Mechanics of Promises

Understanding JavaScript Promise Generation & Behavior

I Will Be Able To…

- Explain the behaviour of promises under multiple conditions (e.g. chaining on same promise, chaining without a handler, returning a new promise)
- Build my own promise library

Async: continuation-passing

```
// Express & node-postgres
client.query(‘SELECT * FROM tweets’, function (err, data){
  if (err) return next(err);
  res.json(data.rows);
});
```

Async: promise

```
// Express & Sequelize!
Page.findOne({where: {name: ‘Promises'}})
.then(function (page) {
  res.json(page);
});
```

Async: promise

```
// Express & Sequelize
Page.findOne({where: {name: 'Promises'}}).then(
  function (page) { res.json(page); },
  function (err)  { res.status(500).end(); }
);
```

Separate the async request from the eventual behavior we want to run

```
const pagePromise = Page.findOne({where: {name: 'Promises'}});

// promise is portable - can move it around
pagePromise.then(
  function (page) { res.json(page); },
  function (err)  { return next(err); }
);
```

Export to other modules…

```
const studentPromise = User.findOne({where: {role: 'student'}});
module.exports = studentPromise;
```

...collect in arrays and pass into functions...

```
const dayPromises = [];
// make 7 parallel (simultaneous) day requests
for (let i = 0; i < 7; i++) {
  const promiseForDayI = Day.findOne({where: {dayNum: i}});
  dayPromises.push( promiseForDayI );
}
// act only when they have all resolved
Promise.all( dayPromises ).then(function(days){
  res.render('calendar', {days: days});
});
```

…and much more

```
promiseForUser
  .then( user => asyncGet(user.messageIDs))
  .then( messages => asyncGet(messages[0].commentIDs))
  .then( comments => UI.display( comments[0] ))
  .catch( err => console.log('Fetch error: ', err));
```

Callback Hell

deep, confusing nesting & forced, repetitive error handling

```
// Basic async callback pattern.
// asyncFetchUser asks a server for some data.
// Internally, it gets a response: { name: 'Kim' }.
// That response is then passed to the receiving callback.

asyncFetchUser( 123, function received ( response ) {
  console.log( response.name ); // output: Kim
});
```

```
// Callback Hell… with error handling, for extra hellishness

const userID = 'a72jd3720h';
getUserData( userID, function ( err, userData ) {
  if (err) console.log('user fetch err: ', err);
  else getMessage( userData.messageIDs[0], function got ( err, message ) {
    if (err) console.log('message fetch err: ', err);
    else getComments( message, function ( err, comments ) {
      if (err) console.log('comment fetch err: ', err);
      else console.log( comments[0] );
    });
  });
});
```

```
promiseForUser
  .then(function (user) {
    return asyncGet(user.messageIDs);
  })
  .then(function (messages) {
    return asyncGet(messages[0].commentIDs);
  })
  .then(function (comments) {
    UI.display( comments[0] );
  })
  .catch(function (err) {
    console.log('Fetch error: ', err);
  });
```

PROMISE ADVANTAGES

- Portable
- Multiple handlers
- “Linear” or “flat” chains
- Unified error handling

So, what is a promise?

> *“A promise represents the eventual result of an asynchronous operation.”*

— THE PROMISES/A+ SPEC

magic!

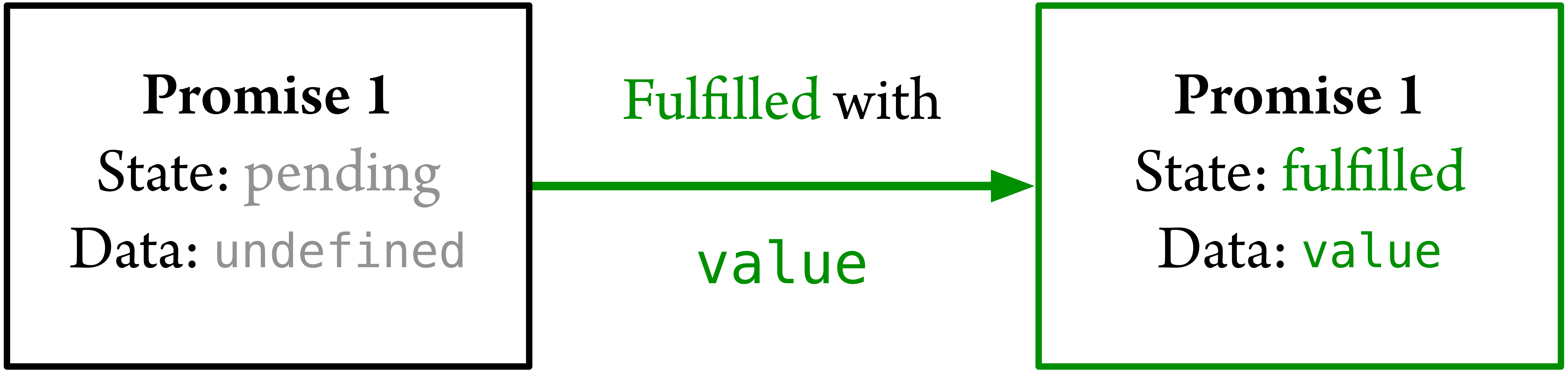
(no)

Promises are Objects

state (pending, fulfilled, or rejected) } (hidden if possible)

information (value or a reason)

`.then()` (public property)

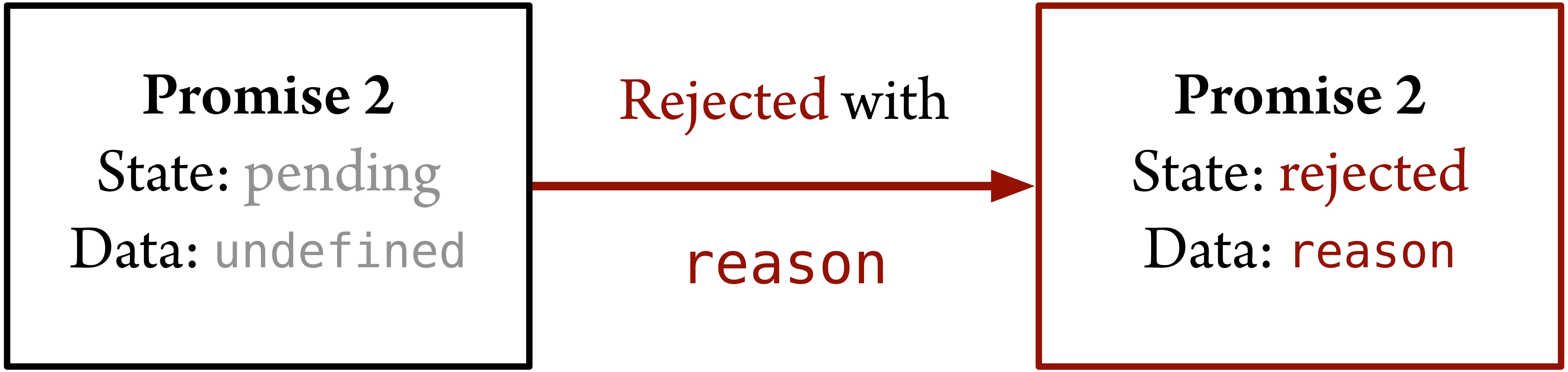


Promise 1
State: pending
Data: `undefined`

Fulfilled with
`value`

Promise 1
State: fulfilled
Data: `value`

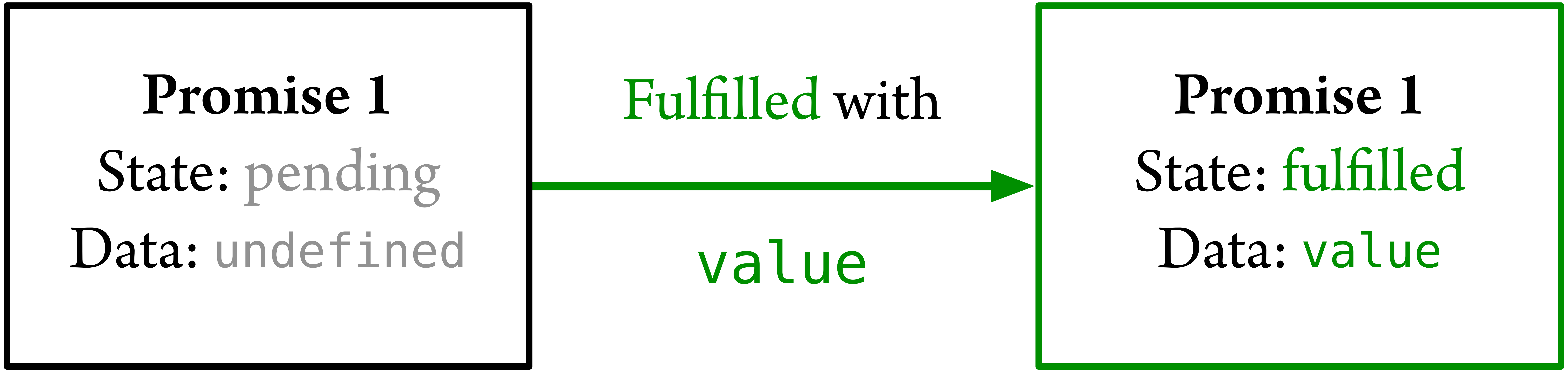
promises only change state while pending



