C++Now 2016

LET'S MAKE A WEB MATCH-3 GAME IN C++14

https://github.com/modern-cpp-examples/match3

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BEING CROSS-PLATFORM?

WRITE ONCE, DEPLOY EVERYWHERE!

Platform	
Desktop	Windows / OS X / Linux
Mobile	Android / iOS / Windows
Web	Chrome / IE / Safari / Firefox

Applications	
Mobile	QT/NDK+djinni
Desktop	QT/wxWidgets
Web	Emscripten/Cheerp/WebAssembly

Games	
Mobile	NDK+OpenGL+SDL/Cocos2d-x/Marmalade
Desktop	Unreal Engine/Cocos2d-x
Web	Emscripten/Cheerp/WebAssembly

COMBINE C++ WITH JS

- Cordova
- Titanium
- ReactNative
- QML

C++ AND THE WEB

EMSCRIPTEN IS AN LLVM-BASED PROJECT THAT COMPILES C AND C++ INTO HIGHLY-OPTIMIZABLE JAVASCRIPT IN ASM.JS FORMAT

```
#include <iostream>
int main() {
  std::cout << "hello world!" << std::endl;
}
```

```
em++ hello_world.cpp -o index.html
```

```
$browser index.html
```

CHEERP IS THE C++ COMPILER FOR THE WEB

write a web application, or port your existing one, all in C++. cheerp will generate JavaScript code that can run on any browser

WEBASSEMLBY

WEBASSEMBLY OR WASM IS A NEW PORTABLE, SIZE- AND LOAD-TIME-EFFICIENT FORMAT SUITABLE FOR COMPILATION TO THE WEB

In Progress!

LET'S MATCH SOME ~~CANDIES~~ / JEWELS

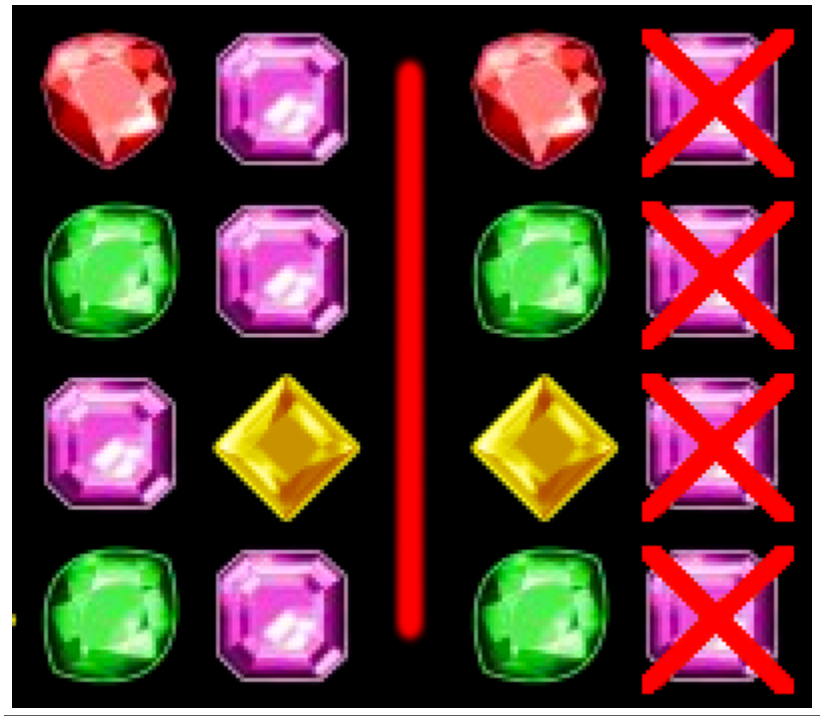
CORE MECHANICS

1. Swipe items (2 given items)
2. For given items
    2.1 Find matches
    2.2 Remove matches
    2.3 Scroll down items (which were above removed)
    2.4 Generate new items
    2.6 Find affected items (new or scrolled items)
    2.7 For affected (new given items) items go to 2

MATCH 3

MATCH 3 - TWICE

MATCH 4



MATCH 5

MATCH L

MATCH CAN GENERATE MORE MATCHES

REQUIREMENTS

C++14 / STL

- Clang-3.7+
- GCC-6+
- Emscripten-1.35

DEPENDENCIES

SDL2

---

https://www.libsdl.org

- SDL2_image
- SDL2_ttf

EXPERIMENTAL BOOST.DI

---

https://github.com/boost-experimental/di

```cpp
#include <boost/di.hpp>

namespace di = boost::di;

struct renderer { int device; };
struct view { view(std::string title, const renderer&) {} };
class model {};
struct controller { controller(model&, view&) {} };
class user {};
struct app { app(controller&, const user&) {} };

int main() {
  auto injector = di::make_injector();
  injector.create<app>();
}
```

EXPERIMENTAL BOOST.MSM-LITE

---

https://github.com/boost-experimental/msm-lite

```cpp
#include <boost/msm-lite.hpp>

namespace msm = boost::msm::lite;

auto guard = [] { return true; };
auto action = [] { std::cout << "action" << std::endl; };

struct hello_world {
  auto configure() const noexcept {
    using namespace msm;
    return make_transition_table(
       *"idle"_s + event1 = "s1"_s
      , "s1"_s + event2 [ guard ] / action = "s2"_s
    );
  }
};
```

```cpp
int main() {
  msm::sm<hello_world> sm;
  using namespace msm;
  sm.process_event(event1{});
  sm.process_event(event2{});
}
```

