

Beyond Consumer-Driven Contract Testing



NICOLE RAUCH
software development &
development coaching

Soooo...

- ▶ We want to build this nice webapp / distributed system / these microservices
- ▶ We want to make sure “Frontend” and “Backend” play nicely together

Soooo...

- ▶ We want to build this nice webapp / distributed system / these microservices
- ▶ We want to make sure “Frontend” and “Backend” play nicely together
- ▶ HOW???

“Super-Naïve” Approach

Frontend

Backend



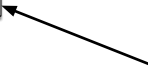
Frontend

Backend



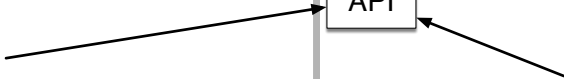
Frontend

Backend



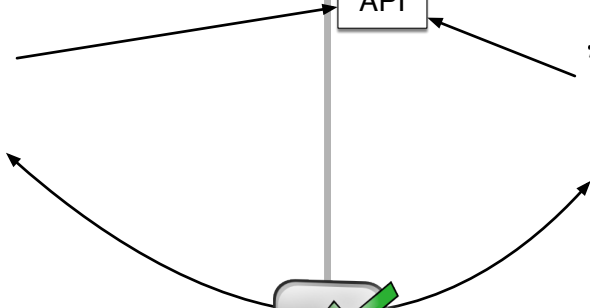
Frontend

Backend



Frontend

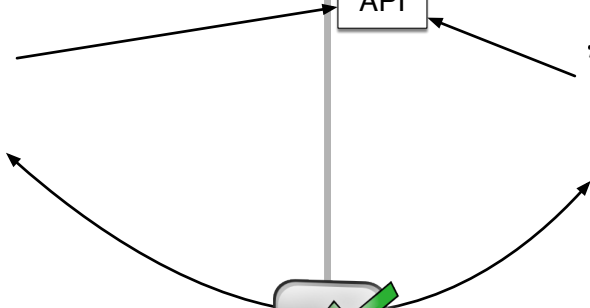
Backend



But . . .