Promise 2
State: pending
Data: `undefined`

Rejected with
`reason`

Promise 2
State: rejected
Data: `reason`



Promise 1

State: pending

Data: `undefined`

Fulfilled with

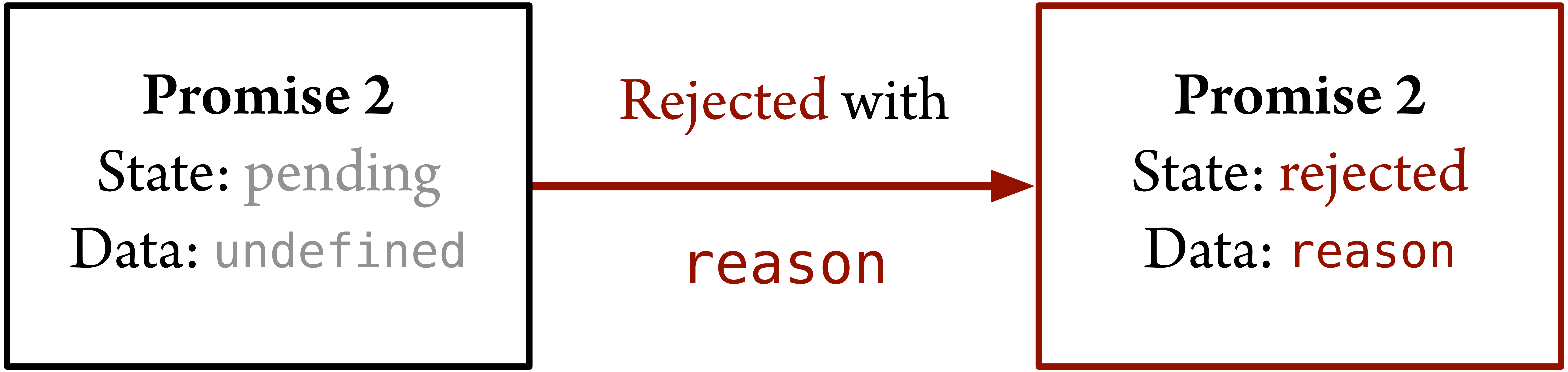
`value`

Promise 1

State: fulfilled

Data: `value`

```
myPromise.then( successHandler, failureHandler )
```



Promise 2

State: pending

Data: `undefined`

Rejected with

`reason`

Promise 2

State: rejected

Data: `reason`

Standards

- **The standard which won: Promises/A+**
  - Only covers one function: `.then`!
- **ES6 promises are a superset of P/A+**
  - Includes some additional methods (`.catch`, `all`, `race`)
- **Main point: promises are *implemented*, not a fundamental type**
  - Some libraries followed earlier standards or no standard
  - Modern libraries follow Promises/A+

```
// Fantasy solution

const containerA = new Container();

asyncGetData( function ( data ) {
  containerA.save( data ); // once async completes
});

// …somewhere else…
containerA.whenSaved( function ( data ) {
  console.log( data ); // once containerA.save() happens
});
```

So where do real promises come from?

- Existing libraries may return promises
  - Sequelize queries / db actions
  - axios
  - fetch
- Wrap vanilla async calls in promise constructor
  - ES6 / `Bluebird`: `new Promise(executor)`
- Promise libraries can wrap for us, e.g. in Node
  - `Bluebird.promisifyAll(fs)`

Making New Promises: How?

new Promise(executor)

```
const promiseForTxt = new Promise( function (resolve, reject) {
  fs.readFile(‘log.txt', function (err, text) {
    if (err) reject( err );
    else resolve( text );
  });
});

// elsewhere
promiseForTxt.then( someSuccessHandler, someErrorHandler );
```

Promisification in Node.js

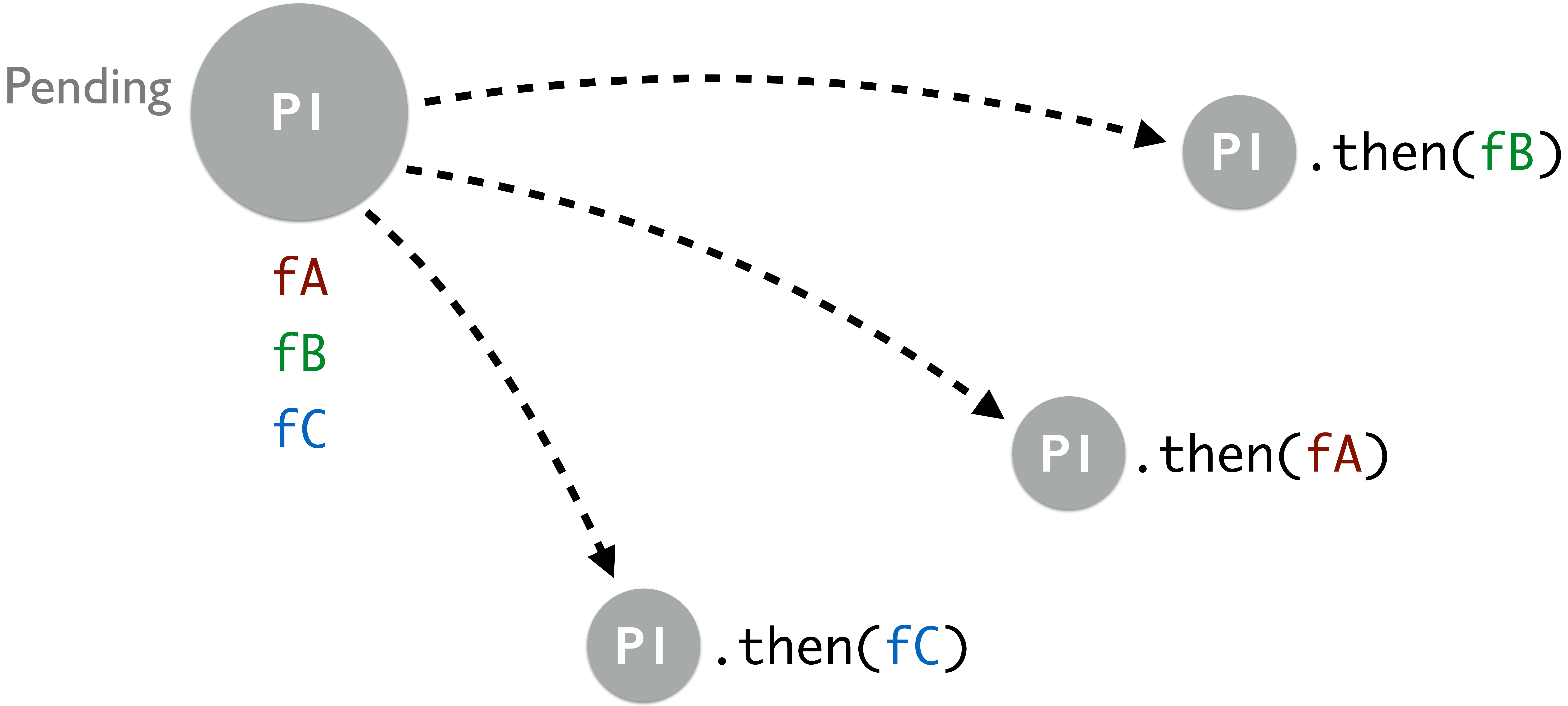
```
fs.readFile('foo.txt', 'utf-8', function (err, text) {
  // use the text
});
```

```
Bluebird.promisifyAll( fs );
fs.readFileAsync('file.j', ‘utf8').then(function (text) {
  // use the text
});
```

The Magic of Promises

- Magical behavior #1: It doesn’t really matter whether .then() is called before or after the promise is resolved. Everything just works properly!

.then on same promise (not chaining!)



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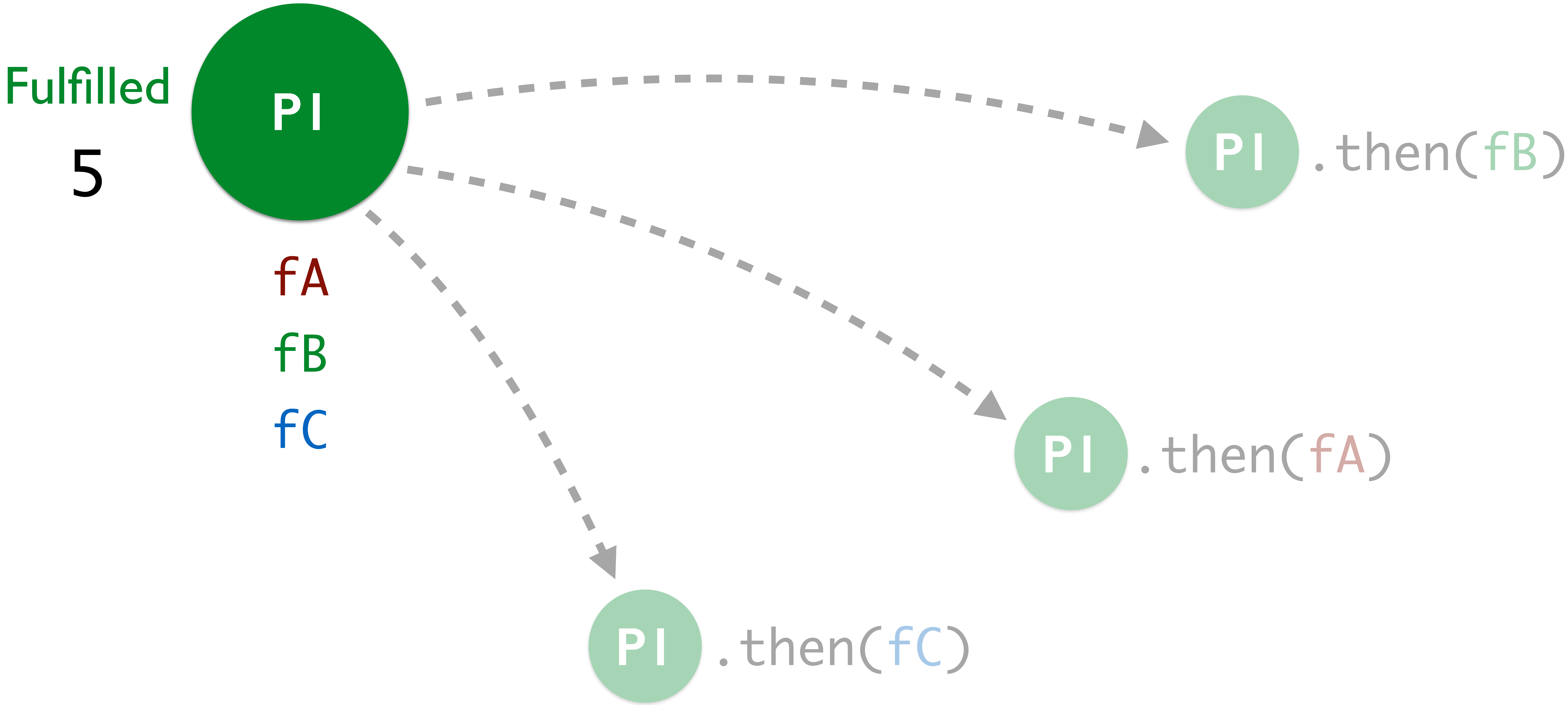