RANGE-V3

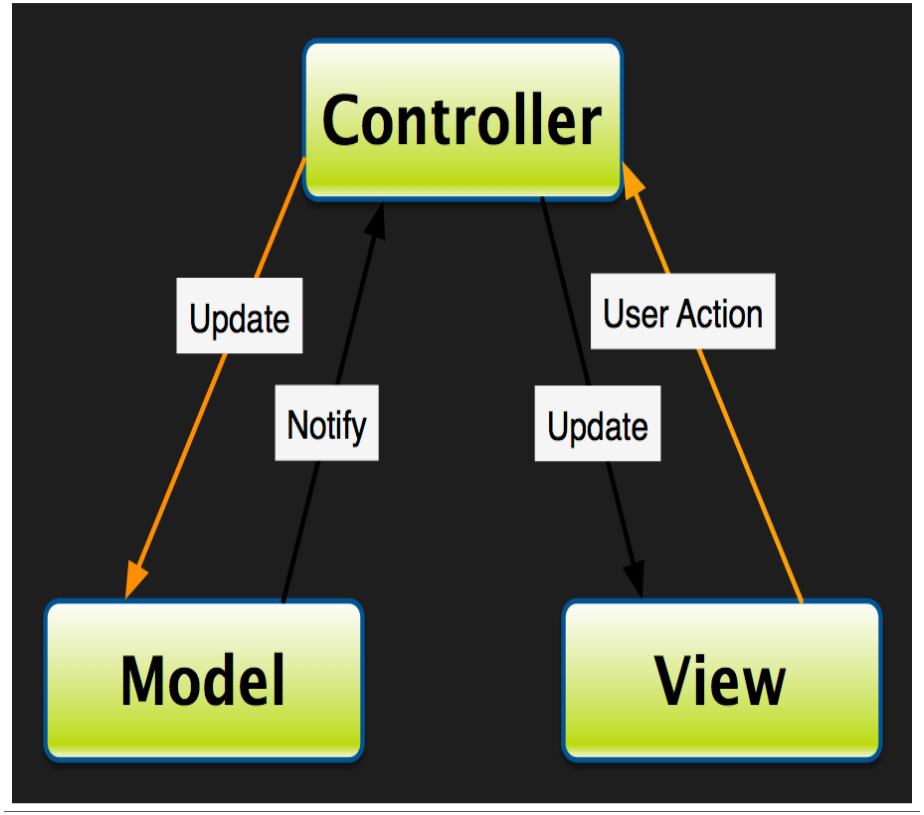
---

https://github.com/ericniebler/range-v3

```
#include <range/v3/all.hpp>

int main() {
  using namespace ranges::view;

  ranges::recursive_range_fn<int> const fibs {[&]{
    return concat(
      closed_ints(0,1)
    , zip_with(std::plus<int>{}, fibs(), tail(fibs()))
    );
  }};

  auto x = take(fibs(), 20);
  ranges::for_each(x, [](int i) { std::cout << i << std::endl; });
}
```