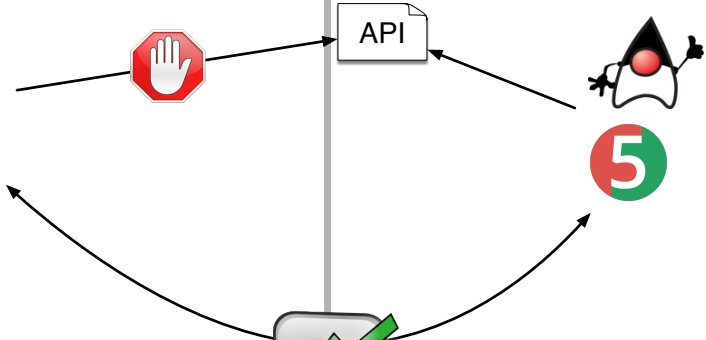
Frontend

Backend



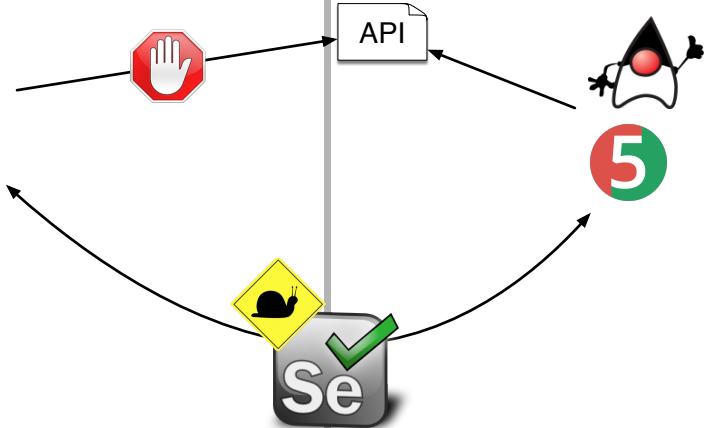
Frontend

Backend



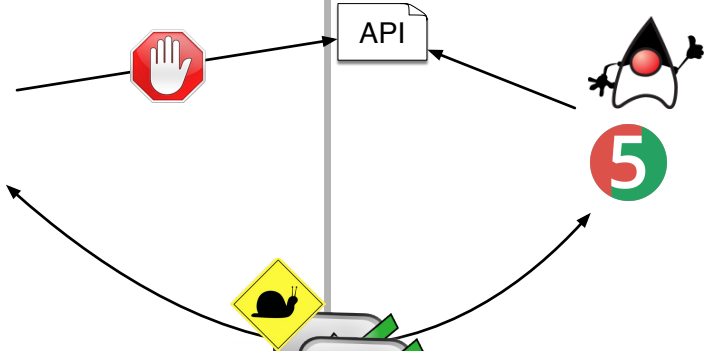
Frontend

Backend



Frontend

Backend



“Still Quite Naïve” Approach

Frontend

Backend



Frontend

Backend



Frontend

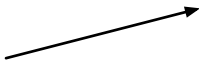


SINON.JS

Backend



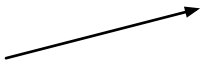
Frontend



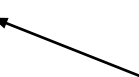
Backend



Frontend



Backend

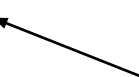


But ...

Frontend

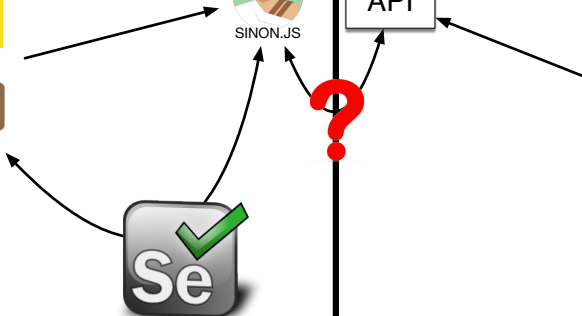


Backend

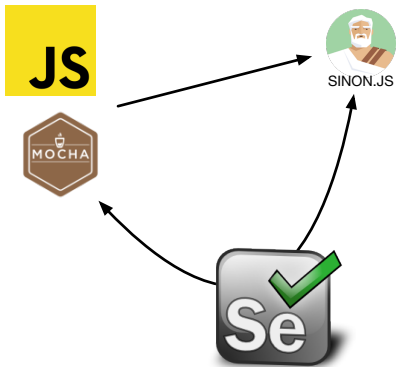


Frontend

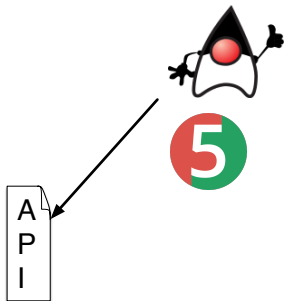
Backend



Frontend

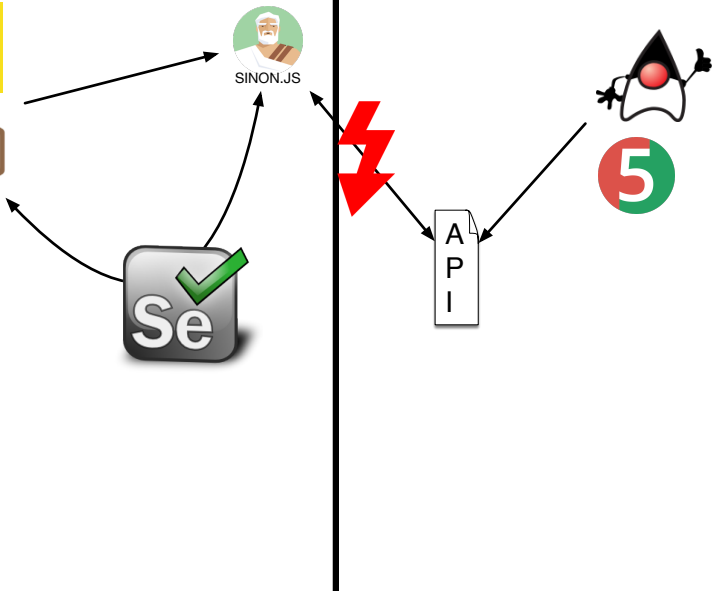
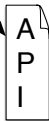


