App
- Wearables seen as the next big frontier in mobile development
- People buy these things ($$$)

Types of Apps

- Pebble Watchface
  - Presents information such as the time, weather, and date
  - Involves minimal user interaction
- Pebble WatchApp
  - App for the Pebble involving some calculation based on user input
- Pebble Companion App paired with WatchApp
  - Pebble WatchApp that communicates with a smart device
- Developer Console Scripting Apps
  - WatchApp, so customizable has its own scripting language
- All development for Pebble watches is in C (yay!)
  - Except for a little bit of optional Javascript

Application Elements

- Pebble apps are event driven
- Developers must setup callback functions to be executed on user events
- Every main function has the same basic structure

```
int main() {

    init();

    app_event_loop();

    deinit();
}
```

- init() will contain all the program setup, callbacks, UI elements etc
- deinit() will “tear down” things setup in init(), don’t leave anything out
- app_event_loop(), infinite loop, allows events to be picked up by listeners

Pebble API in General

- All the structs are typedef-ed
  - Instead of struct Window, we can just type Window (phew)
- Functions relating to certain structs are prefixed with the struct name
  - Ex. window_set_window_handlers deals with Window structs
  - Ex2. layer_add_child(…) deals with layer structs
  - Ex3. menu_cell_basic_draw(…) deals with MenuLayer structs

Pebble API in General

- The Pebble API is object oriented
  - What? In C?
- Functions are bound to structs
  - Structs have fields storing function pointers in the structs
- Structs of the same variety (i.e. Layer, MenuLayer, TextLayer) contain instances of their “parents”
  - Access these fields by calling function (a getter, if you will)
  - i.e. Layer *layer = menu_layer_get_layer(menu_layer);

Pebble API in General

- Explicit dynamic memory allocation is discouraged
  - Pebble has very limited memory
  - i.e. calls to malloc and calloc
  - To allocate and free dynamic memory, Pebble API calls should be used
  - i.e. window_create_window, window_destroy_window, layer_create_layer, menu_layer_create_layer
- Pointers…pointers everywhere…..

Function Pointer Example

- typedef void (* WindowHandler)(struct Window *window)
  - Declares function with void return value that take struct Window to be referenced by WindowHandler type

Ex.

```
void my_function() {
   //stuff
}
int my_function2(struct Window *window) {
   //better stuff
}
void my_function3 (struct Window *window) {
   //best stuff
}
WindowHandler *handler = my_function;
WindowHandler *handler2 = my_function2;
WindowHandler *handler3 = my_function3;
```

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WindowHandler *handler2 = my_function2;
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}
void my_function3 (struct Window *window) {
   //best stuff
}
WindowHandler *handler = my_function; //DOESN’T WORK
WindowHandler *handler2 = my_function2; //DOESN’T WORK
WindowHandler *handler3 = my_function3; //SUCCESS!
```

A Pebble Function Pointer Example

```
static Window *window;

void window_load() {
        //do stuff to setup window like set layers
}
void window_unload() {
        //destroy elements of the window
}
void init() {
        window = create_window();
        WindowHandlers winHandle;

        winHandle.load = window_load;
        winHandle.unload = window_unload;

        window_set_window_handlers(window, winHandle);
        window_stack_push(window);
}
```

Visual Elements

- Window
  - Fundamental UI element of all pebble apps
  - Analogous to an xml layout file in Android
  - Pushed and popped onto window stack for visibility
  - One, and only one, must be displayed at all times
    - Except when animating transitions between windows
  - Handle all user input (button clicks) by using callback functions
    - These callback functions can only be set once per Window

Essential Window Functions

- Window* window_create()
  - Create new window, return a pointer to it

- void window_set_click_config_provider(Window, ClickConfigProvider)
  - Set a function with the signature void <function_name> (void *context) to run every time the window is brought into focus
  - Function passed must setup all button click handlers
    - i.e. the window_single_click_subscribe function below

- void window_single_click_subscribe(ButtonId, ClickHandler)
  - Set callback function for a single button click specified by button_id
  - i.e. BUTTON_ID_SELECT

Window Actions Setup Example