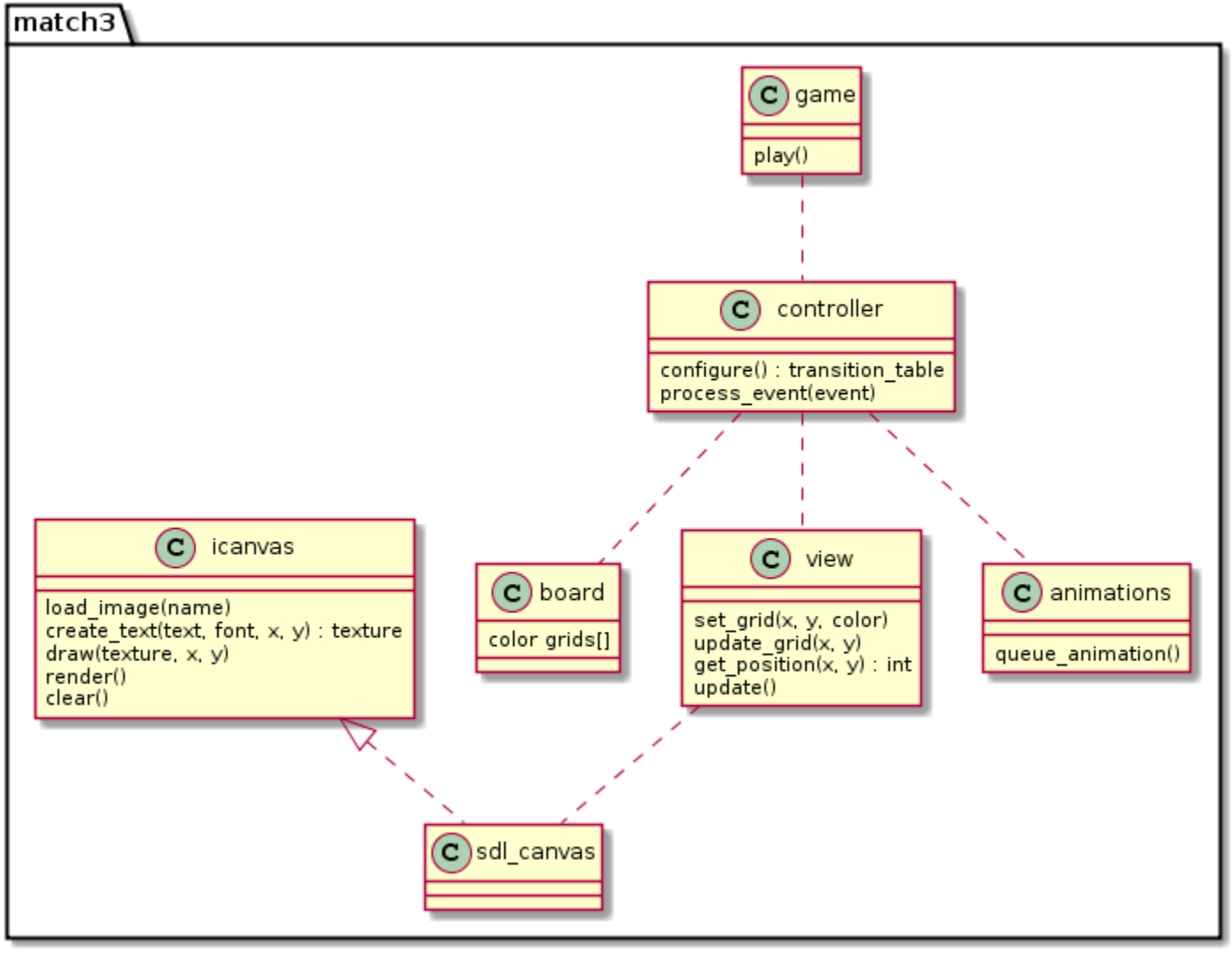
DESIGN

MODEL-VIEW-CONTROLLER

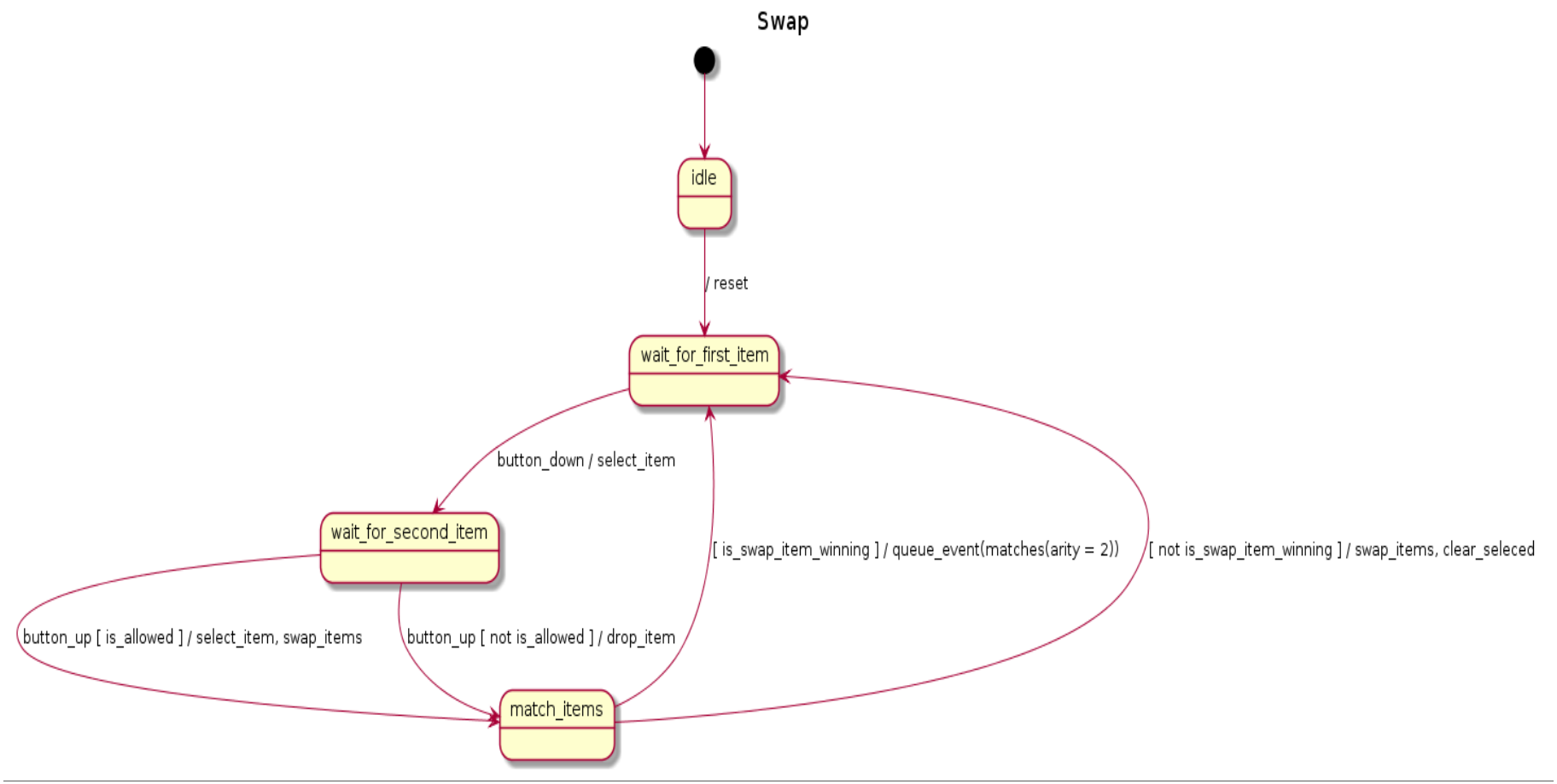

Controller
Update
Notify
User Action
Update
Model
View

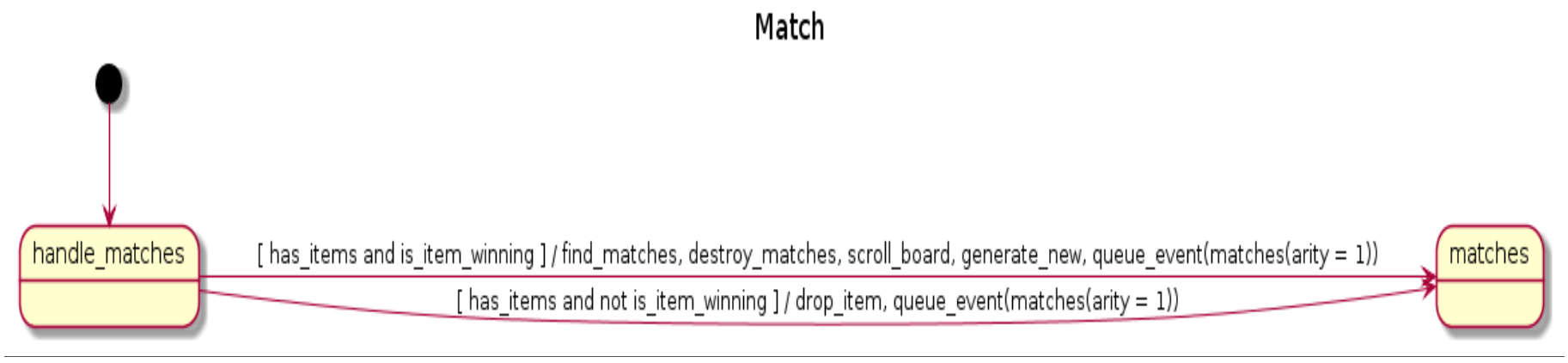
- Seperates business logic from UI
- Good for aplications and/or games
- Compatible with Entity-Component-System

CLASS DIAGRAM


match3
game
play()
controller
configure() : transition_table
process_event(event)
icanvas
load_image(name)
create_text(text, font, x, y) : texture
draw(texture, x, y)
render()
clear()
board
color grids[]
view
set_grid(x, y, color)
update_grid(x, y)
get_position(x, y) : int
update()
animations
queue_animation()
sdl_canvas

STATE DIAGRAM


Swap
idle
/ reset
wait_for_first_item
button_down / select_item
wait_for_second_item
button_up [is_allowed] / select_item, swap_items
button_up [not is_allowed] / drop_item
[is_swap_item_winning] / queue_event(matches(arity = 2))
[not is_swap_item_winning] / swap_items, clear_seleced
match_items


Match
handle_matches
[has_items and is_item_winning] / find_matches, destroy_matches, scroll_board, generate_new, queue_event(matches(arity = 1))
[has_items and not is_item_winning] / drop_item, queue_event(matches(arity = 1))
matches

COMPILE & RUN

DESKTOP

COMPILE

```
clang++ -std=c++14 -lSDL2 -lSDL2_image -lSDL2_ttf
        -o match3 src/main.cpp
```

RUN

```
./match3
```

CMAKE

```
mkdir build
cmake ..
make app
```

WEB

EMSCRIPTEN

Linux / Mac OSX

https://s3.amazonaws.com/mozilla-games/emscripten/releases/emsdk-portable.tar.gz

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Windows (*Installer available)

https://s3.amazonaws.com/mozilla-games/emscripten/releases/emsdk-1.35.0-portable-64bit.zip

```
# Fetch the latest registry of available tools.
./emsdk update

# Download and install the latest SDK tools.
./emsdk install latest

# Make the "latest" SDK "active"
./emsdk activate latest
```

```
# Set the current Emscripten path on Linux/Mac OSX
source ./emsdk_env.sh
```

```
./emsdk list
```

```
The following precompiled tool packages are available for download:
           clang-e1.30.0-64bit
           clang-e1.34.1-64bit
    (*)    clang-e1.35.0-64bit          INSTALLED
    (*)    node-4.1.1-64bit             INSTALLED
           spidermonkey-37.0.1-64bit
           spidermonkey-nightly-2015-04-12-64bit
           emscripten-1.30.0
           emscripten-1.34.1
    (*)    emscripten-1.35.0            INSTALLED
           crunch-1.04

The following tools can be compiled from source:
           clang-tag-e1.36.2-32bit
           clang-tag-e1.36.3-32bit
           clang-tag-e1.36.2-64bit
           clang-tag-e1.36.3-64bit
           clang-incoming-32bit
           clang-incoming-64bit
           clang-master-32bit
           clang-master-64bit
           emscripten-tag-1.36.2-32bit
           emscripten-tag-1.36.3-32bit
           emscripten-tag-1.36.2-64bit
           emscripten-tag-1.36.3-64bit
           emscripten-incoming-32bit
           emscripten-master-32bit
           emscripten-incoming-64bit
           emscripten-master-64bit

The following precompiled SDKs are available for download:
         sdk-1.30.0-64bit
         sdk-1.34.1-64bit
    *    sdk-1.35.0-64bit              INSTALLED

The following SDKs can be compiled from source:
         sdk-incoming-64bit
         sdk-master-64bit
```

