Design and Implementation of Online Experiments

nodeGame.org

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MZES and Heidelberg

nodeGame

Advanced

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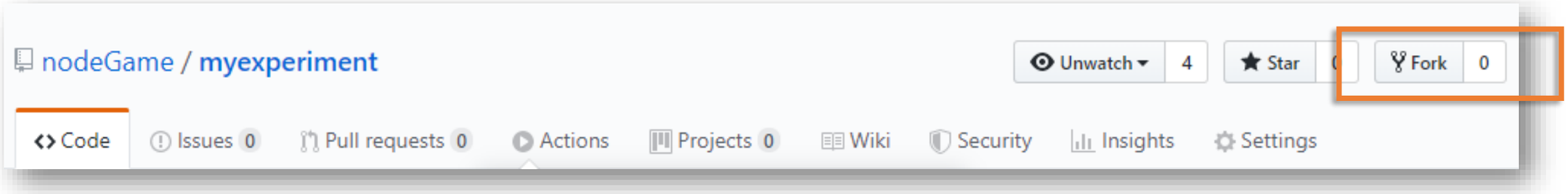
Clone My Experiment

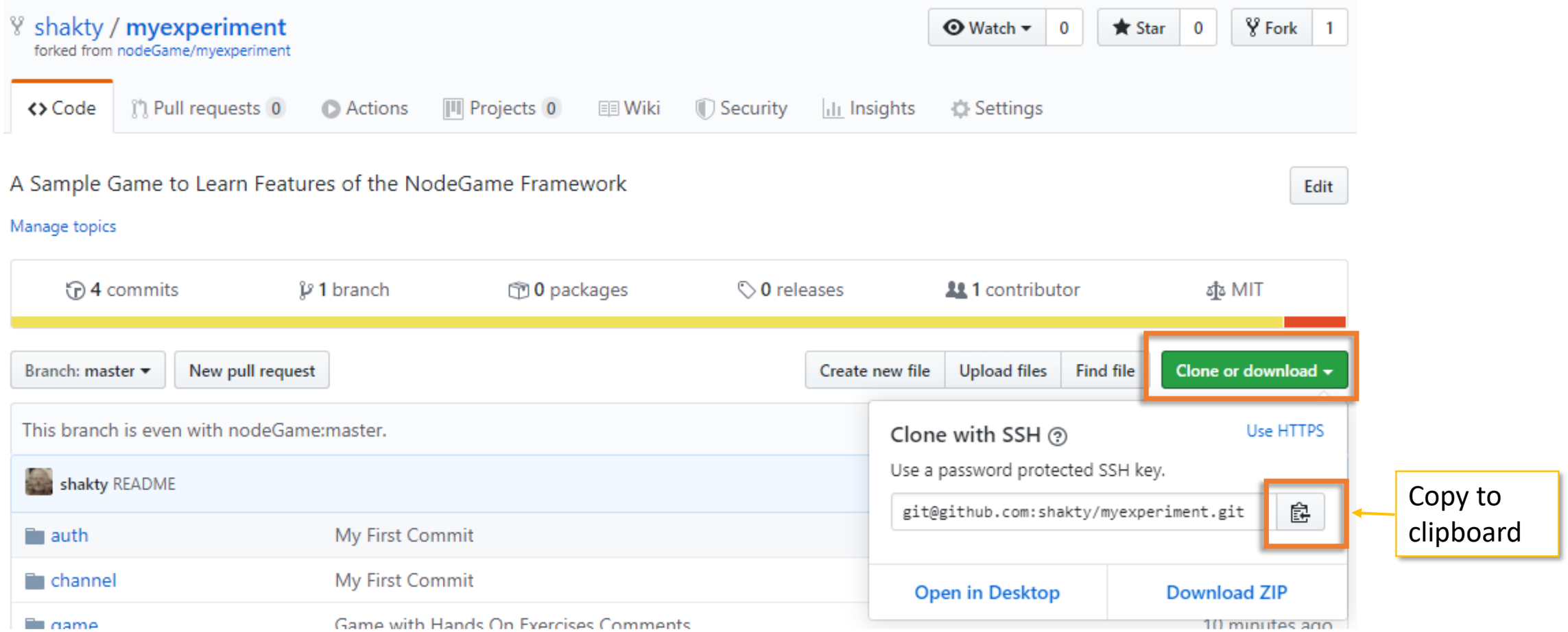
1. Do you already have a GitHub account? Get one!
2. Go to https://github.com/nodeGame/myexperiment
3. **Fork** the repository to get a copy under your account