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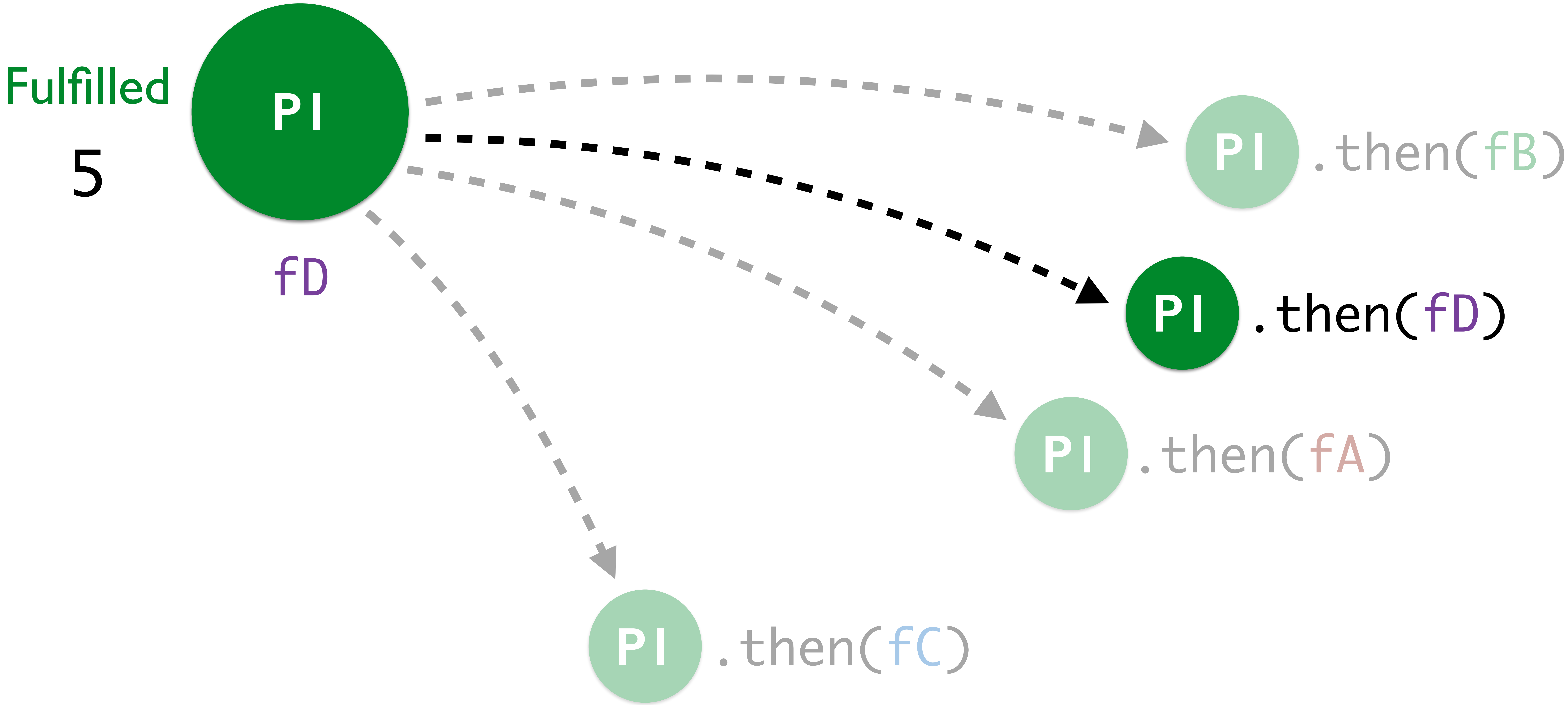


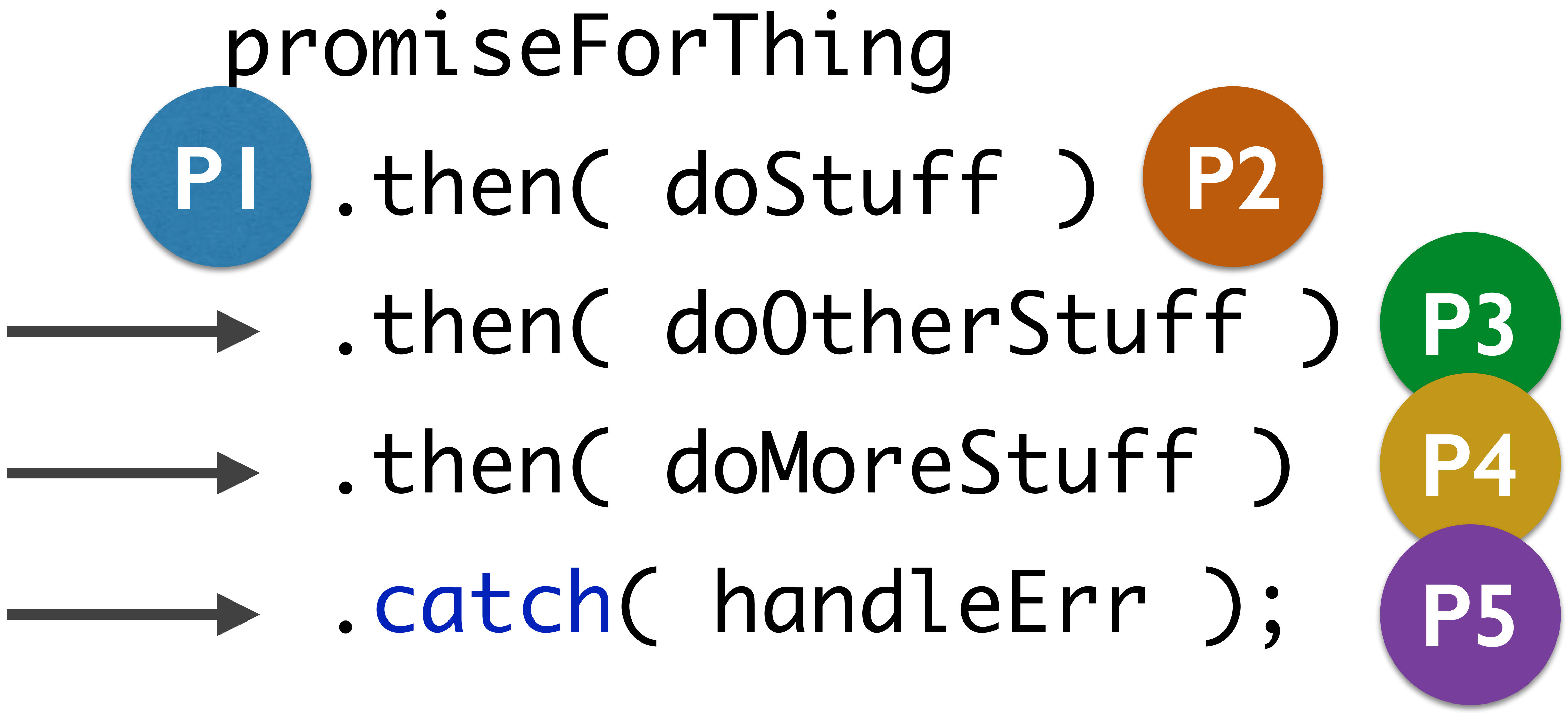
The Magic of Promises

- **Magical Property #1: It doesn’t really matter whether .then() is called before or after the promise is resolved. Everything just works properly!**
- **Magical Property #2: .then() returns a new (different) Promise.**
  - whatever the previous promise returned ends up as the resolved value in the new promise.
  - If the previous promise returned a promise… then the **resolved value** of the returned promise ends up in the new one. Woah.

the magic: `.then` returns a *new* promise

```
promiseB =
promiseA.then( successHandler, errorHandler );
```

This is why we can chain .then



```
promiseForThing
  .then( doStuff )
  .then( doOtherStuff )
  .then( doMoreStuff )
  .catch( handleErr );
```