COMPILE

```
em++ -std=c++14 -s USE_SDL=2 -s USE_SDL_IMAGE=2 -s USE_SDL_TTF=2
     --emrun # log to the console
     --preload-file data # images and fonts
     --use-preload-plugins # load data
     --shell-file data/template.html # custom html template
     -o index.html src/main.cpp
```

RUN

```
$browser index.html
```

OR

```
emrun --port 8080 index.html # start http server
$browser localhost:8080
```

CMAKE

```
mkdir build
CXX=em++ cmake ..
make web emrun
```

COMPILATION TIME BENCHMARK

Compiler (-O2)	Note	Time
Clang-3.8	Without Range-V3	2.122s
Clang-3.8	With Range-V3	9.521s
Emscripten-1.35	Without Range-v3	2.822s
Emscripten-1.35	With Range-V3	9.912s

IMPLEMENTATION

MATCH-3 GAME

---

https://github.com/modern-cpp-examples/match3

FILES...

```
▼ src/
  ▼ controller/
      controller.hpp
      logic.hpp
  ▼ model/
      board.hpp
      config.hpp
  ▼ view/
      animations.hpp
      icanvas.hpp
      sdl_canvas.hpp
      view.hpp
    pph.hpp
    game.hpp
    main.cpp
```

MAIN

CREATE AND PLAY THE GAME

```
int main() {
  auto injector = di::make_injector(configuration());
  injector.create<match3::game>().play();
}
```

DI CONFIGURATION

EXPERIMENTAL BOOST.DI

---

https://github.com/boost-experimental/di

BIND ICANVAS TO SDL_CANVAS

```
di::bind<icanvas>.to<sdl_canvas>()
```

SET-UP CONFIGURATION DETAILS

```
di::bind<>.to(
  config{.win_title = "match3",
         .win_width = 320,
         .win_height = 480,
         .board_width = 7,
         .board_height = 10,
         .board_colors = 5,
         .max_moves = 10}
)
```

SET-UP BOARD

```
di::bind<board::color[]>.to({
    3,5,1,4,3,2,2,
    1,1,4,2,5,1,3,
    5,3,5,4,5,3,2,
    4,4,2,1,3,4,5,
    5,1,1,2,4,5,1,
    5,2,3,5,4,2,1,
    1,5,5,1,5,5,4,
    2,3,3,1,3,3,4,
    3,2,2,5,4,4,1,
    1,2,3,4,1,3,4
 })
```

BIND RANDOMIZER

```
di::bind<randomize>.to([](int begin, int end) {
  static std::random_device rd;
  std::mt19937 gen(rd());
  std::uniform_int_distribution<int> dis(begin, end);
  return dis(gen);
})
```

GAME LOOP

PLAY

```
class game {
 public:
  explicit game(msm::sm<controller>& c) : controller_(c) {}

  void play() {
    EM(emscripten_set_main_loop_arg(
        play_impl, reinterpret_cast<void*>(&controller_), 0, 0))
    (play_impl(reinterpret_cast<void*>(&controller_)));
  }
```

HANDLE EVENTS

```
static void play_impl(void* c) {
  auto& controller_ =
    *reinterpret_cast<msm::sm<controller>*>(c);

  do {
    auto dispatch_event = msm::make_dispatch_table<
      SDL_Event, SDL_QUIT, SDL_FINGERMOTION>(controller_);
    controller_.process_event(time_tick{});
    SDL_Event event;
    while (SDL_PollEvent(&event)) {
      dispatch_event(event, event.type);
    }
  } while (EM(false && )() !controller_.is(msm::X));
}
```

MODEL

BOARD

```
struct board {
  using color = int;
  std::vector<color> grids;
};
```

VIEW

SDL2

---

https://www.libsdl.org

CANVAS

```
class icanvas {
 public:
  virtual ~icanvas() noexcept = default;
  virtual std::shared_ptr<void>
  load_image(const std::string&) const = 0;
  virtual std::shared_ptr<void>
  create_text(
    const std::string&, const std::string&, int) const = 0;
  virtual void draw(
    std::shared_ptr<void>, int x = 0, int y = 0, bool = true) = 0;
  virtual void render() = 0;
  virtual void clear() = 0;
};
```

VIEW

```
class view {
  view(icanvas&, config);
  void set_grid(int x, int y, int c);
  void update_grid(int x, int y);
  auto get_position(int x, int y) const;
  void set_text(const std::string& text, int x, int y);
  void update() { canvas_.render(); }
  void clear() { canvas_.clear();
};
```

ANIMATIONS

```
class animations {
  explicit animations(view& v);
  void queue_animation(const std::function<void()>& f
                       , std::chrono::milliseconds length = {});
  void update();
};
```