Confused about forking? Learn about forking and "spooning" in software programming.
https://www.youtube.com/watch?v=8wUOUmeulNs

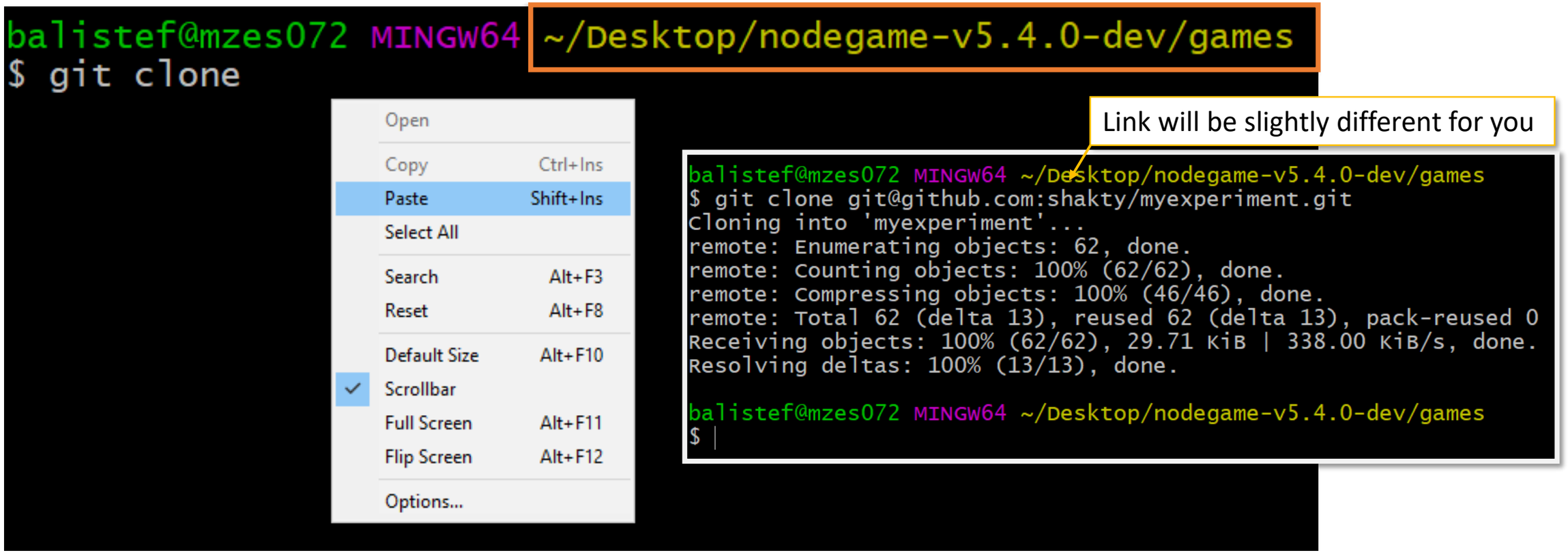
Clone My Experiment

4. Copy the link to clone your **forked** repository



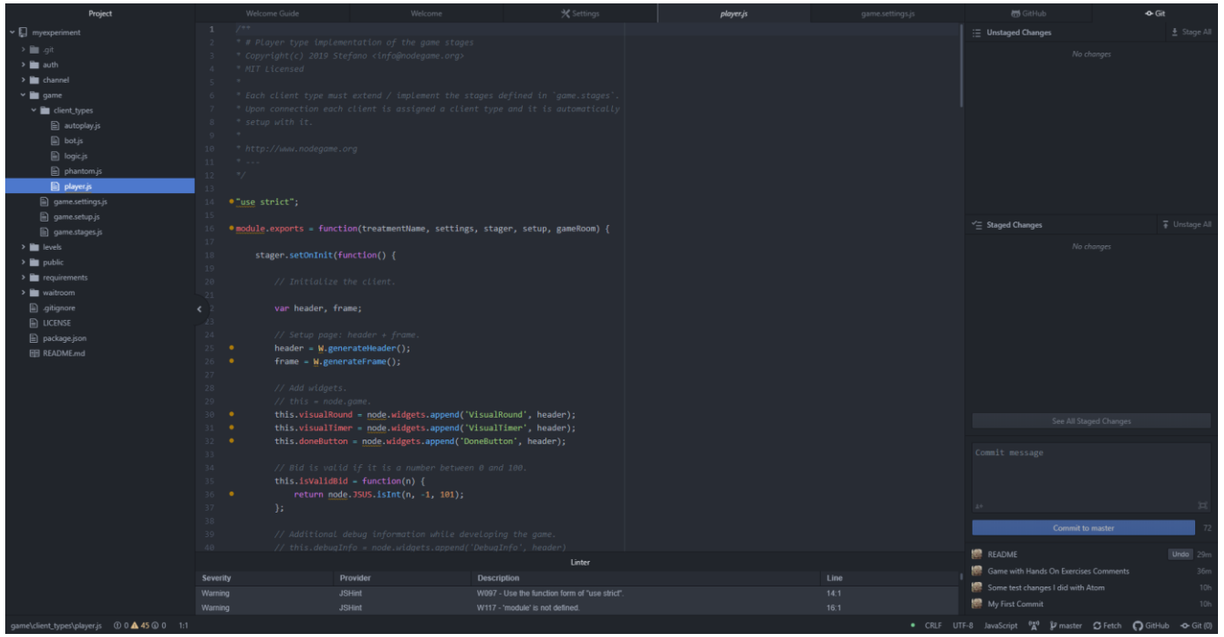
Clone My Experiment

5. Locate the `games/` folder inside the nodeGame folder
6. Clone the forked repository to your local hard drive

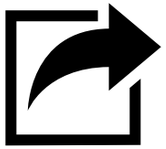


Clone My Experiment

7. Open project in ATOM and try:
   Packages/Bracket Matcher
   Edit/Lines/Auto Indent
   Publish Changes on GitHub
   Extra packages: JSHINT, Teletype, etc.



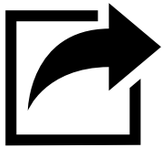
Exchanging Messages



Data-Exchange-Examples

Command	Description	Recipient code required
`node.done`	terminates current step, and sends any optional data to server	no, any data is automatically inserted in database: **node.game.memory**
`node.say`	sends data to other clients or server	yes, must implement event listener: **node.on.data**

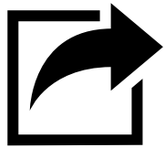
Exchanging Messages



Data-Exchange-Examples

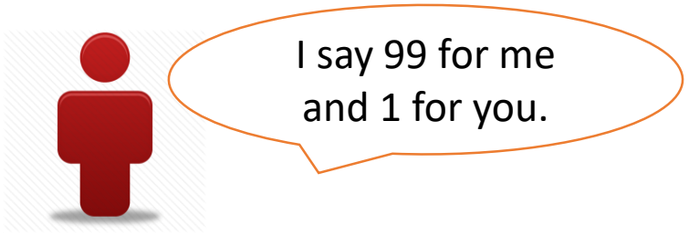
Command	Description	Recipient code required
`node.done`	terminates current step, and sends any optional data to server	no, any data is automatically inserted in database: **node.game.memory**
`node.say`	sends data to other clients or server	yes, must implement event listener: **node.on.data**
`node.set`	sends data to database	no, any data is automatically inserted in database: **node.game.memory**
`node.get`	invokes a remote function, and waits for return value	yes, must implement event listener: **node.on**

Examples: node.done



Step-Callback-Functions-v5

Dictator



Observer


player.js

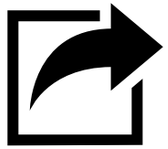
```
// Get offer from input
// onclick send to server.
var offer = W.gid("offer").value; // 1
var submit = W.getElementById("submitOffer");

submit.onclick = function() {
   node.done({ offer: offer });
};
```

node.done terminates current step and send any input parameter to the server

Waiting for a game message labeled "decision" from *someone* (server or player), then ends step.

```
node.on.data("decision", function(msg) {
    // msg.data = 1;
    var offer = "The offer is: " + msg.data;
    // Display offer using W.
    W.setInnerHTML("decision", offer);
    node.done();
});
```