```
static Window *window;

static void select_handler(ClickRecognizerRef recognizer, void *context) {
    //Action to execute when select is clicked
}
static void up_handler(ClickRecognizerRef recognizer, void *context) {
    //Action to execute when up is clicked
}
static void down_handler(ClickRecognizerRef recognizer, void *context) {
    //Action to execute when down is clicked
}
static void click_config_provider(void *context) {
    window_single_click_subscribe(BUTTON_ID_SELECT, select_handler);
    window_single_click_subscribe(BUTTON_ID_UP, up_handler);
    window_single_click_subscribe(BUTTON_ID_DOWN, down_handler);
}

static void window_load(Window *window) {
    window_set_click_config_provider(window, click_config_provider);
}

int main () {
    init();
    app_event_loop();
    deinit();
}
```

Visual Elements

- Window Stack
  - Hold all currently, previously displayed windows (unless explicitly removed)
  - Top of stack is the currently displayed window
  - Simple push/pop operations to change out windows
  - Can remove windows by index from the stack (but not add)

Essential Window Stack Functions

- void window_stack_push(Window *window, bool animated)
  - Pushes passed in window onto top of window stack, making it visible
- Window* window_stack_pop(bool animated)
  - Pops the currently visible window off the window stack
- bool window_stack_remove(Window *window, bool animated)
  - Removes passed in window from stack, returns false on failure
  - NOTE: There is no corresponding add function

Visual Elements

- Layers
  - Display text, images, other layers
  - Many types
    - MenuLayer, ActionBarLayer, TextLayer, BitmapLayer, MenuBarLayer and more….
  - Every Layer type (TextLayer, MenuLayer etc) contains a base Layer object that provides the same fundamental operations
  - Store information about state necessary to draw or redraw the object that it represents

Layer Details

- Pass a GRect struct to layer_create, must define what space the layer will occupy
  - GRect has two fields, origin, and size

    - origin: specifies where the layer starts, is GPoint struct with two int fields (x, y)
      - NOTE: The origin of the pebble is at the top left corner of the screen

    - size: specifies size of rectangle and is GSize struct with two int fields (h and w) (height and width)

Layer Details

- Layers can store data, i.e a callback function, by calling layer_create_with_data and passing size of data region
  - Data is set by calling layer_get_data(const Layer *layer)
    - Return void* type pointing to data and manipulating data at address

Layer Details