`.catch(handleErr)` is equivalent to `.then(null, handleErr)`

So what happens if we ‘return’ in a handler

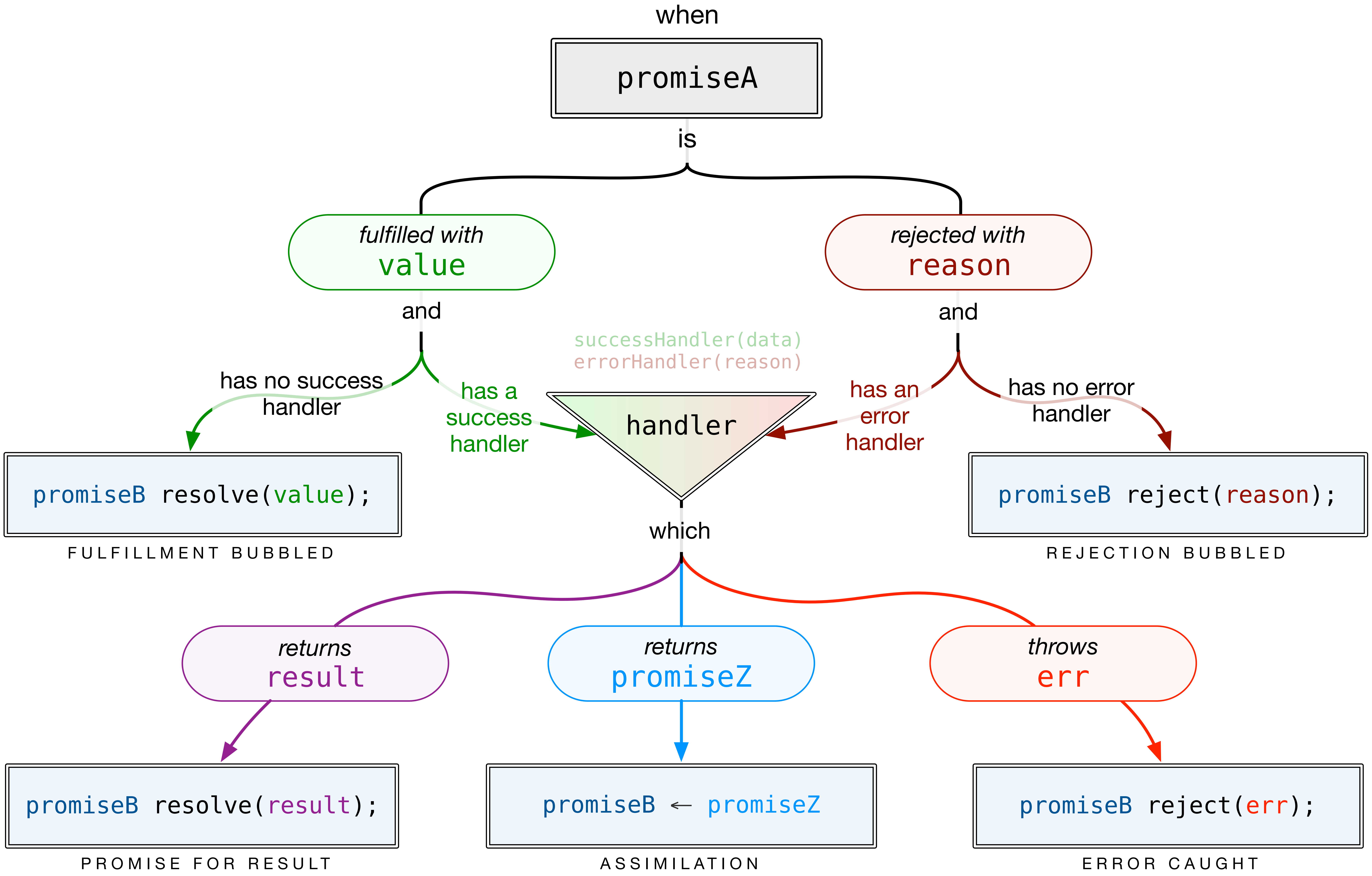
```
const promiseB = promiseA
  .then(function thingSuccess (thingA) {
    // run some code
    return thingB;
  })
```

Brace yourselves…

(Break)

Brace yourselves...

```
promiseB = promiseA.then( [successHandler], [errorHandler] );
```



when

promiseA

is

fulfilled with value

and

has no success handler

promiseB resolve(value);

FULFILLMENT BUBBLED

has a success handler

successHandler(data)

errorHandler(reason)

handler

rejected with reason

and

has an error handler

has no error handler

promiseB reject(reason);

REJECTION BUBBLED

which

returns result

promiseB resolve(result);

PROMISE FOR RESULT

returns promiseZ

promiseB ← promiseZ

ASSIMILATION

throws err

promiseB reject(err);

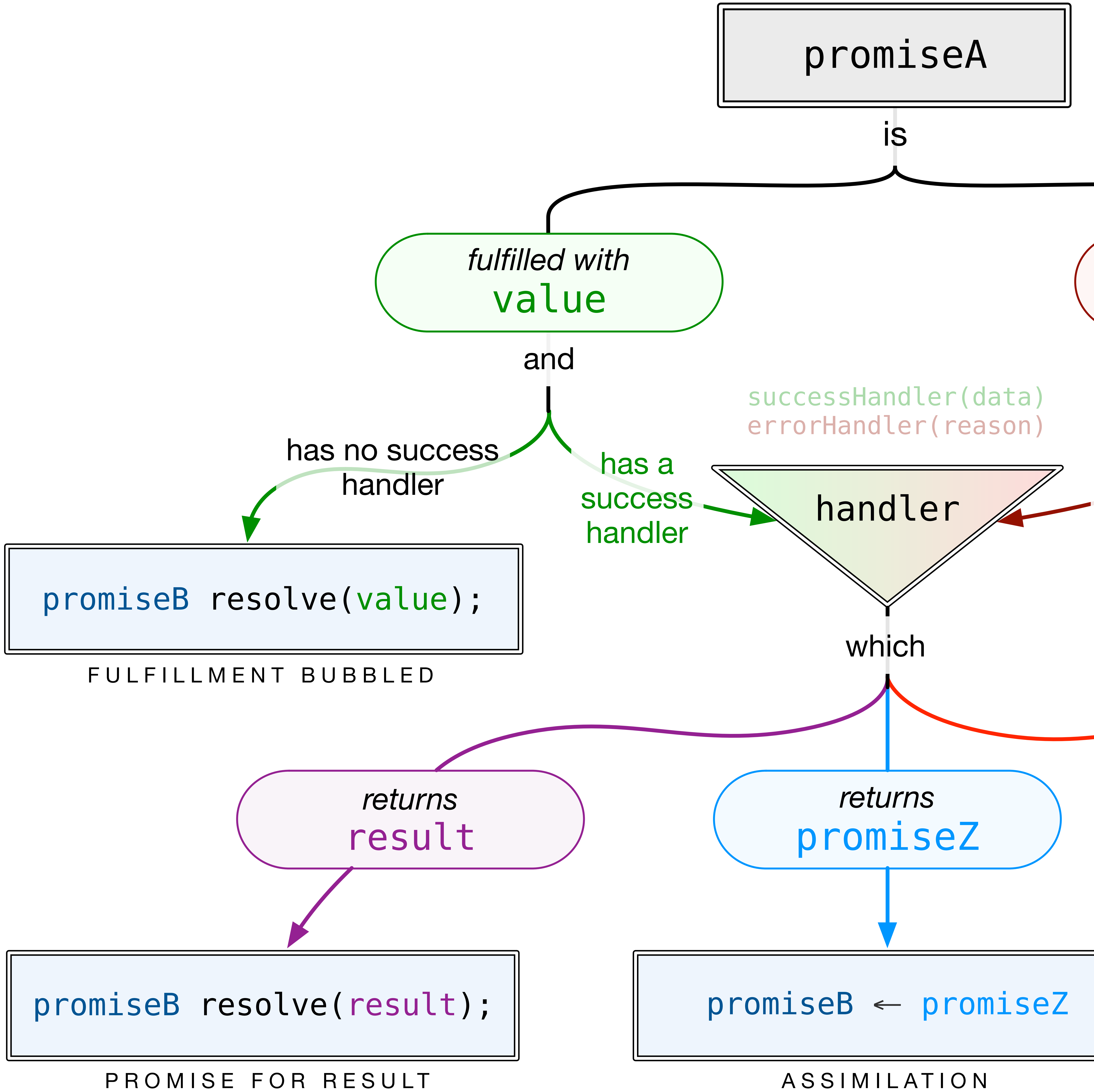
ERROR CAUGHT

```
// promiseA fulfills with 'Hello.'

promiseA
  .then() // -> p1
  .then() // -> p2
  .then() // -> p3
  .then() // -> p4
  .then() // -> p5
  .then(blue);
```

Fulfillment bubbled down to first available success handler:

Console says "Hello."



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FULFILLMENT BUBBLED

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promiseB resolve(result);