Examples: node.done



Step-Callback-Functions-v5

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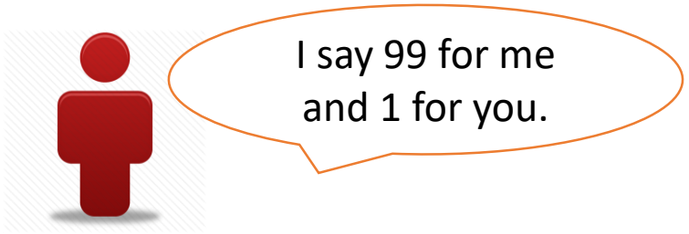

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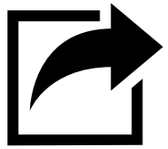
// Get offer from input
// onclick send to server.
var offer = W.gid("offer").value; // 1
var submit = W.getElementById("submitOffer");

submit.onclick = function() {
   node.done({ offer: offer });
};
```

When both players are **DONE** the game advances to next step.

```
node.on.data("decision", function(msg) {
    // msg.data = 1;
    var offer = "The offer is: " + msg.data;
    // Display offer using W.
    W.setInnerHTML("decision", offer);
    node.done();
});
```

Logic and Player Exchanging Messages



Step-Callback-Functions-v5

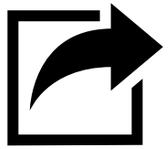
Dictator

```
node.done({ offer: offer });
```

Sends info to server database and ends step

player.js

Logic and Player Exchanging Messages



[Step-Callback-Functions-v5]

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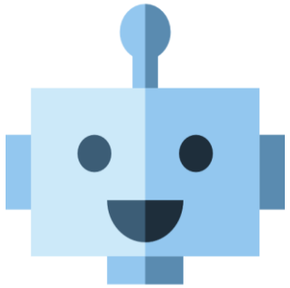


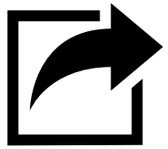
Icon by Freepik

```
node.on.data('done', function(msg) {
    var observer = node.game.matcher.getMatchFor(msg.from);
    // Send the decision to the other player.
    node.say('decision', observer, msg.data.offer);
});
```

logic.js

Receives the input (could do additional computation), gets the observer ID with matcher API, and forwards the offer with node.say

Logic and Player Exchanging Messages



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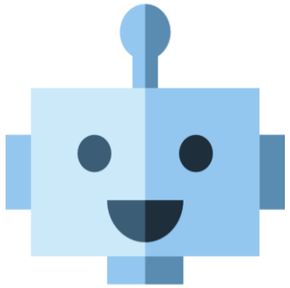

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Receives the input (could do additional computation), gets the observer ID with matcher API, and forwards the offer with node.say

logic.js

Observer

```
node.on.data("decision", function(msg) {
    // Display offer.
    node.done();
});
```

Displays the offer and ends the step.

player.js

Understanding node.say

```
node.say('decision', observer, msg.data.offer);
```

node.say takes 3 parameters, the last two of which are optional.

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2. The recipient is a string containing the **ID of the recipient** of the message (optional, if missing message is sent to the logic).

Understanding node.say

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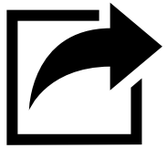
1. The label is a string summarizing the **purpose of the message**.
2. The recipient is a string containing the **ID of the recipient** of the message (optional, if missing message is sent to the logic).
3. A **payload**, that is additional data attached to the message (optional). Here, it is the value of the offer.

Sending and Receiving Game Messages



Game-Messages-v5

When sending a message with any of the interactive methods (say, set, get, done), an object of class Game Message is created

1 2 3

```
node.say('decision', observer, msg.data.offer);
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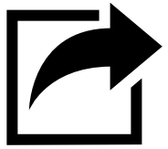
Sending and Receiving Game Messages



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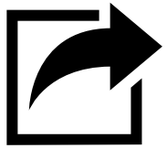
```