- Every Layer (MenuLayer, TextLayer, BitmapLayer) contains a field of plain old Layer type
  - Provides useful properties of polymorphism
  - Allows passing around Layer reference contained in MenuLayer to a function that only accepts the Layer type

Essential Layer Functions

- Layer* layer_create(GRect frame)
  - Create a layer, size determined by GRect struct
- void layer_destroy(Layer *layer)
  - Destroy the layer
- GRect layer_get_frame(const Layer *layer)
  - Gets the bounds of the frame in the form of a GRect struct
- struct Window* layer_get_window(const Layer *layer)
  - Get Window struct layer is in or NULL if layer not bound to window
- void layer_add_child(Layer *parent, Layer *child)
  - Set child layer inside parent layer
  - Probably the most used layer function….

Text Layer

- Simple layer that provides functions to write and erase text
- Can set text color, font, background color, text alignment…
- Simplest Layer

Menu Layer

- Layer which defines a familiar menu layout
  - Each cell can have its data altered
- Heavy to setup, minimum of about 5 callback functions
- Little interaction required afterwards (unless you’re doing something tricky)

Bitmap Layer

- Used to display a picture
- Good for icons and simple figures, no HD pictures…

Action Bar Layer

- A layer which provides a vertical row of buttons on the right side of the window
    - See the default music player app on the Pebble for an example
- Can contain up to 3 customizable icons (i.e. next, prev, play)
- Icons can be swapped out in real-time
- ActionBarLayer is bound to the window directly
    - No intermediary layer
    - All click handlers are automatically setup on binding
    - Additional Layers may cover up the ActionBar

Persistence on the Pebble

- Storage space is identified by the (hopefully) unique app UUID
- Values are all stored in key, value pairs
  - Keys are uint32_t values
  - Values are integers, c-strings (char *), and byte arrays
  - structs can be saved as byte arrays too!
- Maximum storage space for any single app is 256 bytes
- Calls to Persistence API are slow
  - best used in the init() and deinit() functions

Persistence Function Calls

- Writing
  - persist_write_bool(BOOL_KEY_VALUE, true/false);
  - persist_write_int(INT_KEY_VALUE, 42);
  - persist_write_string(STRING_KEY_VALUE, “Douglas”);
  - uint8_t bytes[42];
    persist_write_data(BYTES_KEY_VALUE, bytes, sizeof(bytes));
- Reading
  - bool truth = persist_read_bool(BOOL_KEY_VALUE);
  - char username[20]
    persist_read_string(STRING_KEY_VALUE);
  - uint8_t bytes[42];
    persist_read_data(BYTES_KEY_VALUE, bytes, sizeof(bytes));