Backend



Frontend

Backend



“Industry-Strength” Approach: Consumer-Driven Contract Testing







Generate



SINON.JS



Use in Dev

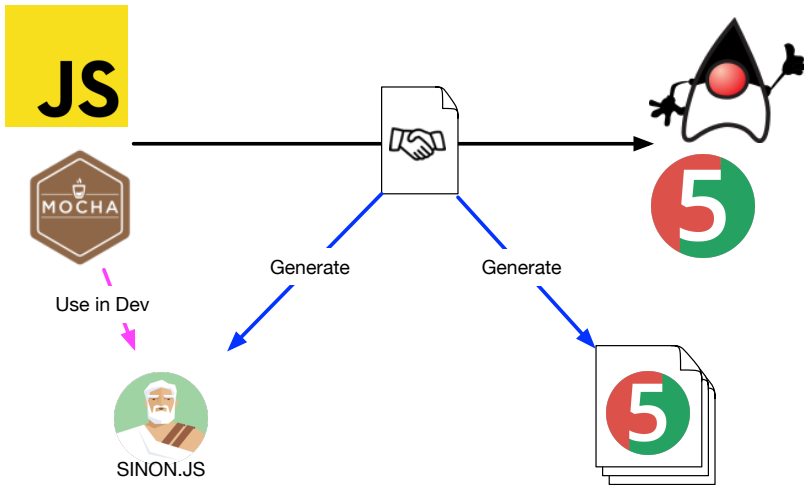


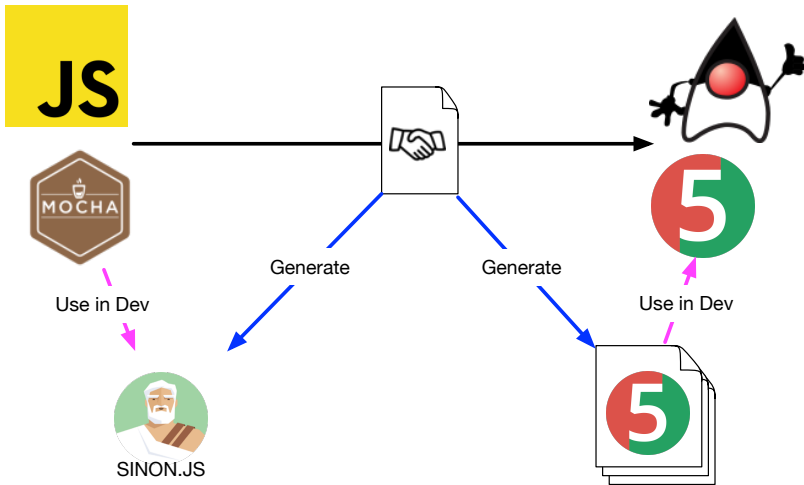
SINON.JS

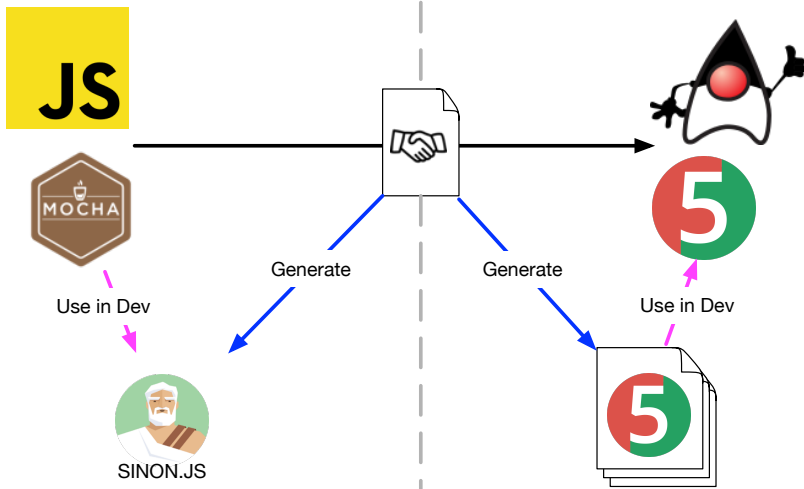


Generate









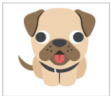
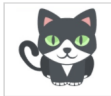
Welcome to our Pet Store

Add a New Pet

Pet name:

Pet price:

Species:



Add Pet

Pets in our Store



Dodo

Sell Dodo



Fifi

Sell Fifi



Minka

Sell Minka

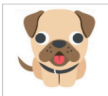
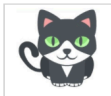
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Add Pet

Pets in our Store

GET



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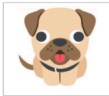
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POST

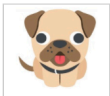
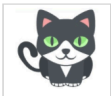
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Pet name:

Pet price:

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Add Pet

Pets in our Store



Dodo

Sell Dodo



Fifi

Sell Fifi



Minka

Sell Minka

DELETE

Example: Pet Store Contracts I

```
{
  "description": "a request for all pets",
  "providerState": "i have no pets",
  "request": {
    "method": "GET",
    "path": "/pets",
    "headers": { "Accept": "application/json" }
  },
  "response": {
    "status": 200,
    "headers": { "Content-Type": "application/json" },
    "body": {
      "tag": "Pets",
      "pets": []
    }
  }
}
```

Situation

- ▶ GET-Request

Situation

- ▶ GET-Request
- ▶ Does not depend on state

Situation

- ▶ GET-Request
- ▶ Does not depend on state
- ▶ Easy to handle with CDCT

Questions

- ▶ Completeness

Questions

- ▶ Completeness
 - ▶ Did we really capture all requests (+ responses) in our contract?

Example: Pet Store Contracts II

```
{
  "description": "a request for all pets",
  "providerState": "i have a list of pets",
  "request": {
    "method": "GET",
    "path": "/pets",
    "headers": { "Accept": "application/json" }
  },
  "response": {
    "status": 200,
    "headers": { "Content-Type": "application/json" },
    "body": {
      "tag": "Pets",
      "pets": [
        { "petName": "Fifi", "petType": "Dog" },
        { "petName": "Minki", "petType": "Cat" }
      ]
    }
  }
}
```

Situation

- ▶ GET-Request that depends on state

Situation

- ▶ GET-Request that depends on state
- ▶ POST-/PUT-/DELETE-Requests

Situation

- ▶ GET-Request that depends on state
- ▶ POST-/PUT-/DELETE-Requests
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- ▶ Backend state needs to be established somehow

Situation

- ▶ GET-Request that depends on state
- ▶ POST-/PUT-/DELETE-Requests
- ▶ Difficult to handle with CDCT
- ▶ Backend state needs to be established somehow
- ▶ State checks need to be established somehow

Questions

- ▶ Completeness

Questions

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 - ▶ Did we really capture all requests (+ responses) in our contract?

Questions

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 - ▶ All possible combinations with different backend states?

Questions

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- ▶ State Validity

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 - ▶ All possible combinations with different backend states?
- ▶ State Validity
 - ▶ What are valid states in our stub?

Questions

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 - ▶ Did we really capture all requests (+ responses) in our contract?
 - ▶ All possible combinations with different backend states?
- ▶ State Validity
 - ▶ What are valid states in our stub?
 - ▶ Did we always establish a valid state in our stub?

Questions

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- ▶ What are valid states in our stub?
- ▶ Did we always establish a valid state in our stub?
- ▶ How do we establish them (technically) before the request?

Questions

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Questions

- ▶ Completeness
 - ▶ Did we really capture all requests (+ responses) in our contract?
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- ▶ Maintenance

Questions

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- ▶ How can we keep track of our contracts and avoid redundancies?

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▶ Maintenance

- ▶ How can we keep track of our contracts and avoid redundancies?
- ▶ How can we effectively maintain the contracts in case of changes?

We need the Functional Essence!



Sounds cool, but...

Sounds cool, but...

...what does that mean?

Functional Essence

- ▶ Fake Server

Functional Essence

- ▶ Fake Server
- ▶ Lightweight Implementation

Functional Essence

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- ▶ Model

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Functional Essence

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- ▶ Model
- ▶ Rapid Prototype
- ▶ Minimal Viable Product

Functional Essence Serves Many Purposes

- ▶ To learn about the domain

Functional Essence Serves Many Purposes

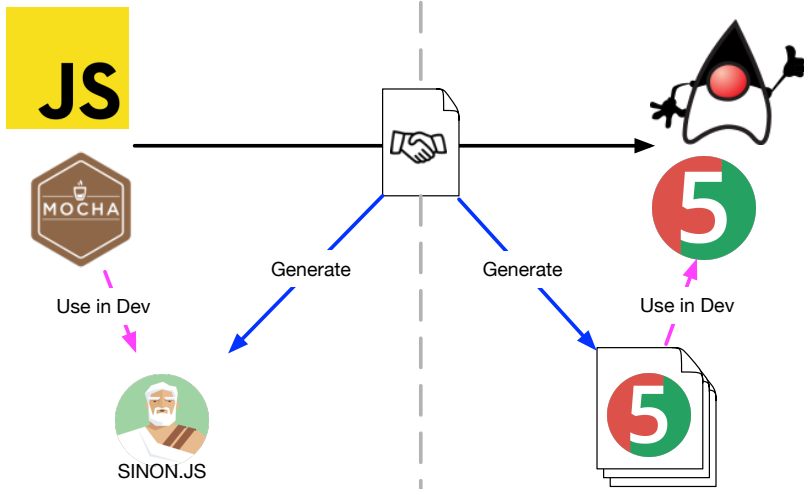
- ▶ To learn about the domain
- ▶ To discuss with domain experts