```
GameMsg {
    session: "210549709824085l",
    created: "2019-11-24T20:46:41.318Z",
    action: "say",
    target: "DATA",
    text: "decision", 1
    to: "584498971106495", 2
    data: 1, 3
    from: "myexperiment",
    sid: undefined,
    stage: null,
    id: 81124,
    forward: 0,
    priority: 0,
    reliable: 1
    }
```

The ID of the logic is hidden with the name of the channel

Sending and Receiving Game Messages



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Hands On Exercises

1. Tit-for-Tat Bot
2. Timeup Property
3. Observer's Reply

A Tit-for-Tat Bot

Let's build a bot that plays the **TIT-for-TAT strategy.**
If the bot goes first as dictator, it makes a *nice* offer of splitting the money 50-50.
If the bot goes first as observer, it repeats the last offer received as a dictator.

Original Bot Structure: Game Step

```
stager.extendStep('game', {
roles: {
    DICTATOR: {
        cb: function() {
            this.node.done({ offer: 1 });
        }
    },
    OBSERVER: {
        cb: function() {
            // Store a local reference of node.
            var node = this.node;
            node.on.data('decision', function(msg) {
                setTimeout(function() {
                  node.done();
                }, 5000);
            });
        }
    }
});
```

node.on.data is waiting for a message from the server

When a message arrives which is labeled 'decision', the callback function is executed with the message as input parameter.

A more complex bot in a more complex game could make use of this information to send a reply accordingly. *Let's do it!*

A Tit-for-Tat Bot

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If the bot goes first as dictator, it makes a *nice* offer of splitting the money 50-50.
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OBSERVER

```
cb: function() {
    var node = this.node;
    node.on.data('decision', function(msg){
        // Store previous offer.
        node.game.offer = msg.data;
        setTimeout(function() {
            node.done();
        }, 5000);
    });
}
```

As *observer*, the bot needs to store a reference to the last offer received.

node.game is the right place, because it is persistent across steps.

Note! The variable `msg` is a "**game message**" sent by `node.say`. We will later see how game messages look like inside.

A Tit-for-Tat Bot

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DICTATOR

```
cb: function() {
    var node = this.node;
    // Did we receive an offer already?
    if ('undefined' === typeof node.game.offer){
        node.done({ offer: 50 });
    }
    else {
        node.done({ offer: node.game.offer });
    }
}
```

As *dictator*, the bot needs to check if a previous offer was saved.

If not, it makes the first **nice offer** of 50.

Otherwise, repeat the last offer.

Understanding JavaScript Types

In the previous code example, we used **`'undefined' === typeof node.game.offer`** to know if a variable was previously defined. **typeof** returns the type of a variable in a string.

```
typeof 'John';          // 'string'
typeof 1234;            // 'number'
typeof function(){…}    // 'function'
typeof { foo: 'bar' } // 'object'
```

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However, **arrays** are also considered objects

```
typeof [ 0, 1, 2, 3 ] // 'object'
```

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If a variable has not yet been defined or assigned a value, its default type is **undefined**.

```
var aNewVariable;         // no value is assigned
typeof aNewVariable       // 'undefined'
aNewVariable = {};        // we assign an empty object
typeof aNewVariable;      // 'object'
typeof aNewVariable.foo; // 'undefined'
```

Understanding JavaScript Types

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```
typeof 'John';          // 'string'
typeof 1234;            // 'number'
typeof function(){…}    // 'function'
typeof { foo: 'bar' } // 'object'
```

It should be clear why:

```
typeof (typeof 1234); // 'string'
```

However, **arrays** are also considered objects

```
typeof [ 0, 1, 2, 3 ] // 'object'
```

To know if a variable is an array you can use:

```
J.isArray();
```

Remember! The `J` object is created by nodeGame and it contains several helper methods.

If a variable has not yet been defined or assigned a value, its default type is **undefined**.

```
var aNewVariable;         // no value is assigned
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typeof aNewVariable;      // 'object'
typeof aNewVariable.foo; // 'undefined'
```

The **timeup** step-property

The **timeup** step-property determines what happens when the timer runs out

The default behavior is to call **node.done** and go to the next step

In some steps, the *user need to take a decision before advancing*, so you must code what happens in this case

In **group-behavior experiments**, it is recommended that you keep the game flowing and avoid any further delay, which might cost other people to dropout

A standard policy is: *repeat the last decision, or make a random one if none is available.* Let's implement it!