PROMISE FOR RESULT

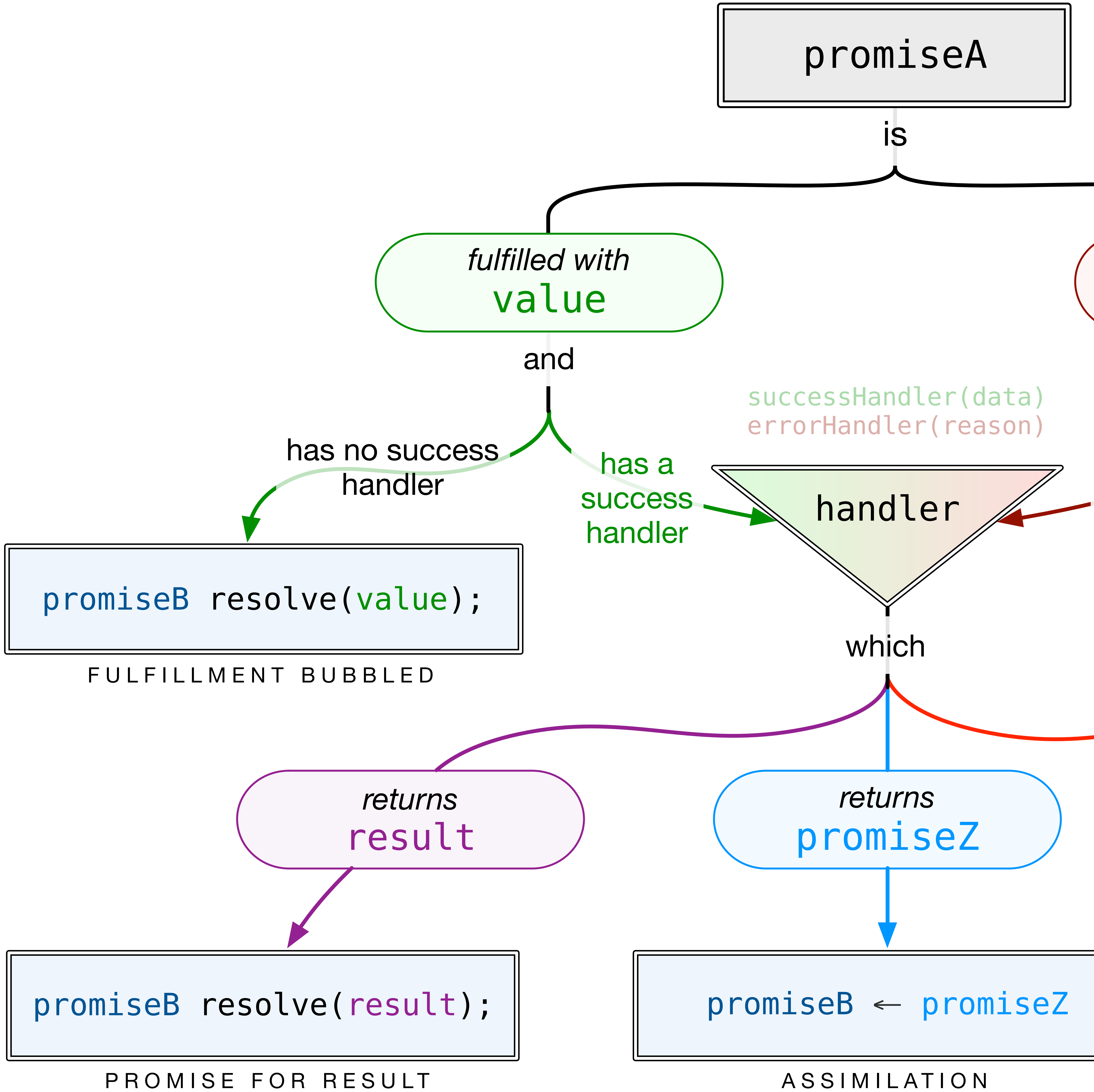
promiseB ← promiseZ

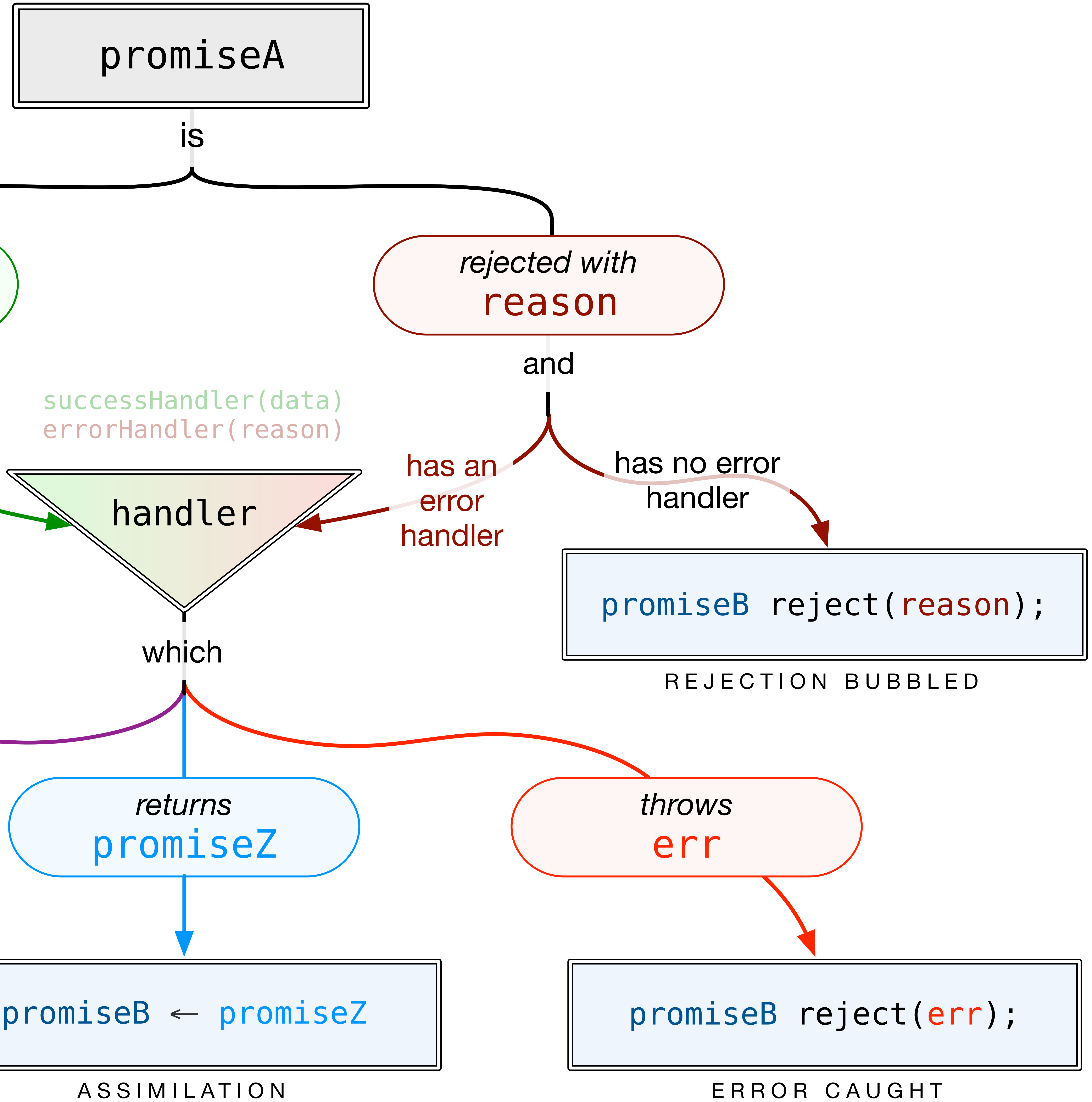
ASSIMILATION

```
// promise0 fulfills with 'Hello.'

promiseA
  .then(null, warnUser) // -> p1
  .then()               // -> p2
  .then()               // -> p3
  .then(null, null)     // -> p4
  .then()               // -> p5
  .then(blue);
```

Same thing! Each outgoing promise is resolved with "Hello," and every .then will pass it along unless it has a success handler.

Console log reads "Hello."

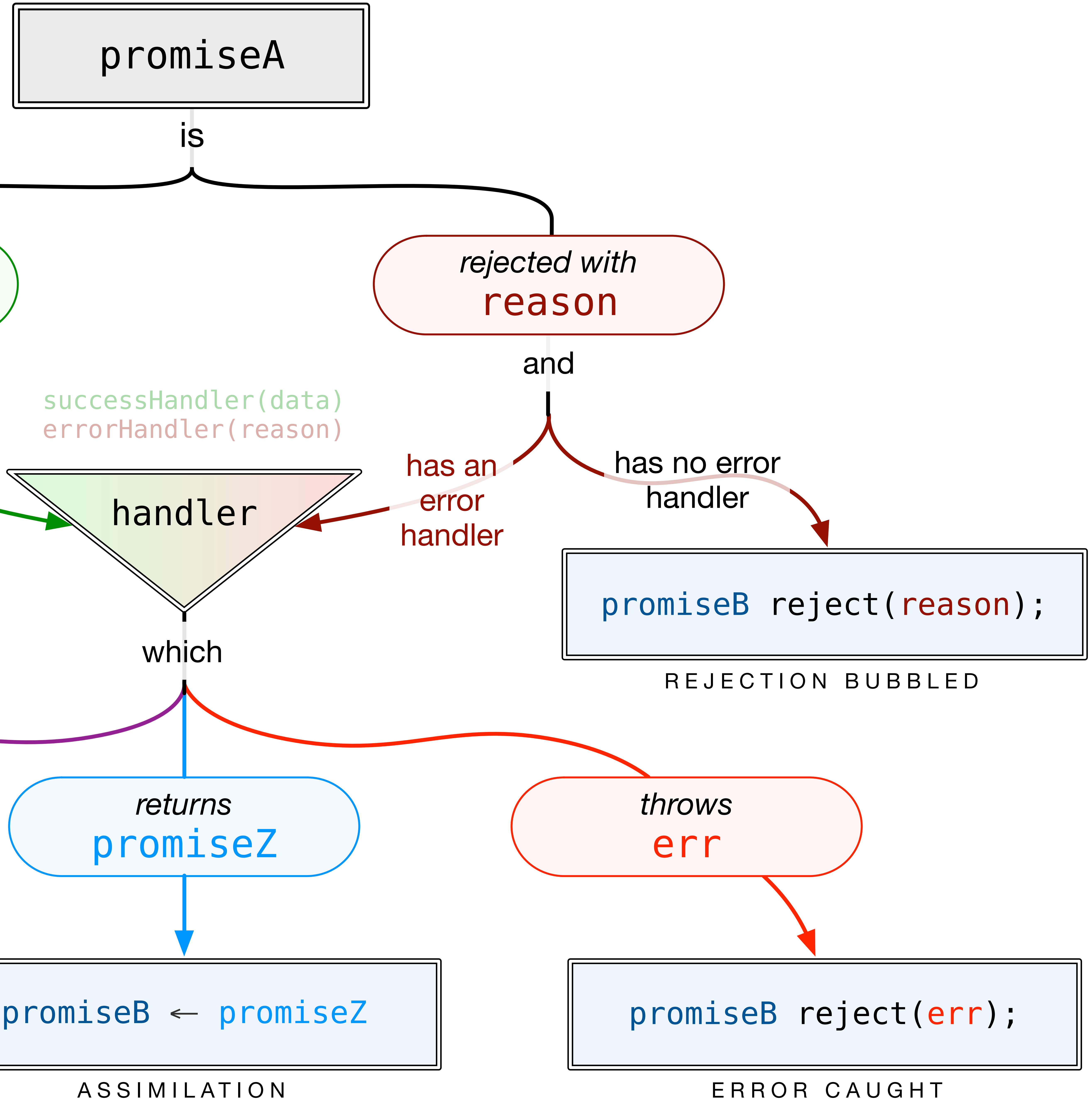




```
function logYell (input) {
  console.log(input+'!');
}

// promiseA rejected with ‘Sorry'

promiseA
  .then() // -> p1
  .then() // -> p2 and so on
  .then()
  .then(null, magenta);
```

Rejection bubbles down to the first available error handler.