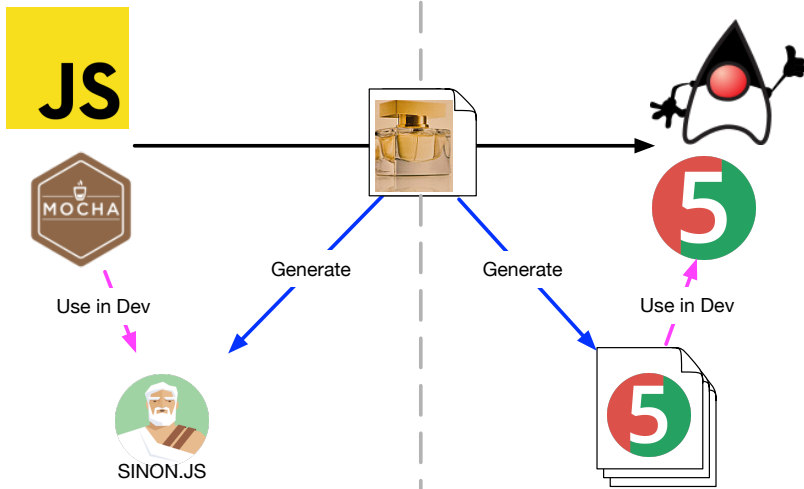
Functional Essence Serves Many Purposes

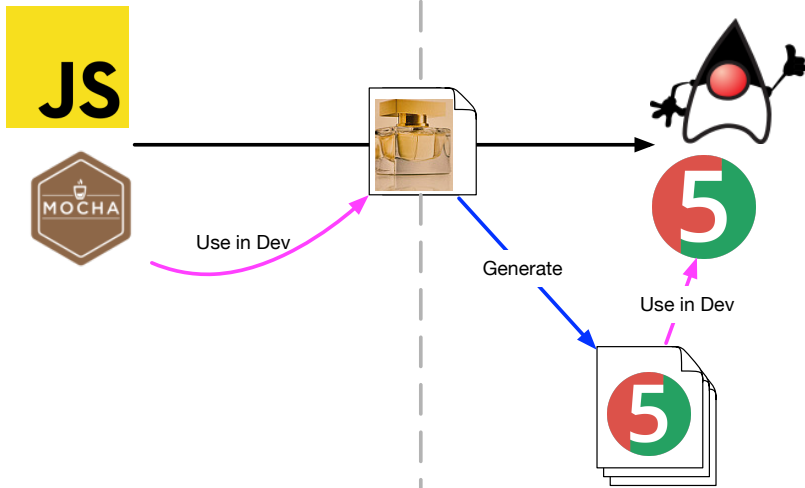
- ▶ To learn about the domain
- ▶ To discuss with domain experts
- ▶ To validate assumptions at an early stage

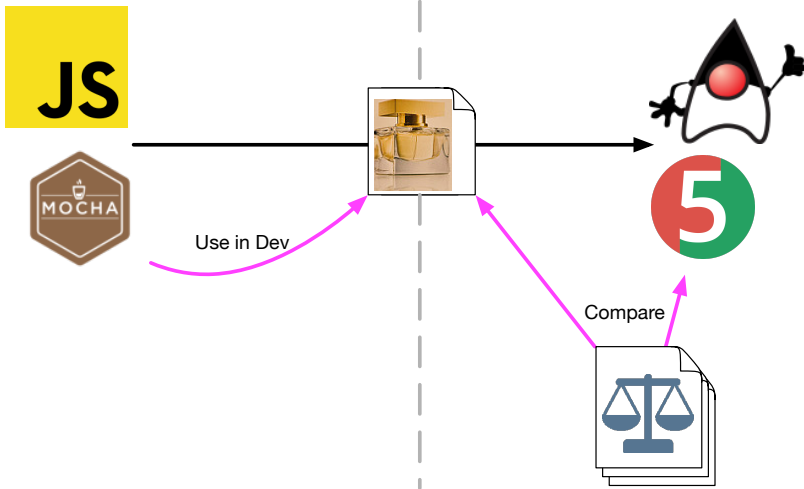
Functional Essence Serves Many Purposes

- ▶ To learn about the domain
- ▶ To discuss with domain experts
- ▶ To validate assumptions at an early stage
- ▶ To check the real implementation:









Sounds cool, but...