The **timeup** step-property for the DICTATOR

```
cb: function() {
    // Note! Some code has been omitted for space limitation.
    button.onclick = function() {
        // When the user clicks the button, we store the decision under node.game
        node.game.decision = lastDecision;
        node.done({ offer: decision });
    };
},
timeup: function() {
    var n;
    if ('undefined' === typeof node.game.decision) {
        n = J.randomInt(-1, 100);
    }
    else {
        n = node.game.decision;
    }
    W.getElementById('offer').value = n;
    W.getElementById('submitOffer').click();
}
```

The **timeup** step-property for the DICTATOR

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cb: function() {
    // Note! Some code has been omitted for space limitation.
    button.onclick = function() {
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    var n;
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    }
    else {
        n = node.game.decision;
    }
    W.getElementById('offer').value = n;
    W.getElementById('submitOffer').click();
}
```

Random decision.

Previous decision.

We update the display, by inserting the value inside the input form.

We click the button to trigger the onclick listener, which will store the offer and call node.done.

Let the Observer Reply

- Modify `'game'` step:
  - Observer replies with a text message to approve or disapprove offer

Prepare HTML Elements

We begin by modifying the HTML file **`public/game.htm`**

```
<div id="observer" style="display: none">
  <h4 id="waitingFor">
    Waiting for the decision of the dictator<span id="dots"></span>
  </h4>
  <span id="decision"></span>
  <p style="display: none" id="reply">
    Tell the dictator what you think
    <input type="text" id="observer_reply" />
    <button id="submit_reply">Submit</button>
  </p>
  <br/>
</div>
```

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    <input type="text" id="observer_reply" />
    <button id="submit_reply">Submit</button>
  </p>
  <br/>
</div>
```

These elements are initially **hidden.** We will show them with JavaScript at the right time.

Always add ids to make it easy to fetch these elements in JavaScript

Add Observer Code

Observer

player.js

```
node.on.data("decision", function(msg) {
    // Display offer using W.
    W.setInnerHTML("decision", "The dictator offered: " + msg.data);
    // Show hidden part.
    W.show("reply");
    // Add listener that sends the text back to dictator.
    W.gid("submit_reply").onclick = function() {
        // Say message directly to dictator.
        node.say("reply", "dictator_id", W.gid("observer_reply").value);
        // End step.
        node.done();
    };
});
```

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node.on.data("decision", function(msg) {
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        node.say("reply", "dictator_id", W.gid("observer_reply").value);
        // End step.
        node.done();
    };
});
```

Shows the button and the input form to reply

Sends the reply to the dictator with **node.say**.

Recipient ID for node.say

```
node.say("reply", "dictator_id", W.gid("observer_reply").value);
```

How do I know the ID of the recipient of a message?

For security reason, only the logic has all the IDs.

So, the ID needs to be sent from the logic to the client if needed. There are a few options how to do it.

In this example, we are using the Matcher API to match participants in pairs and assign them roles (dictator and observer). When the matcher API is used, the ID can be found under **`node.game.partner`**

```
node.say("reply", node.game.partner, W.gid("observer_reply").value);
```

Recipient ID for node.say

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```
node.say("reply", node.game.partner, W.gid("observer_reply").value);
```

Or, even simpler, here we are replying to an incoming msg, so we can use the **`msg.from`** property.

```
node.say("reply", msg.from, W.gid("observer_reply").value);
```

Add Dictator Code

Dictator

player.js

```
submit.onclick = function() {

    // We send offer directly to the observer,
    // and we delay calling node.done.
    node.say("decision", node.game.partner, offer);
};

// We wait for the reply, we display it, and
// we call node.done (with a random timer).
node.on.data("reply", function(msg) {
    W.writeln("Your partner thinks of your offer: " + (msg.data || "nothing"));
    node.timer.randomDone();
});
```

Add Dictator Code

Dictator

player.js

```
submit.onclick = function() {

    // We send offer directly to the observer,
    // and we delay calling node.done.
    node.say("decision", node.game.partner, offer);
};

// We wait for the reply, we display it, and
// we call node.done (with a random timer).
node.on.data("reply", function(msg) {
    W.writeln("Your partner thinks of your offer: " + (msg.data || "nothing"));
    node.timer.randomDone();
});
```

Same labels as in Observer: "decision" and "reply"

Logical OR, shortcut to assign a default value, if the first term is "falsy." **Hint!** Undefined if falsy, remember the comparison tables with two and three equals?