CONTROLLER

EXPERIMENTAL BOOST.MSM-LITE

---

https://github.com/boost-experimental/msm-lite

```
return make_transition_table(
 // +-------------------------------------------------------------------------------------------------------------------------------------------------------------+
    "wait_for_first_item"_s  <= *("idle"_s)                                          / (reset, show_board, show_points, show_moves)

  ,  "wait_for_click"_s      <=   "wait_for_first_item"_s                            [ not [](moves& m) { return m > 0; } ] / show_game_over
  ,  "wait_for_first_item"_s <=   "wait_for_click"_s       + event<button_up>       [ not is_mobile ] / (reset, show_board, show_points, show_moves)

  , "wait_for_second_item"_s <=   "wait_for_first_item"_s  + event<button_down> / select_item
  , "match_items"_s          <=   "wait_for_second_item"_s + event<button_up>   [ is_allowed ] / (select_item, swap_items, show_swap)
  , "wait_for_first_item"_s  <=   "wait_for_second_item"_s + event<button_up>   [ not is_allowed ] / drop_item

  , "wait_for_first_item"_s  <=   "match_items"_s                                  [ is_swap_items_winning ] / (
                                                                                    [](moves& m) {--m;}, show_moves,
                                                                                    msm::queue_event(matches{.arity = 2})
                                                                                  )
  , "wait_for_first_item"_s  <=   "match_items"_s                                  / (swap_items, show_swap, clear_selected)
 // +-------------------------------------------------------------------------------------------------------------------------------------------------------------+
  ,                          *("handle_matches"_s)      + event<matches>     [ has_items and is_item_winning ] / (
                                                                               find_matches, show_matches
                                                                             , destroy_matches, show_board
                                                                             , add_points, show_points
                                                                             , scroll_board, show_board
                                                                             , generate_new, show_board
                                                                             , msm::queue_event(matches{.arity = 1})
                                                                             )
  ,                            "handle_matches"_s       + event<matches>     [ has_items and not is_item_winning ] / (
                                                                               drop_item, msm::queue_event(matches{.arity = 1})
                                                                             )
 // +-------------------------------------------------------------------------------------------------------------------------------------------------------------+
  , X                        <= *("wait_for_client"_s)     + event<key_pressed> [ is_key(SDLK_ESCAPE) ]
  , X                        <=   "wait_for_client"_s      + event<quit>
 // +-------------------------------------------------------------------------------------------------------------------------------------------------------------+
  ,                            *("handle_animations"_s)   + event<time_tick>   / [](animations& a) { a.update(); }
 // +-------------------------------------------------------------------------------------------------------------------------------------------------------------+
);
```

GUARDS/ACTIONS

IS MOVE ALLOWED

```
auto is_allowed =
  [](auto event, const view& v, const selected& s, config c) {
  assert(!s.empty());
  const auto _1 = s.back();
  const auto _2 = v.get_position(event.x, event.y);
  const auto diff = std::abs(_1 - _2);
  const auto board_size = c.board_width * c.board_height;
  return (_1 >= 0 && _1 < board_size) &&
         (_2 >= 0 && _2 < board_size) &&
         (diff == 1 || diff == c.board_width);
};
```

GENERATE NEW ITEMS

```
auto generate_new = [](board& b, const auto& m, selected& s,
                       config c, randomize r) {
  ranges::action::transform(b.grids,
    [c, r](auto i) { return i ? i : r(1, c.board_colors); }
  );

  s |= ranges::action::push_front(affected(m.matches, c.board_widt
    | ranges::action::sort | ranges::action::unique;
};
```

SWAP ITEMS

```
auto swap_items = [](const selected& s, board& b) {
  assert(s.size() >= 2);
  std::swap(b.grids[s[0]], b.grids[s[1]]);
};
```

MORE GUARDS/ACTIONS

---

https://github.com/modern-cpp-examples/match3/blob/master/src/controller/controller.hpp

LOGIC

RANGE-V3

---

https://github.com/ericniebler/range-v3

ROW VIEW

IDEA

```
| 1 2 3 |             |  1   2   3  |
| 3 4 5 | => n:1 -> | [3] [4] [5] |
| 6 7 8 |             |  6   7   8  |
```

ROW

```
auto row = [](View&& v, Number n, Number width) {
  return v | ranges::view::drop(width * n) |
             ranges::view::take(width); // or slice
};
```

COLUMN VIEW

IDEA

```
| 1 2 3 |             | 1 [2] 3 |
| 3 4 5 | => n:1 -> | 3 [4] 5 |
| 6 7 8 |             | 6 [7] 8 |
```

COLUMN

```
auto col = [](View&& v, Number n, Number width) {
  return v | ranges::view::drop(n) |
             ranges::view::stride(int(width));
};
```

MATCH N

IDEA

```
| 1 3 3 3 2 1 | => color:3, n:3 -> {begin: 1, length: 3}
| 1 2 3 3 3 3 | => color:3, n:3 -> {begin: 2, length: 4}
```

MATCH 3

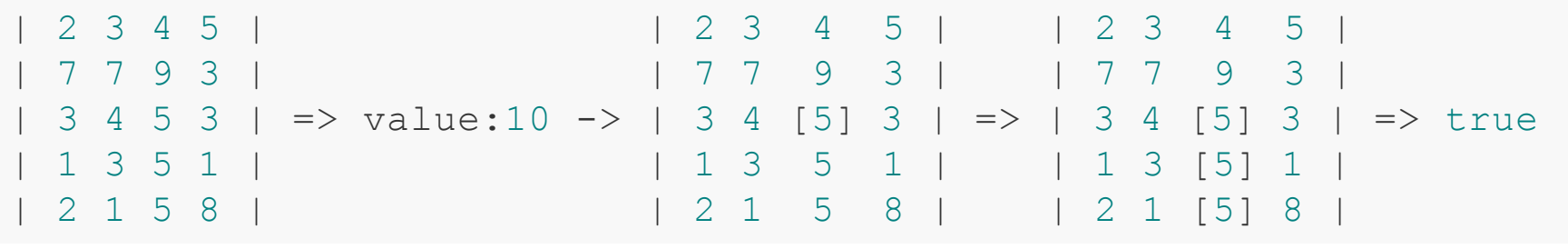
```
auto match_n = [](View&& v, Color color, Number n = 3) {
  const auto&& matches =
    ranges::view::ints |
    ranges::view::take(ranges::size(v) - n + 1) |
    ranges::view::transform([=](auto i) {
      return ranges::count(v | ranges::view::drop(i) |
                               ranges::view::take(n), color) == n;
    });
```

MATCH 3

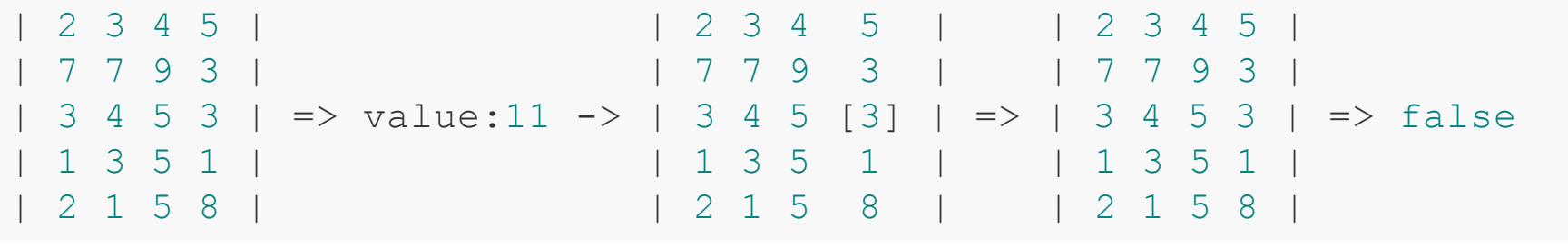
```
  constexpr auto is_match = true;
  const auto it = ranges::find(matches, is_match);
  const auto found = it != ranges::end(matches);
  const auto mlength =
    found ? ranges::count(matches, is_match) + (n - 1) : 0;
  const auto mbegin =
    found ? ranges::distance(ranges::begin(matches), it) : 0;

  struct { decltype(mbegin) begin; decltype(mlength) length; }
    result{mbegin, mlength};

  return result;
};
```