Sounds cool, but...

...how can I build this?

How to Build a Functional Essence

- ▶ Implement the domain logic

How to Build a Functional Essence

- ▶ Implement the domain logic
- ▶ In the simplest possible way

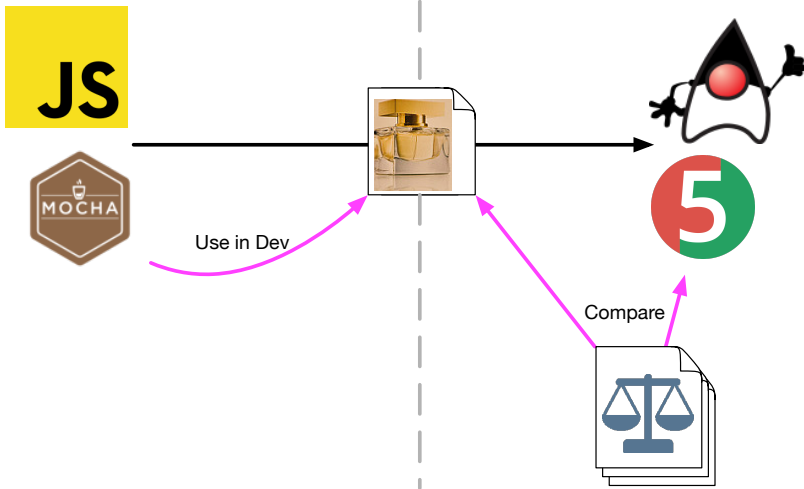
How to Build a Functional Essence

- ▶ Implement the domain logic
- ▶ In the simplest possible way
- ▶ In an arbitrary language

How to Build a Functional Essence

- ▶ Implement the domain logic
- ▶ In the simplest possible way
- ▶ In an arbitrary language





The Pets Essence

```
class Pets {
  constructor(){
    this._pets = [];
  }

  getPets() {
    return petSorter.sortPets(this._pets);
  }

  addPet(pet) {
    this._pets.push(pet);
    return 'Pet successfully added.';
  }

  removePet(pet) {
    this._pets = this._pets.filter(
      p => p.petName !== pet.petName || p.petType !== pet.petType);
    return 'Pet successfully removed.';
  }
}
```

The Overall Essence

```
class Essence {  
    constructor() {  
        this._pets = new Pets();  
        this._somethingElse = new SomethingElse();  
    }  
  
    pets() {  
        return this._pets;  
    }  
  
    somethingElse() {  
        return this._somethingElse;  
    }  
}
```

The Essence App

```
let essence = new Essence();

router.get('/pets', (req, res) => {
  const pets = essence.pets().getPets();
  res.json({tag: 'Pets', pets});
});

router.post('/pets', (req, res) => {
  const message = essence.pets().addPet({ petName: req.body.petName,
    petPrice: req.body.petPrice, petType: req.body.petType });
  res.json({message});
});

router.delete('/pets', (req, res) => {
  const message = essence.pets().removePet({ petName: req.body.petName,
    petPrice: req.body.petPrice, petType: req.body.petType });
  res.json({message});
});
```

Important Addition

```
router.delete('/reset', (req, res) => {  
  essence = new Essence();  
  res.json({message: 'All pets successfully removed.'});  
});
```


Important Addition

```
router.delete('/reset', (req, res) => {  
  essence = new Essence();  
  res.json({message: 'All pets successfully removed.'});  
});
```

Also for the real backend!

Isn't That The Same Code As The Backend?

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- ▶ No performance-tuning (e.g. slower but simpler algorithms)

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- ▶ Some parts can be left out
- ▶ ...



Use in Dev

Compare



How does the Comparison work?