Client Type logic.js

- Contains code that will be executed on the server
  - Has access to the nodeGame client API AND to all server objects

Client Type logic.js

- Contains code that will be executed on the server
  - Has access to the nodeGame client API AND to all server objects
- What does it do?
  - It waits for all players to finish a step, if there is nothing better to do
  - Make sure the timers are respected
  - Can push/kick out non-responsive players
  - It receives incoming messages from players and stores them (`node.game.memory`)
  - It matches partners, and assigns roles

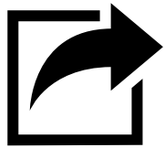
Client Type logic.js

Matching-Roles-Partners-v5

Logic Client Type

```
stager.extendStep('bidder', {
     matcher: {
          // Available roles.
          roles: [ 'BIDDER', 'RESPONDENT' ],
          // Each player is matched with a
          // partner and is assigned a role.
          match: 'roundrobin',
          // How to continue matching after
          // all combinations are exhausted
          cycle: 'repeat_invert'
     }
});
```

Matcher API



Matching-Roles-Partners-v5

logic.js

Logic Client Type

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          // all combinations are exhausted
          cycle: 'repeat_invert'
     }
});
```

Player Client Type

```
stager.extendStep('bidder', {
     roles: {
          BIDDER: {
               frame: 'bidder.htm',
               cb: function() {
                  // Bidder stuff.
               }
          },
          RESPONDENT: {
               frame: 'resp.htm',
               cb: function() {
                  // Respondent stuff.
     }}}
});
```

Client Type logic.js

Matching-Roles-Partners-v5

Logic lists roles
Player implements

Logic Client Type

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stager.extendStep('bidder', {
     matcher: {
          // Available roles.
          roles: [ 'BIDDER', 'RESPONDENT' ],
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Player Client Type

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```

Custom Group Matching: Logic


```
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// Returns an array of ids.
var ids = node.game.playerList.id.getAllKeys();
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Custom Group Matching: Logic


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// Make two random groups.
var groups = J.getNGroups(ids, 2);
```

Custom Group Matching: Logic

logic.js

```
// Let us assume a 4 player game, and we want 2 groups of two.

// Returns an array of ids.
var ids = node.game.playerList.id.getAllKeys();

// Get a copy of original array.
var ids2 = ids.slice();
node.say('yourpartner', ids[0], ids2.splice(0, 1));

// Make two random groups.
var groups = J.getNGroups(ids, 2);

// Loop through the groups and assign partners.
for (var i = 0; i < groups.length; i++) {
    // Get array of group member ids.
    var members = groups[i];
    // Tell ea      up me      is
    node.say('yourpartner', members[0], members[1]);
```

Label

Recipient ID

Payload (Partner ID)

Custom Group Matching: Player


player.js

```
node.on.data('yourpartner', function(msg) {
    // Store partner ID for later use.
    node.game.mypartner = msg.data;
    // Continue with the rest of the step.
});
```

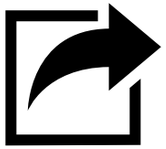
If creating all the groups takes long (e.g., if the group size is very large), it makes sense to have custom grouping in an own step and call **node.done** as soon as the group information arrives.

Custom Group Matching: Player


player.js