IS MATCH

IDEA - MATCH FOUND



IDEA - NO MATCH

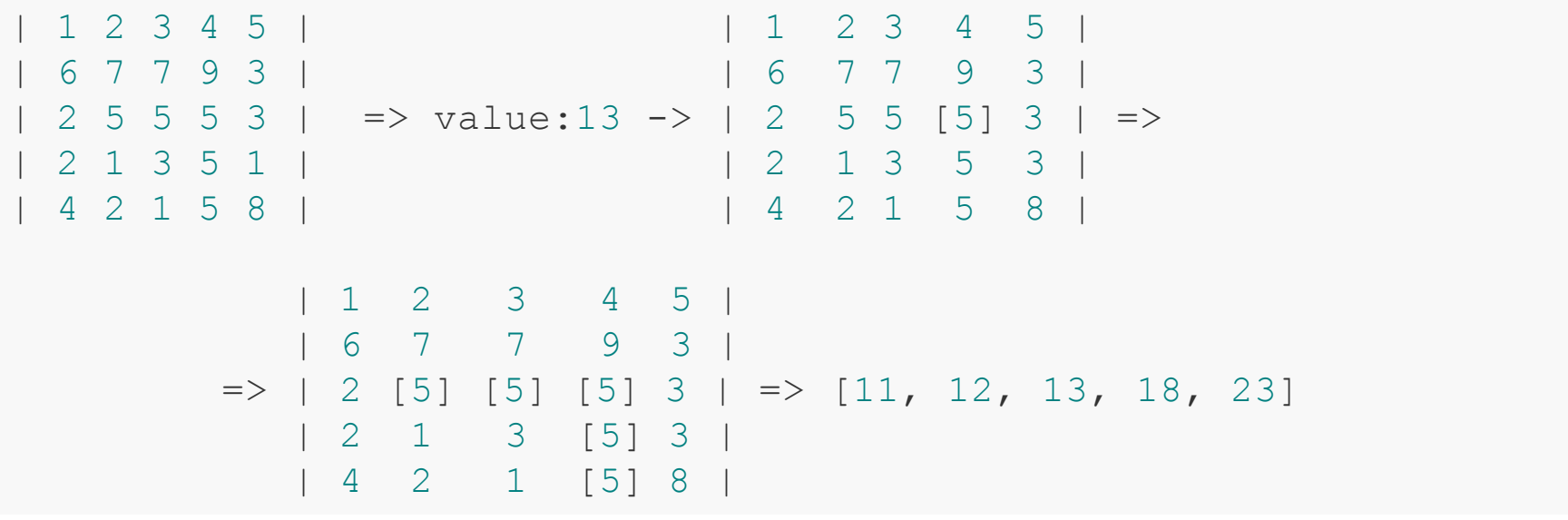


IS MATCH

```
auto is_match = [](View&& v, Number value, Number width) {
  const auto color = v[value];
  const auto x = value % width;
  const auto y = value / width;
  return match_n(row(v, y, width), color).length ||
         match_n(col(v, x, width), color).length;
};
```

MATCH

IDEA


| 1 2 3 4 5 |
| 6 7 7 9 3 |
| 2 5 5 5 3 |
| 2 1 3 5 1 |
| 4 2 1 5 8 |
=> value:13 ->
| 1 2 3 4 5 |
| 6 7 7 9 3 |
| 2 5 5 [5] 3 |
| 2 1 3 5 3 |
| 4 2 1 5 8 |
=>
| 1 2 3 4 5 |
| 6 7 7 9 3 |
| 2 [5] [5] [5] 3 |
| 2 1 3 [5] 3 |
| 4 2 1 [5] 8 |
=>
=> [11, 12, 13, 18, 23]

MATCH 1/2

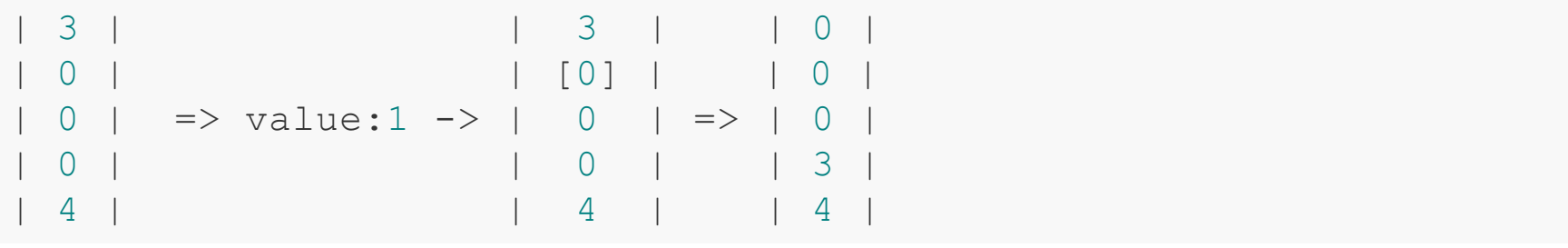
```
auto match = [](View&& v, Number value, Number width) {
  const auto color = v[value];
  const auto x = value % width;
  const auto y = value / width;
  const auto match_r = match_n(row(v, y, width), color);
  const auto match_c = match_n(col(v, x, width), color);
  const auto transform = [](auto length, auto expr) {
    return ranges::view::ints | ranges::view::take(length) |
           ranges::view::transform(expr);
  };
```

MATCH 2/2

```
  std::vector<decltype(value)> result = ranges::view::concat(
      transform(match_r.length,
        [=](auto i) { return y * width + match_r.begin + i; }),
      transform(match_c.length, [=](auto i) {
        return (match_c.begin + i) * width + x;
      }));
  result |= ranges::action::sort | ranges::action::unique;
  return result;
};
```

SCROLL

IDEA



SCROLL

```
auto scroll = [](View&& v, const Container& value, Number width) {
  const auto&& c = col(v, value % width, width) |
                   ranges::view::take(value / width + 1);
  auto begin = ranges::begin(c);
  ranges::advance(begin, value / width);
  ranges::rotate(c, begin);
};
`
```

AFFECTED ITEMS

IDEA

```
                                | 1  2   3   4  5 |
                                | 6  7   7   9  3 |
[11, 12, 13, 18, 23] => | 2 [5] [5] [5] 3 | =>
                                | 2  1   3  [5] 3 |
                                | 4  2   1  [5] 8 |

    | 1  [2] [3] [4] 5 |
    | 6  [7] [7] [9] 3 |
 => | 2  [5] [5] [5] 3 | => [1, 2, 3, 6, 7, 8, 11, 12, 13, 18, 23]
    | 2   1   3  [5] 3 |
    | 4   2   1  [5] 8 |
```

AFFECTED

```
auto affected = [](const Container& matches, Number width) {
  const auto&& columns =
    matches | ranges::view::transform([=](auto m) {
      return ranges::view::ints |
             ranges::view::take(m / width + 1) |
             ranges::view::transform([=](auto i) {
               return m % width + (i * width); });
    });

  std::decay_t<decltype(matches)> result =
    columns | ranges::view::join;

  result |= ranges::action::sort | ranges::action::unique;
  return result;
};
```

WARNING

IT'S NOT 100% C++14!