Detour: Quick Check / Property-Based Testing

Detour: Quick Check / Property-Based Testing

- ▶ User specifies properties
- ▶ Tool generates examples
- ▶ Checks properties against examples

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```
prop_RevRev :: [Int] -> Bool  
prop_RevRev xs = reverse (reverse xs) == xs
```

Detour: Quick Check / Property-Based Testing

- ▶ User specifies properties
- ▶ Tool generates examples
- ▶ Checks properties against examples

```
prop_RevRev :: [Int] -> Bool  
prop_RevRev xs = reverse (reverse xs) == xs
```

```
*Main> quickCheck prop_RevRev  
+++ OK, passed 100 tests.
```

Detour: Quick Check / Property-Based Testing

- ▶ User specifies properties
- ▶ Tool generates examples
- ▶ Checks properties against examples

```
prop_RevRev :: [Int] -> Bool  
prop_RevRev xs = reverse (reverse xs) == xs
```

```
*Main> quickCheck prop_RevRev  
+++ OK, passed 100 tests.
```

```
prop_RevId :: [Int] -> Bool  
prop_RevId xs = reverse xs == xs
```


Detour: Quick Check / Property-Based Testing

- ▶ User specifies properties
- ▶ Tool generates examples
- ▶ Checks properties against examples

```
prop_RevRev :: [Int] -> Bool
prop_RevRev xs = reverse (reverse xs) == xs
```

```
*Main> quickCheck prop_RevRev
+++ OK, passed 100 tests.
```

```
prop_RevId :: [Int] -> Bool
prop_RevId xs = reverse xs == xs
```

```
*Main> quickCheck prop_RevId
*** Failed! Falsifiable (after 7 tests and 3 shrinks):
[0,1]
*Main> quickCheck prop_RevId
*** Failed! Falsifiable (after 4 tests and 1 shrink):
[1,0]
```

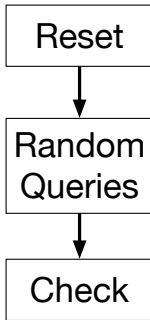
How to Mimic QuickCheck?

Reset

Reset



Random
Queries



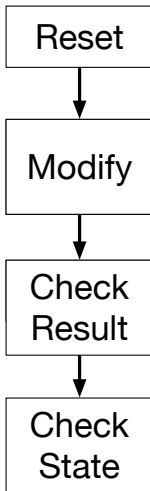
Reset

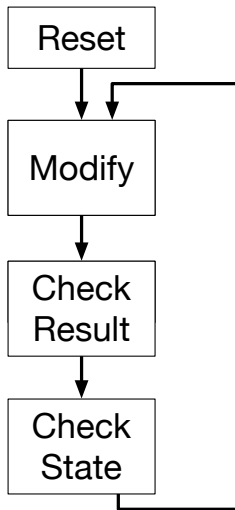


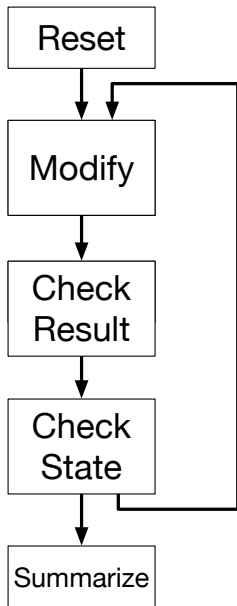
Modify

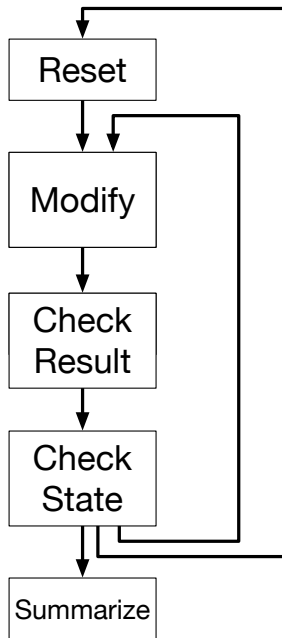


Check



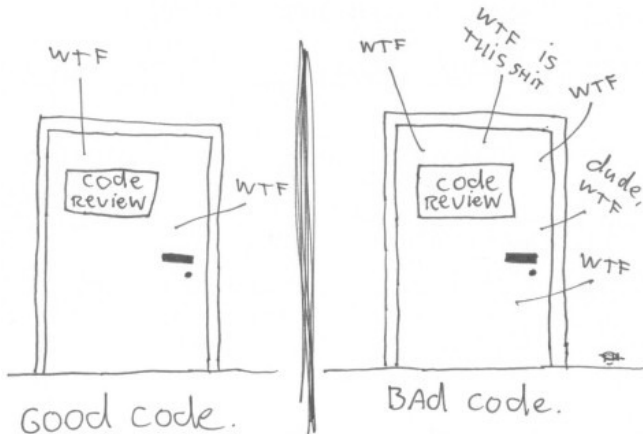






Comparator Implementation

The ONLY VALID MEASUREMENT OF CODE QUALITY: WTFs/MINUTE



The Main Loop