Console log is “Sorry”.



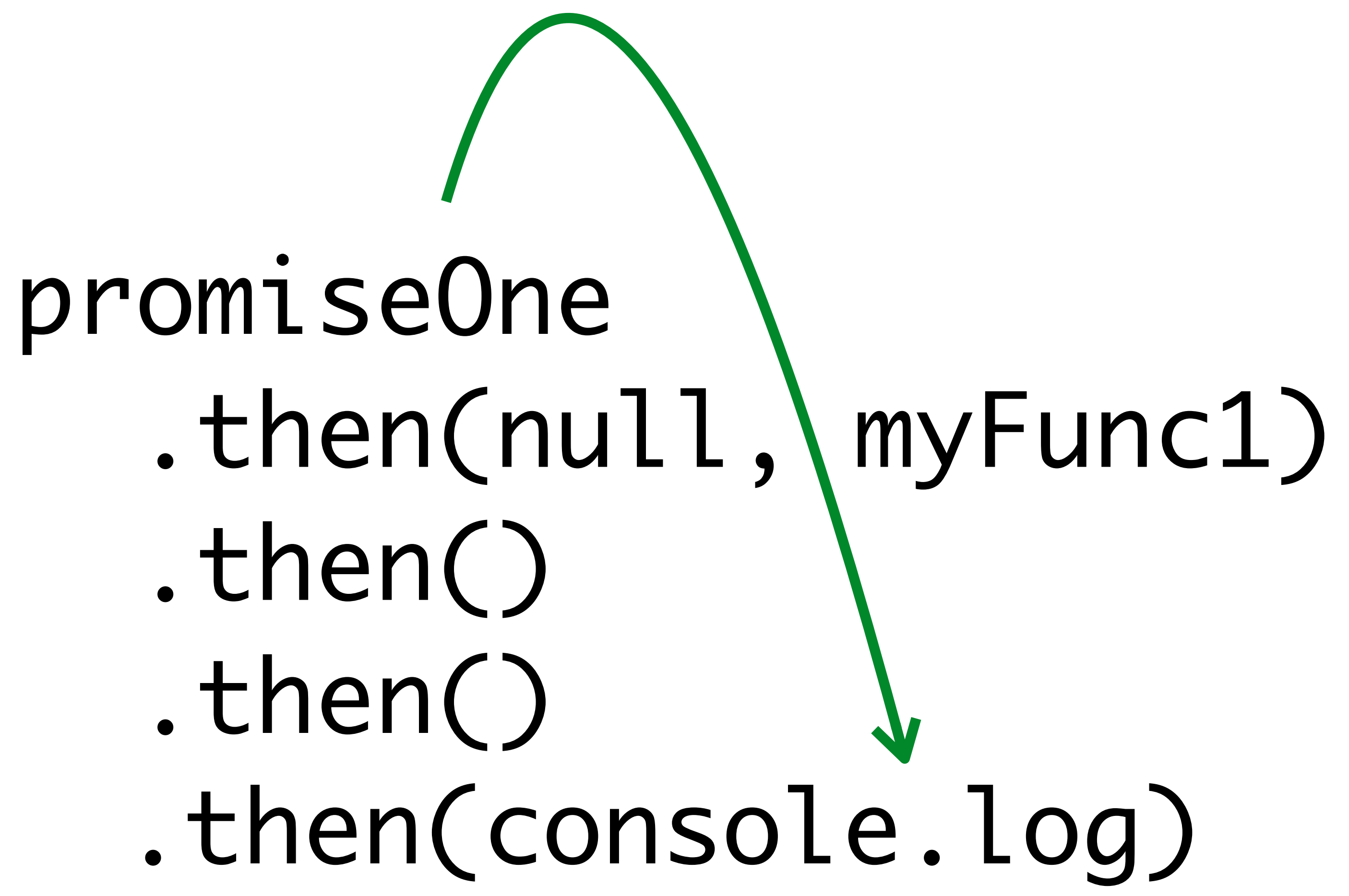
```
function logYell (input) {
  console.log(input+'!');
}

// promiseA rejected with ‘Sorry'

promiseA
  .then(boundLog)     // -> p1
  .then()             // -> p2
  .then(null, null)   // -> p3
  .then(null, logYell);
```

Again, rejection bubbles down to the first available **error** handler.

Console log is "Sorry!"

Review: Success & Error Bubbling

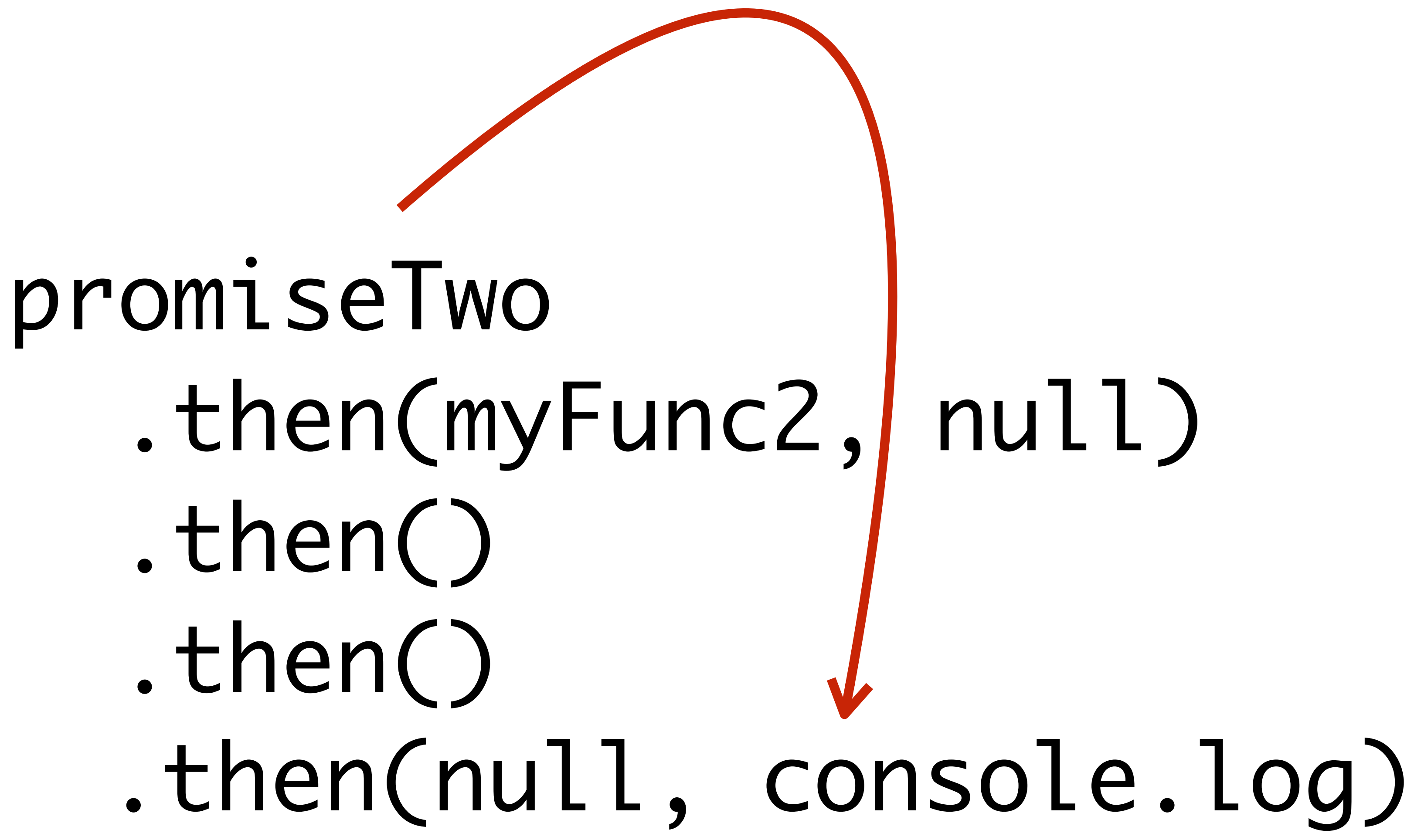
```
// promiseOne is fulfilled
with ‘hello’
```



```
promiseOne
  .then(null, myFunc1)
  .then()
  .then()
  .then(console.log)
```

```
// result: console shows
‘hello’
// fulfilled value bubbled
to success handler
```