- Existence
  - bool exists = persist_exists(QUESTIONABLE_KEY);

Pebble Device Communication

- Communication can be initiated from device or the Pebble
- Phone companion app must have the unique UUID of the app to communicate with it
- All data must be sent as a dictionary, in key-value pairs
- Two packages to use for communication:
  - AppMessage
  - AppSync
- Additional data structures provided on both Pebble and Android
  - PebbleDictionary
  - Tuple
  - Tuplet

Pebble Communication with AppMessage

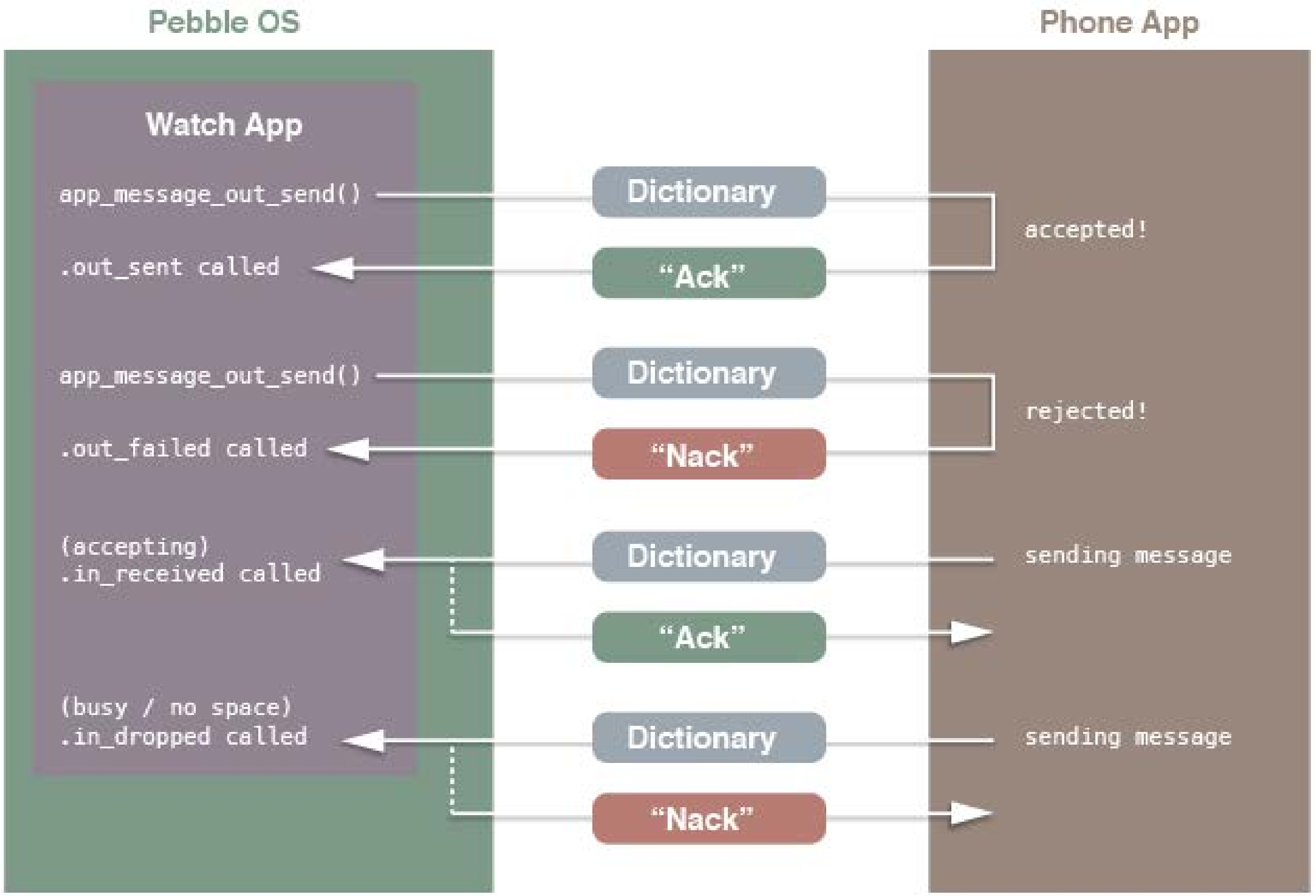
- Allows high level of control over each individual message
- Must implement at most 4 callback functions
- Sending
  - Write values to Dictionary and call "app_message_outbox_send()"
- Receiving
  - void in_received_handler(DictionaryIterator *iter, void *context)
    - In body check for fields you are expecting to receive with:
      - dict_find(DictionaryIterator *iter, int id)

- Older firmware (1.1) doesn't support AppMessage

Android Communication with AppMessage

- Import PEBBLE_KIT project in to Eclipse and add to Build Path of Android apps
- Receiving Messages
  - registerReceivedDataHandler
  - One function to implement:
    - void receiveData(final Context, final int transactionId, final PebbleDictionary)
  - Must acknowledge receipt of message (or NACK it)
    - PebbleKit.sendAckToPebble(final Context context, final int transactionId);
- Sending Messages
  - sendDataToPebble(final Context, final UUID, final PebbleDictionary)
- Status Updates
  - Listen for watch connected event
  - Listen for ACK/NACK messages from the Pebble

Pebble Communication with AppMessage



Pebble Communication with AppSync

- Built on top of AppMessage
- Maintains and updates a single Dictionary
- Has built-in listeners to automatically update UI elements when the Dictionary changes
- Good for applications involving many updates
  - No user-incurred synchronization costs
- Setup one callback, call a setup function, done!

Pebble Communication with AppSync

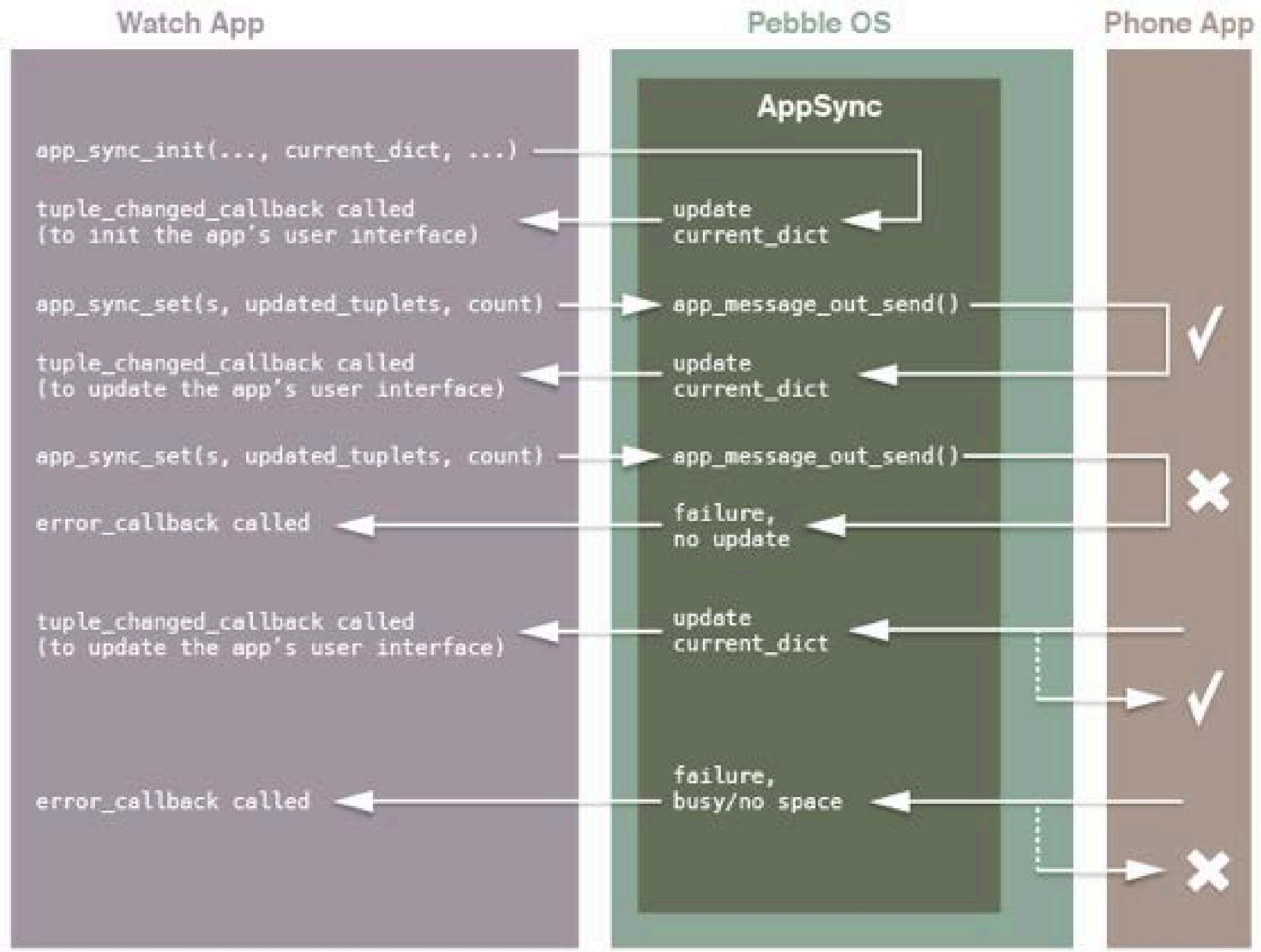
- Setup sync listeners and callbacks
- app_sync_init(

  struct AppSync *s,
  uint8_t *buffer,
  const uint16_t buffer_size,
  const Tuplet *const keys_and_initial_values,
  const uint8_t count,
  AppSyncTupleChangedCallback tuple_changed_callback,
  AppSyncErrorCallback error_callback,
  void *context)
- Sync_tuple_changed_callback(
  const uint32_t key,
  const Tuple *new_tuple,
  const Tuple *old_tuple,
  void *context)

Android Communication with AppSync

- Exactly the same as AppMessage

Pebble Communication with AppSync