```
// Optional step for custom grouping.
// Note! This step is skipped in game.stages, and these groups are not
// actually used in the game step. Do you know how to adjust it?
stager.extendStep('grouping', {
    widget: {
        name: 'ContentBox',
        options: {
            mainText: 'Please wait while groups are being formed'
        }
    },
    cb: function() {
        node.on.data('yourpartner', function(msg) {
            node.game.mypartner = msg.data;
            console.log("My partner is: " + msg.data);
            node.timer.randomDone();
        });
    }
});
```

Memory Database



Memory-Database-v5

logic.js

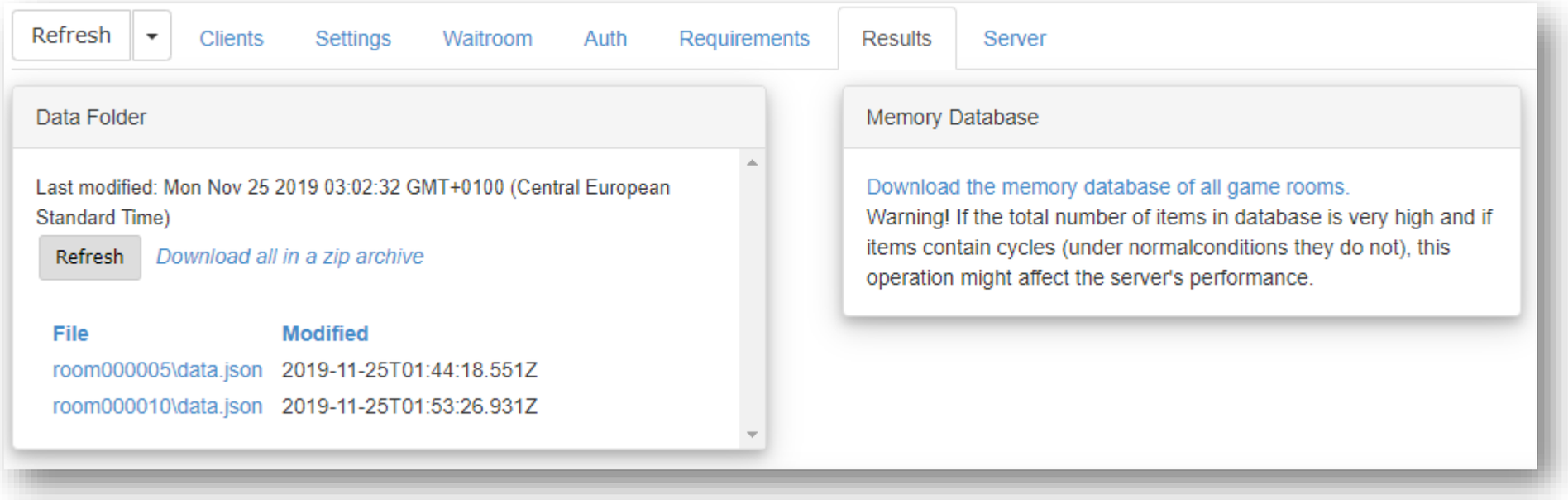
`node.game.memory`

```
stager.extendStep('end', {
        cb: function() {
            node.game.memory.save('data.json');
        }
    });
```

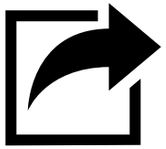
Get Your Data

logic.js

```
stager.extendStep('end', {
     cb: function() {
          node.game.memory.save('data.json');
     }
});
```



Memory Database



Memory-Database-v5

logic.js

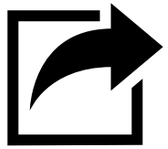
player.js

`node.game.memory`

```
node.done({ offer: 1 });
```

```
{
  stage: { stage: 2,
           step:  1,
           round: 1 },
  player: "id12345678",
  timestamp: 1480336721939
  offer:  1,
  timeup: false,
  time:   4321, // Time passed from the beginning of the step
  done:   true
};
```

Memory Database



Memory-Database-v5

logic.js

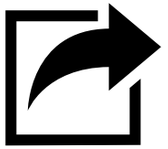
node.game.memory

```
{
  stage: { stage: 2,
           step:  2,
           round: 1 },
  player: "id12345678",
  timestamp: 148033845673
  foo: "bar" ,
};
```

player.js

```
// Set an object in memory explicitly.
node.set({ foo: "bar" });
```

Memory Database



Memory-Database-v5

logic.js

```
var m = node.game.memory;

// Lazy evaluation: add a bunch of statements
// and evaluates all of them at the end.
m.select("player", "=", "id12345678");
m.and("stage.step", "=", 1)
  .and("offer") // Must have property “offer”
  .fetch()[0];  // Returns array, get first element

// Use indexes.

// By sender.
m.player["id12345678"].last();

// By stage.
m.stage["2.1.1"].select("offer").fetch()[0];
```

Self Exercise

- Explore this RunKit on selecting and fetching items from `node.game.memory`
  - https://runkit.com/shakty/gamedb