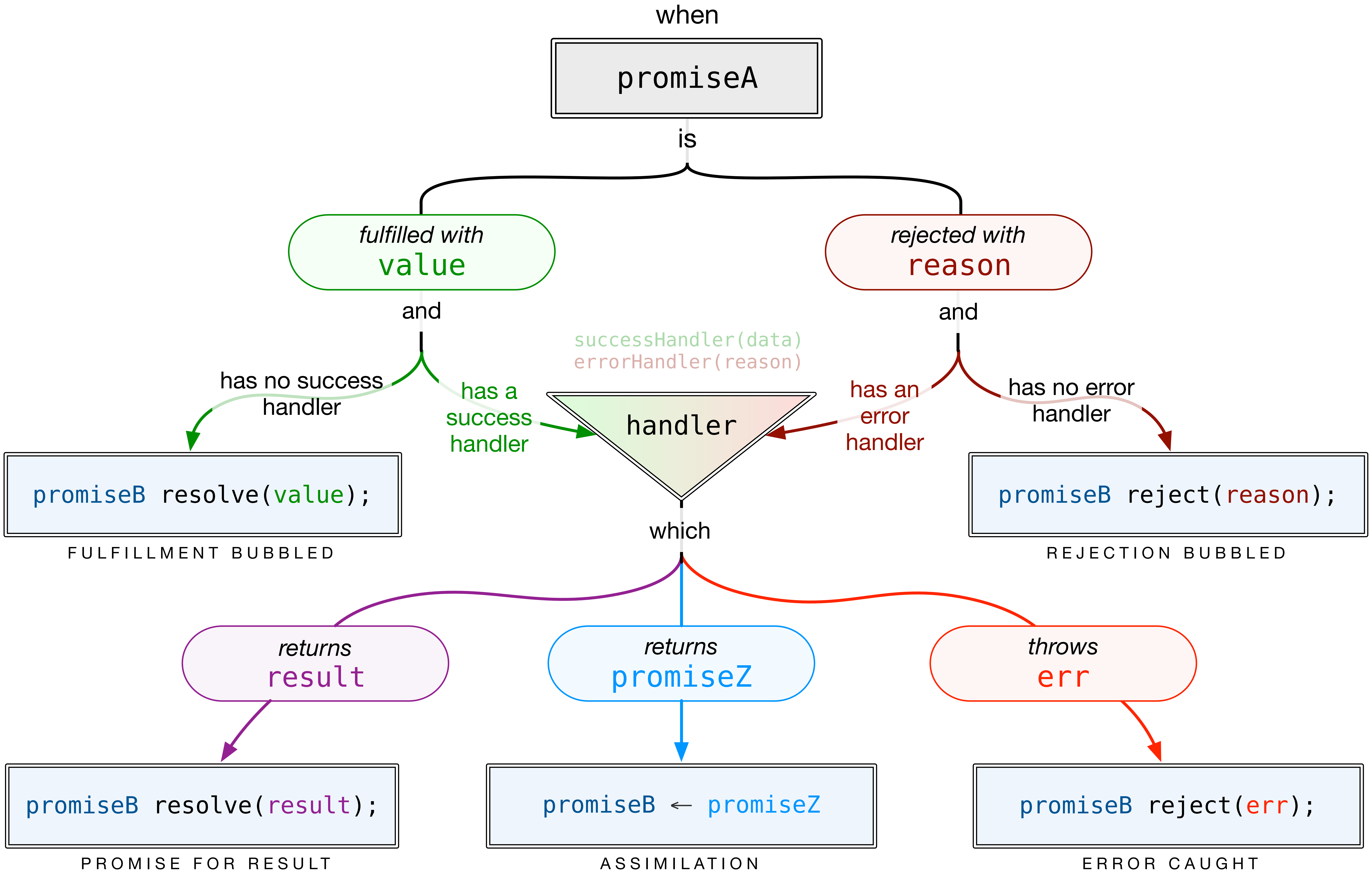
```
// promiseTwo is rejected
with ‘bad request’
```



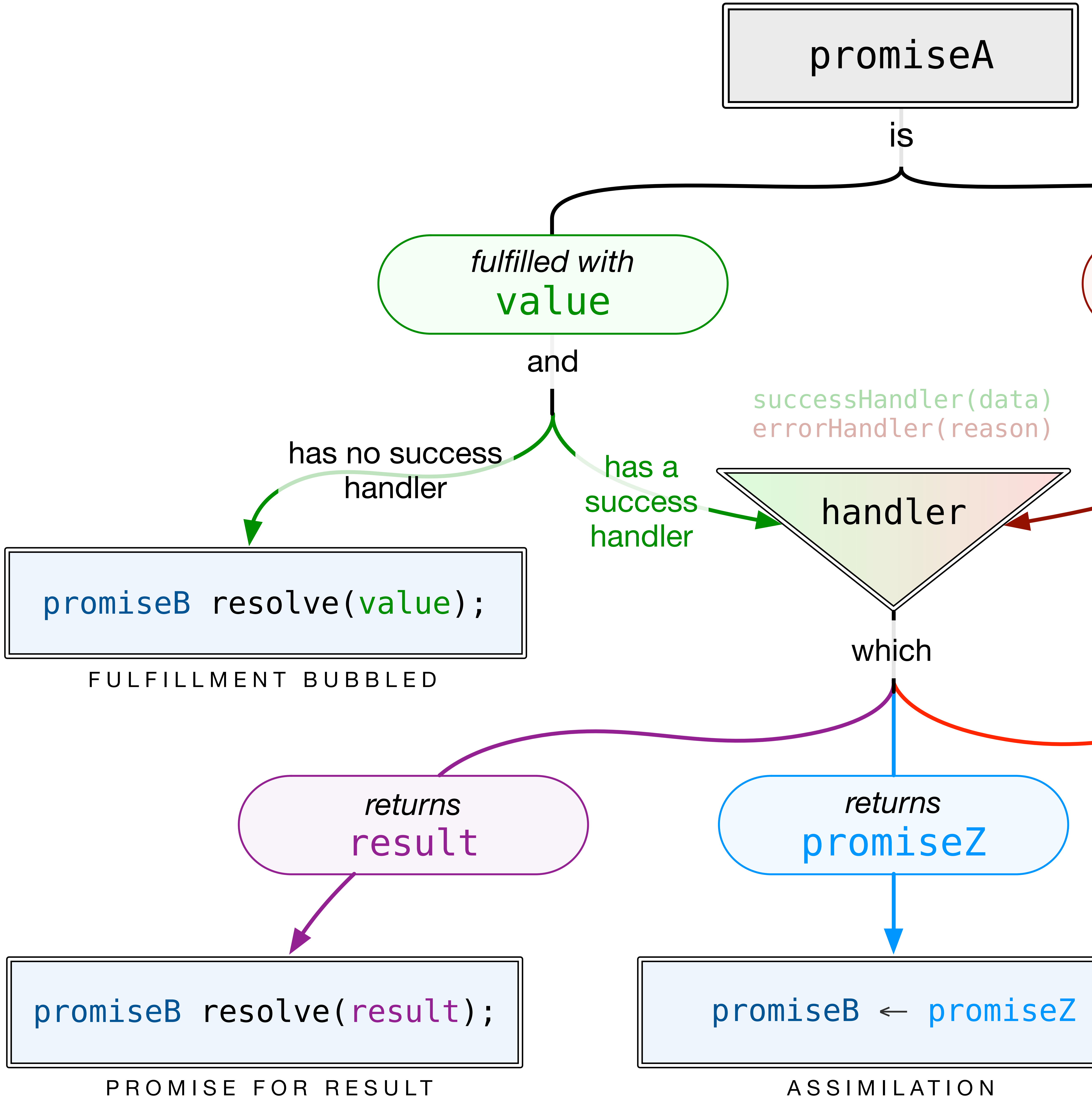
```
promiseTwo
  .then(myFunc2, null)
  .then()
  .then()
  .then(null, console.log)
```

```
// result: console shows
‘bad request’
// rejection bubbled to
error handler
```

```
promiseB = promiseA.then( [successHandler], [errorHandler] );
```



```
promiseA
  .then(function(valueOne){
    // do some code to make valueTwo
    return valueTwo
  })
  .then(function(valueTwo){
    console.log(valueTwo)
  })
```



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PROMISE FOR RESULT

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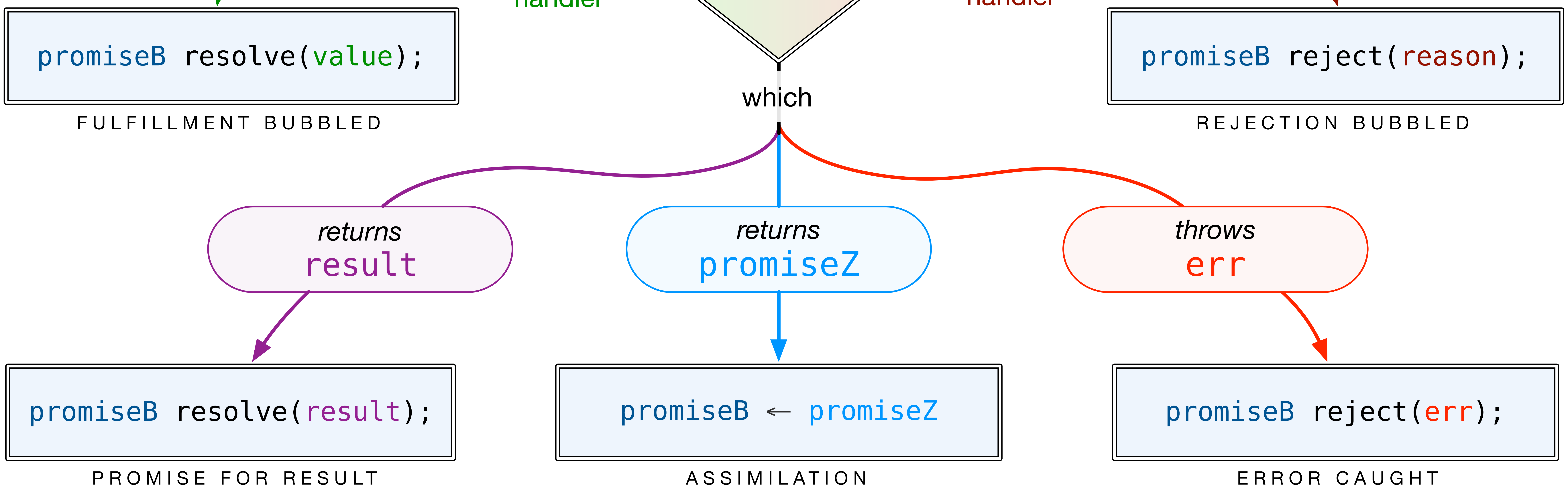

```
promiseA
  .then(function(valueOne){
    // do some code to make a
    // totally new promise,
    return someTotallyNewPromise
  })
  .then(function(someValue){
    console.log(someValue)
  })
```

Review: Returning from Handler

```
// with a value

promiseOne
  .then(function(valueOne){
    // do some code to make valueTwo
    return valueTwo
  })
  .then(function(valueTwo){
    console.log(valueTwo)
  })
```

```
// with a promise

promiseTwo
  .then(function(valueOne){
    // do some code to make a
    // totally new promise,
    return someTotallyNewPromise
  })
  .then(function(someValue){
    console.log(someValue)
  })
```