- `"idle"_s` - GNU extension / string-literal-operator-template
  - Standard replacement: `state<class idle>`
- `matches{.arity = 2}` - C99 / designated-initializer
  - Standard replacement: `matches{2}`

TESTS

UNIT TESTS

LOGIC

```
"scroll"_test = [] {
  int v[] = {1, 1, 3, 4, 0, 2, 7, 2, 3};
  scroll(v, 4, 3);
  expect(ranges::equal({1, 0, 3, 4, 1, 2, 7, 2, 3}, v));
};
```

GUARDS

```
"is key"_test = [] {
  constexpr auto key = 42;
  struct {
    int key;
  } event{key};
  expect(is_key(key)(event));
};
```

ACTIONS

```
"swap items"_test = [] {
  board b;
  b.grids = {1, 2};
  selected s = {0, 1};
  swap_items(s, b);
  expect(ranges::equal({2, 1}, b.grids));
};
```

FUNCTIONAL TESTS

FAKEIT - MOCKING FRAMEWORK

---

https://github.com/eranpeer/FakeIt.git

HELPERS

FAKE SWIPE

```
template <class SM>
void
swipe(SM& sm, std::pair<int, int> from, std::pair<int, int> to) {
 sm.process_event(
  make_click_event<match3::button_down>(from.first, from.second));
 sm.process_event(
  make_click_event<match3::button_up>(to.first, to.second));
};
```

MOCKS PROVIDER

AUTOMATICALLY CREATES MOCKS USING FAKEIT FOR ABSTRACT TYPES

DI - MOCKS PROVIDER

```
auto injector = di::make_injector<mocks_provider>(...);
```

GIVEN

CONFIGURATION

```
di::bind<>.to(match3::config{"", 0, 0, 7, 10, 5, 10})
```

BOARD

```
di::bind<match3::board::color[]>.to({
    /*0 1 2 3 4 5 6*/
/*0*/ 3,5,1,4,3,2,2,
/*1*/ 1,1,4,2,5,1,3,
/*2*/ 5,3,5,4,5,3,2,
/*3*/ 4,4,2,1,3,4,5,
/*4*/ 5,1,1,2,4,5,1,
/*5*/ 5,2,3,5,4,2,1,
/*6*/ 1,5,5,1,5,5,4,
/*7*/ 2,3,3,1,3,3,4,
/*8*/ 3,2,2,5,4,4,1,
/*9*/ 1,2,3,4,1,3,4
})
```

FAKE RANDOMIZER

```
di::bind<match3::randomize>.to([](int, int) {
  static auto i = 42; return i++;
})
```

CANVAS MOCK

```
using namespace fakeit;
auto&& canvas = mocks_provider::get_mock<match3::icanvas>();
When(Method(canvas, load_image)).AlwaysReturn(shared_ptr<void>{});
When(Method(canvas, create_text)).AlwaysReturn(shared_ptr<void>{});
When(Method(canvas, draw)).AlwaysDo([](...){});
When(Method(canvas, render)).AlwaysDo([]{});
When(Method(canvas, clear)).AlwaysDo([]{});
```

CONTROLLER

```
auto sm = injector.create<msm::sm<match3::controller>>();
```

WHEN

TRIGGER SWIPE

```
swipe(sm, {3, 5}, {3, 6});
```

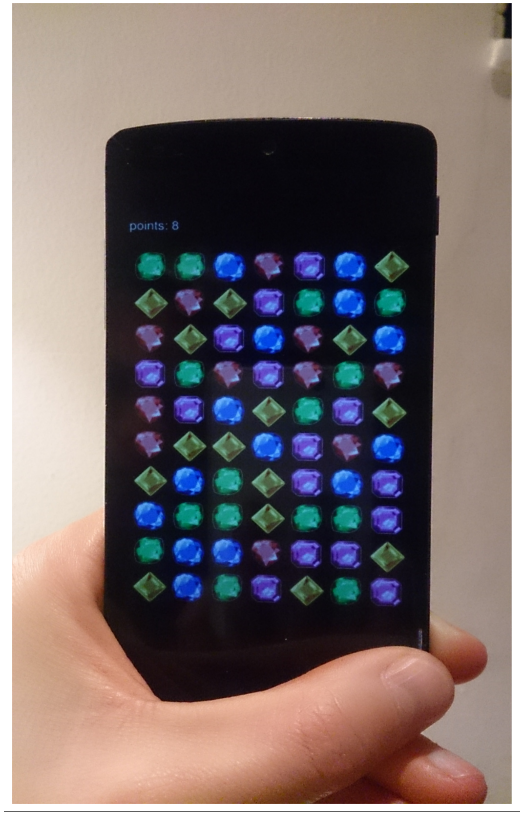
THEN

BOARD SHOULD CHANGE

```
  expect(ranges::equal({/*0 1 2 3 4 5 6*/
                        /*0*/ 3, 42, 43, 44, 45, 46, 2,
                        /*1*/ 1, 5, 1, 4, 3, 2, 3,
                        /*2*/ 5, 1, 4, 2, 5, 1, 2,
                        /*3*/ 4, 3, 5, 4, 5, 3, 5,
                        /*4*/ 5, 4, 2, 1, 3, 4, 1,
                        /*5*/ 5, 1, 1, 2, 4, 5, 1,
                        /*6*/ 1, 2, 3, 1, 4, 2, 4,
                        /*7*/ 2, 3, 3, 1, 3, 3, 4,
                        /*8*/ 3, 2, 2, 5, 4, 4, 1,
                        /*9*/ 1, 2, 3, 4, 1, 3, 4},
                       injector.create<match3::board&>().grids));
};
```

LET'S TRY SOMETHING CRAZY?