```
const requests = [resets[0]()]; // initial reset

let count = 0;

while (count < 50) {
  count++;
  requests.push(chooseFrom(modifyingRequestGenerator()));
}

async.mapSeries(requests, requestAndCompare, (err, results) => {
  results.map(result => console.log(result));
  if (err) {
    console.log(err);
  }
});
```

Request Generator

```
const resets = [  
  // delete all pets  
  () => ({url: '/reset', method: 'DELETE'}),  
];  
  
const modifyingRequestGenerator = [  
  // addPet  
  () => ({url: '/pets', method: 'POST', json: true, body: randomPet()}),  
  // removePet  
  () => ({url: '/pets', method: 'DELETE', json: true, body: randomPet()})  
];  
  
const comparisons = [  
  // getPets  
  () => ({url: '/pets', method: 'GET'}),  
];
```

Pet Generator

```
const chooseFrom = arr => arr[Math.floor(arr.length * Math.random())];

const possibleNames = ['Minka', 'Fifi', 'Pucki'];
const possibleSpecies = ['Cat', 'Dog', 'Canary', 'Rabbit', 'Fish'];

const name = () => chooseFrom(possibleNames);
const price = () => Math.floor(150 * Math.random());
const species = () => chooseFrom(possibleSpecies);

const randomPet = () =>
  ({petName: name(), petPrice: price(), petType: species()});
```

Revisiting the Main Loop

```
const requests = [resets[0]()]; // initial reset

let count = 0;

while (count < 50) {
  count++;
  requests.push(chooseFrom(modifyingRequestGenerator()));
}

async.mapSeries(requests, requestAndCompare, (err, results) => {
  results.map(result => console.log(result));
  if (err) {
    console.log(err);
  }
});
```


Request-Compare-Loop

```
const requestAndCompare = (request, mainCallback) => {

  console.log('Running the modification request:');

  runRequest(request, (err, result) => {
    const backendString = JSON.stringify(result.backend);
    const essenceString = JSON.stringify(result.essence);

    if (backendString !== essenceString) {
      mainCallback('Backend and Essence responses differ! Backend: '
        + backendString + ' - Essence: ' + essenceString);
    } else {

      console.log('Comparing all data:');
      compareEverything(mainCallback);
    }
  });
};
```

Query Submission

```
const backend = {baseUrl: 'http://localhost:9090'};  
const essence = {baseUrl: 'http://localhost:8080'};  
  
const merge = (req, server) =>  
  Object.assign({}, req, {url: server.baseUrl + req.url});  
  
const requestFunctionFor = (req, server) =>  
  callback => request(merge(req, server),  
    (err, response) => callback(err, response.body));  
  
const runRequest = (req, callback) => {  
  console.log('Now checking:', req);  
  async.parallel({  
    backend: requestFunctionFor(req, backend),  
    essence: requestFunctionFor(req, essence)  
  }, callback);  
};
```

Comparisons

```
function compareEverything(mainCallback) {
  async.map(comparisons, (itemFunc, callback) =>
    runRequest(itemFunc(), (err, res) => {
      if (res.backend === res.essence) {
        callback(null, null); // no differences
      } else {
        const formatDiff = formatter.formatDiff({
          backend: JSON.parse(res.backend),
          essence: JSON.parse(res.essence)
        });
        callback(null, formatDiff);
      }
    }),
    (err, results) => {
      const nonmatching = results.filter(x => x);
      mainCallback(nonmatching.length
        ? 'Backend and Essence differ in their data' : null);
    });
}
```

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 - ▶ All possible combinations with different backend states?

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 - ▶ Completeness is established over time

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- ▶ What are valid states in our stub?
- ▶ Did we always establish a valid state in our stub?
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*Assuming no coding errors!

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- ▶ This is rather at the top of the test pyramid.

Thank you very much!

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EventStorming · Domain-Driven Design
Training · Coaching · Facilitation
Software Craftsmanship
React.js and Redux
Functional Programming

Credits

Essence: Mark Morgan - Perfume

<https://www.flickr.com/photos/markmorgantrinidad/5959461561>

WTF's per minute: Tom Holwerda

http://www.osnews.com/story/19266/WTFs_m