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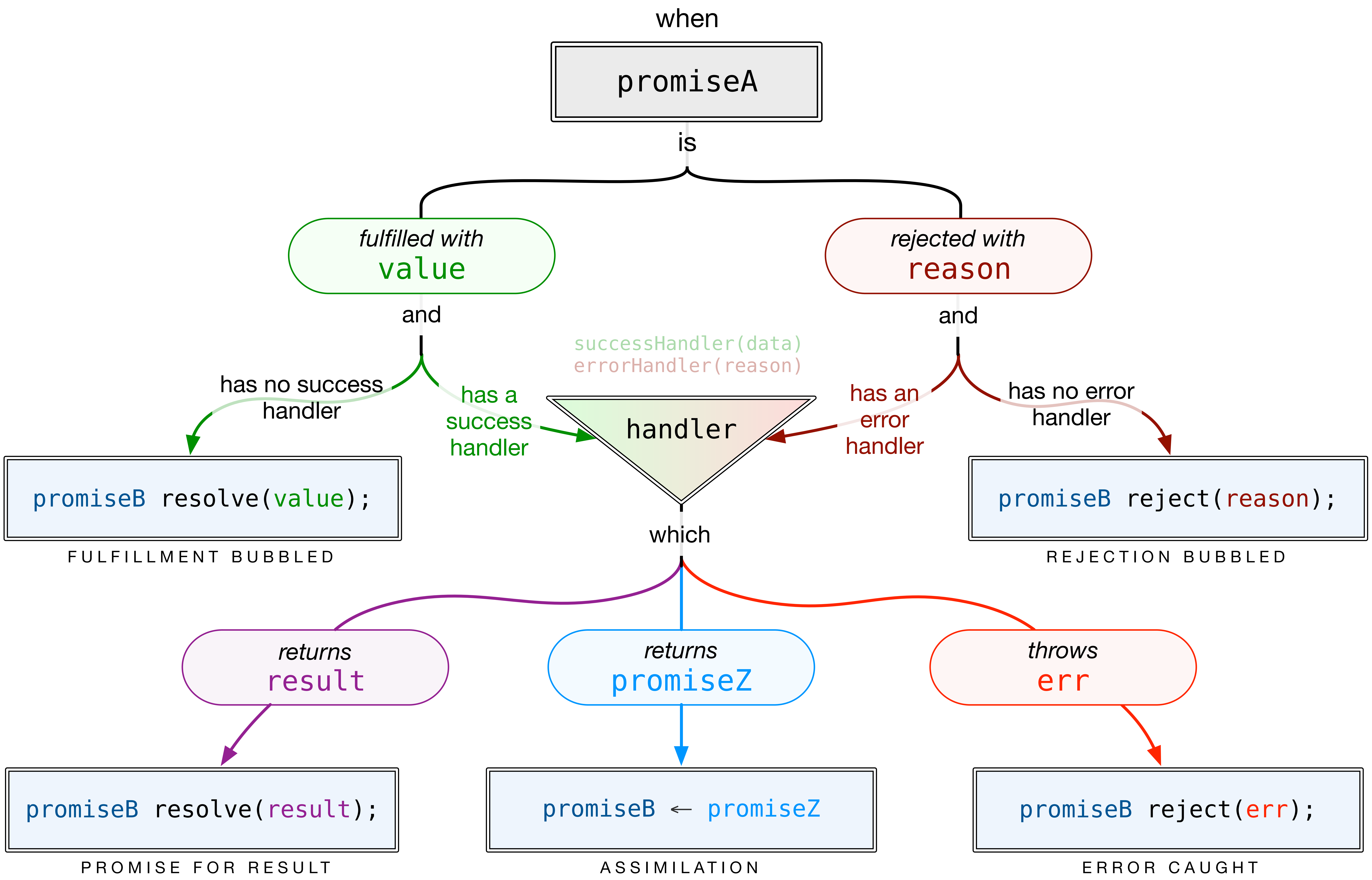
```
promiseB = promiseA.then( [successHandler], [errorHandler] );
```



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PROMISE FOR RESULT

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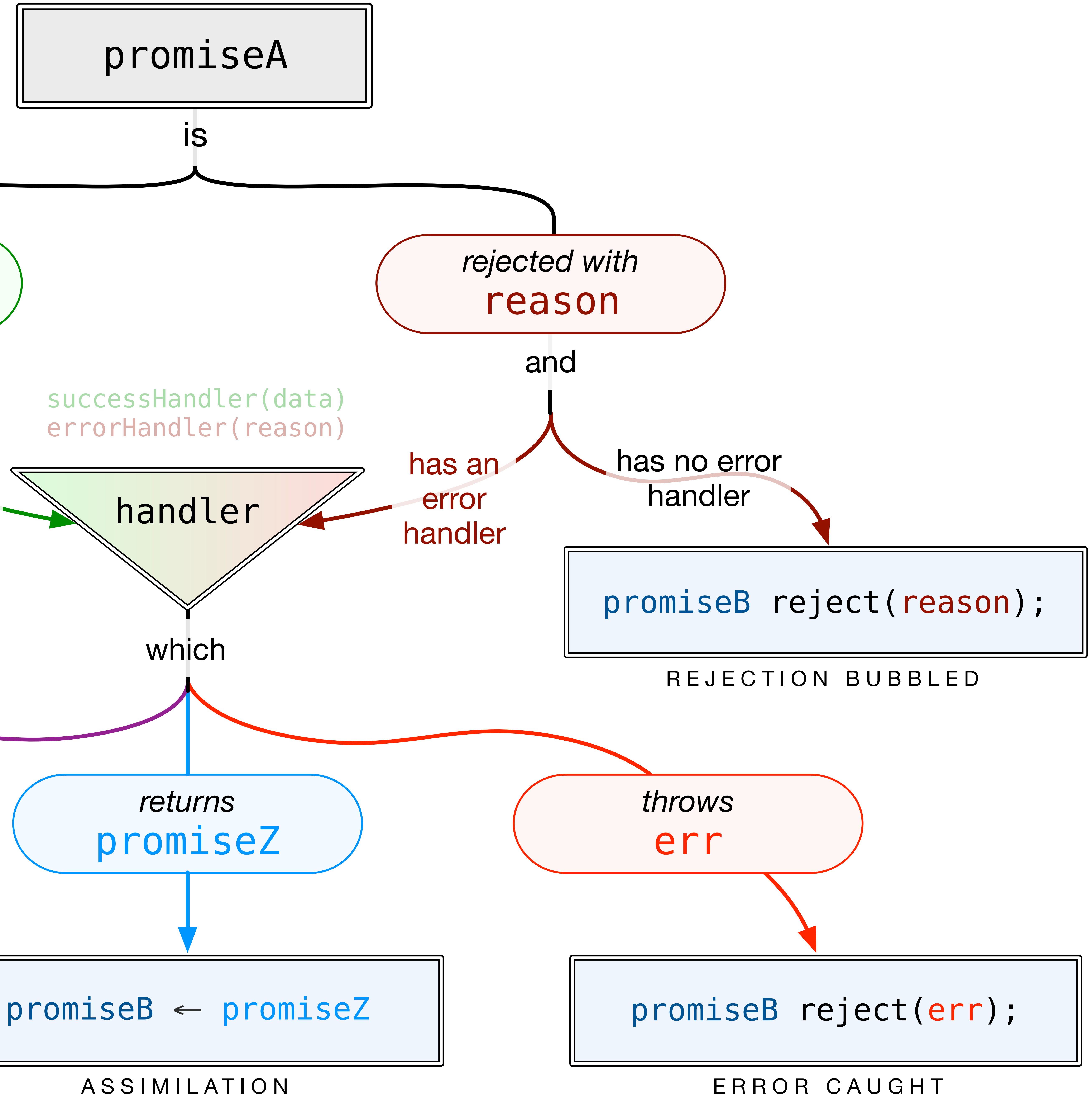
ERROR CAUGHT



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REJECTION BUBBLED

which

returns
promiseZ

throws
err

promiseB ← promiseZ

ASSIMILATION

promiseB reject(err);

ERROR CAUGHT

```
promiseA
  .then(function(valueOne){
    // OH NO! THROW AN ERROR, 404
    return valueOne
  })
  .then(null, function(err){
    console.error(err)
  })
```

that was .then

```
// array of API calls to make
const apiCalls = [
  '/api1/',
  '/api2/',
  '/api3/'
];
// map each url to a promise for its call result
apiCallPromises = apiCalls.map( function makeCall (url) {
  return $http.get(url).then( function got (response) {
    return response.data;
  });
});
// make a promise for an array of results once all arrive:
const thingsPromise = Promise.all( apiCallPromises );
// use it:
thingsPromise.then( function got (results) {
  results.forEach( function print (result) {
    console.log(result);
  });
});
```

Node.js promises: native & Bluebird

```
Promise // built-in
```

```
npm install bluebird --save

const bluebird = require('bluebird');
```

(some) Sequelize Promises

```
const usersPromise = User.find({where: {age: 30}});

const createdUserPromise = User.create({name: 'Gandalf'});

const savedUserPromise = gandalf.save();

const userIsDestroyedPromise = gandalf.destroy();

const usersPromise = sequelize.query('SELECT * FROM users',
{type: sequelize.queryTypes.SELECT});

const syncedPromise = sequelize.sync();
```

External Resources for Further Reading

- Kris Kowal & Domenic Denicola: Q (the library $q mimics; great examples & resources)
- The Promises/A+ Standard (with use patterns and an example implementation)
- We Have a Problem With Promises
- HTML5 Rocks: Promises (deep walkthrough with use patterns)
- DailyJS: Javascript Promises in Wicked Detail (build an ES6-style implementation)
- MDN: ES6 Promises (upcoming native functions)
- Promise Nuggets (use patterns)
- Promise Anti-Patterns

I Will Be Able To…

- Explain the behaviour of promises under multiple conditions (e.g. chaining on same promise, chaining without a handler, returning a new promise)
- Build my own promise library