C++ -> JS -> MOBILE -> BROWSER



EMBEDDING JS IN C++

IS MOBILE DEVICE

```
auto is_mobile = [] {
  return bool(EM_ASM_INT_V({
    return /iPhone|iPad|iPod|Android/i.test(navigator.userAgent);
  }));
};
```

FINGER TOUCH INSTEAD OF BUTTON CLICK

TRANSITION TABLE

```
"second_item"_s <= "first_item"_s  + touch_down  [is_mobile] ...
"match_items"_s <= "second_item"_s + touch_up    [is_mobile] ...

"second_item"_s <= "first_item"_s  + button_down [!is_mobile] ...
"match_items"_s <= "second_item"_s + button_up   [!is_mobile] ...
```

PROBLEMS / LIMITATIONS

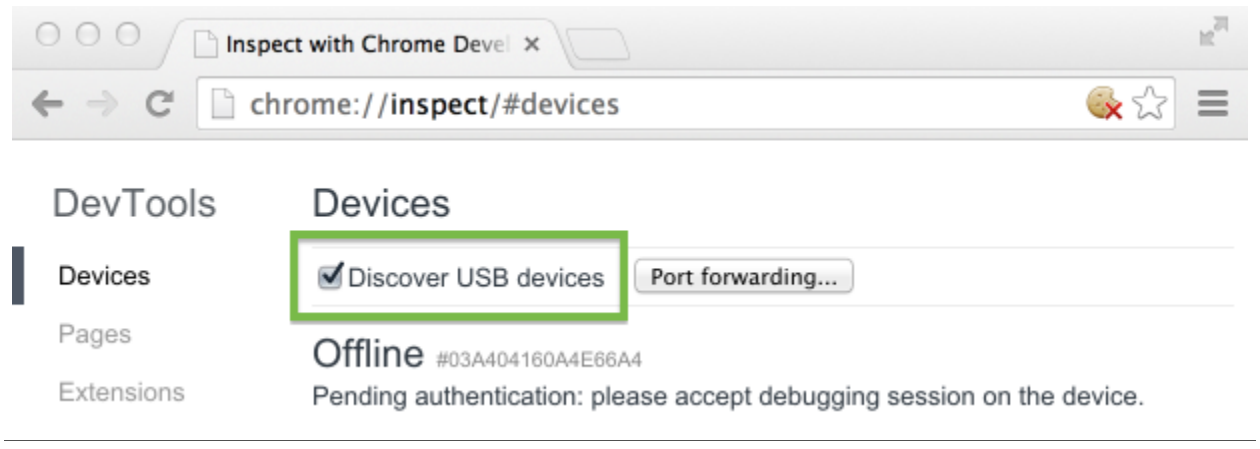
IOS

SECURITY REASONS

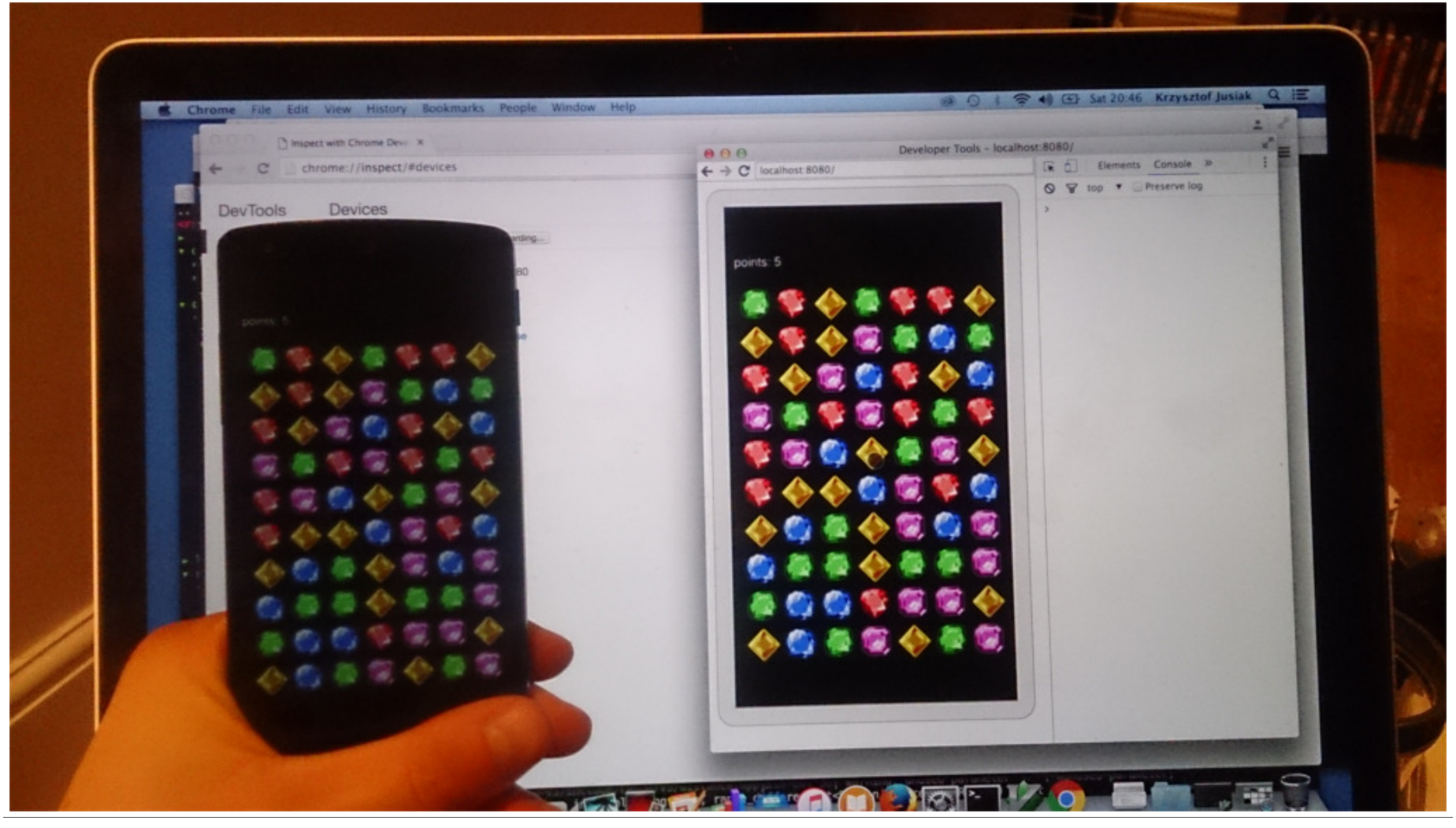
- JS is not compiled causing a slow execution
- Full screen is not allowed

DEBUGGING C++ -> JS -> MOBILE -> CHROME

ANDROID / CHROME




```
chrome://inspect/#devices
```


Chrome File Edit View History Bookmarks People Window Help
Sat 20:46 Krzysztof Jusiak
chrome://inspect/#devices
DevTools Devices
points: 5
Developer Tools - localhost:8080/
localhost:8080/
Elements Console
top
Preserve log
points: 5

IOS / SAFARI

SAFARI WEB INSPECTOR

BEAT THE RECORD / PLAY

QUESTIONS?

Match-3 Game	https://github.com/modern-cpp-examples/match3
Experimental Boost.DI	https://github.com/boost-experimental/di
Experimental Boost.MSM-lite	https://github.com/boost-experimental/msm-lite
Range-V3	https://github.com/ericniebler/range-v3
FakeIt	https://github.com/eranpeer/FakeIt.git

Thank you