Watch App
Pebble OS
Phone App
AppSync
app_sync_init(..., current_dict, ...)
tuple_changed_callback called
(to init the app's user interface)
update
current_dict
app_sync_set(s, updated_tuplets, count)
app_message_out_send()
✓
tuple_changed_callback called
(to update the app's user interface)
update
current_dict
app_sync_set(s, updated_tuplets, count)
app_message_out_send()
✗
error_callback called
failure,
no update
tuple_changed_callback called
(to update the app's user interface)
update
current_dict
✓
error_callback called
failure,
busy/no space
✗

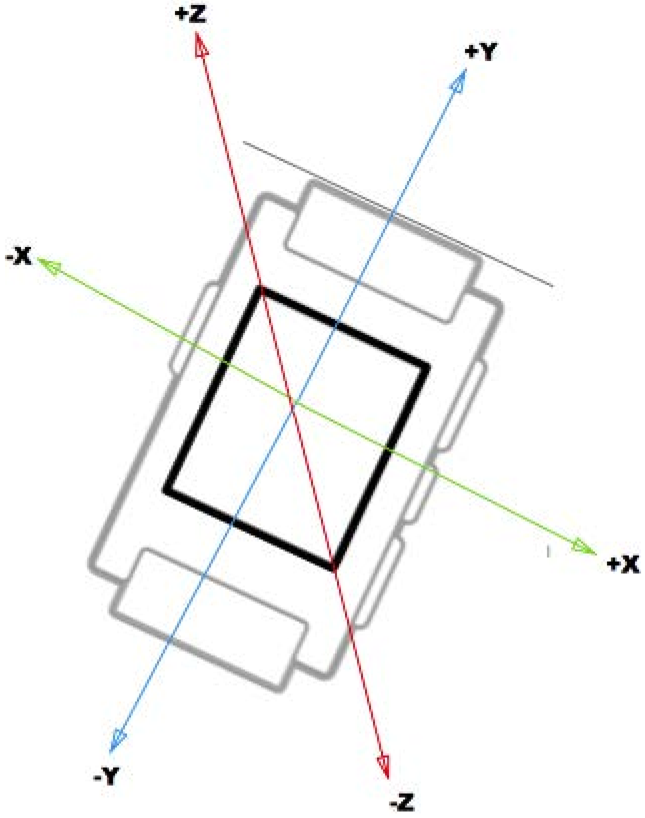
Javascript Aided Communication

- Platform independent way to communicate with Pebble
- Interface to make HTTP requests
  - Turns phone into a server where your Pebble is the client
- Interface from phone to Pebble using “Pebble” Javascript object
- Interface with the web using Javascript function calls
  - Part of W3C standard
- Data sent in Key-Value pairs
  - Follow JSON specification
- To make a Pebble app using Javascript
  - Create new project with command:
    pebble new-project --javascript my_js_project

Pebble Accelerometer

- Very sensitive
  - Sensitive enough to detects taps on the phone
- Measured in milli-Gs
  - Has a range of -4000 to 4000
- Watch vibrations affect accelerometer readings
- Grabs struct with x, y, z, bool did_vibrate indicating whether vibration occurred while grabbing values and timestamp in milliseconds

Pebble Accelerometer Axes



Using the Pebble Accelerometer

- Three main ways to utilize accelerometer
  - Register for shake or tap events
    - Predefined standards for taps and shakes
  - Process data in batch jobs to analyze for patterns
    - Can automatically poll for data at predefined intervals
  - Real time data usage
- Easy to subscribe to services for all three

JSON Configuration File

- JSON file in root directory of project (settings on CloudPebble)
- Includes various values, most are pre-generated
  - App Kind (watch app, watch face, companion app)
  - Long Name
  - Short Name
  - Menu Image
  - Version Code
  - Version Label
  - App UUID
- Also define Javascript Message Keys (if desired)

Pebble Development Setup

- Must be running Ubuntu (other Linux distros won’t work out of box)
- Download SDK and follow the instructions:
  - https://developer.getpebble.com/2/getting-started/linux/
- There may also be some Python dependencies that are necessary to download using apt-get
- All project activities (create, build, install, etc) are issued using the “pebble” terminal utility
- To test that you have configured this correctly run:

```
pebble new-project hello_world
```

Pebble Development

- Create a new project:
  - pebble new-project <project-name>
- Build project code:
  - pebble build (run inside the project directory)
- Install to Pebble watch:
  - Connect phone and computer to the same Wi-Fi
  - Get IP Address from Pebble watch companion app
  - pebble install --phone <ip-address of phone>
- Debug code running on Pebble:
  - To print debug messages add calls to the function below to your code

    ```
    void app_log(uint8_t log_level, const char *src_filename, int
        src_line_number, const char *fmt, …)
    ```
  - pebble debug --phone <ip-address of phone>
  - This will stream print statements initiated by app_log to the terminal

Uploading to the Pebble App Store

- Create various graphics to include with your app
  - To upload your Pebble app to the market you need a minimal of 4 graphics for:
    - Large Icon
    - Small Icon
    - Screenshots (at least one)
    - Header Image (at least one)

Things to Keep in Mind

- Memory is valuable, free it as soon as possible, and avoid unnecessary global variables
  - Although many global variables are necessary
- Memory is NOT managed, you must match every _create() function call with a _destroy() function call
- The interface to the Pebble is very limited…try to come up with novel ways to input data easily

Downsides

- Back button cannot yet be overridden
- Feature set still young, 2.0 SDK added persistence, accelerometer access, magnetometer and many other features
- Closed-source
- Not much memory

Need References?

- The online Pebble API is fantastic
  - https://developer.getpebble.com/2/api-reference/modules.html
- When you run pebble new-project <project_name> you get the default hello world Pebble app
- Inside the Pebble SDK folder is a folder named Examples which demonstrates most of the functionality of the Pebble watch
- PebbleCloud has several example projects you can select from