Mechanics of Promises

Understanding Javascript Promise Generation & Behavior

Async: continuation-passing

```
// Mongoose & Express
models.Page.findOne({_id: id}).exec(function(err, page){
  if (err) res.status(500).end();
  res.json(page);
});
```

Async: promise

```
// Mongoose & Express
models.Page.findOne({_id: id}).exec().then(
  function (page) { res.json(page); },
  function (err)  { res.status(500).end(); }
);
```

Why?

Async: promise

```
// Mongoose & Express
models.Page.findOne({_id: id}).exec().then(
  function (page) { res.json(page); },
  function (err)  { res.status(500).end(); }
);
```

Break free from the async call!

```
var promise = models.Page.findOne({_id: id}).exec();

// promise is portable - can move it around
promise.then(
  function (page) { res.json(page); },
  function (err)  { res.status(500).end(); }
);
```

Export to other modules...

```
var presidentPromise = models.User.findOne({ role: 'president' }).exec();
module.exports = presidentPromise;
```

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

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

...and much more

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

So, what is a promise?

"A promise represents the eventual result of an asynchronous operation."

— THE PROMISES/A+ SPEC


magic!
(no)
iHDWALLPAPERS.COM

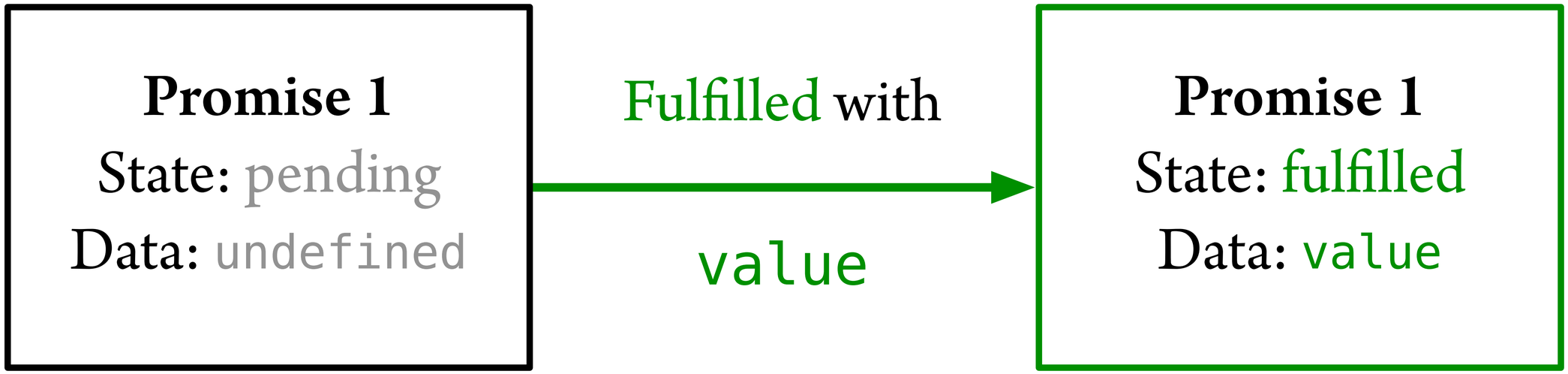
Promises are Objects

state (pending, fulfilled, or rejected)

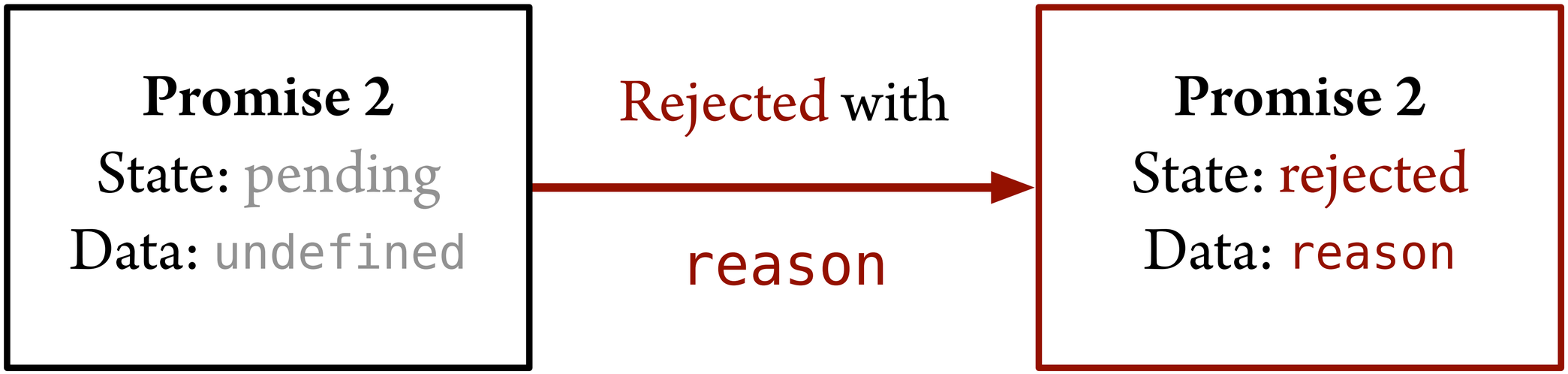
information (value or a reason)

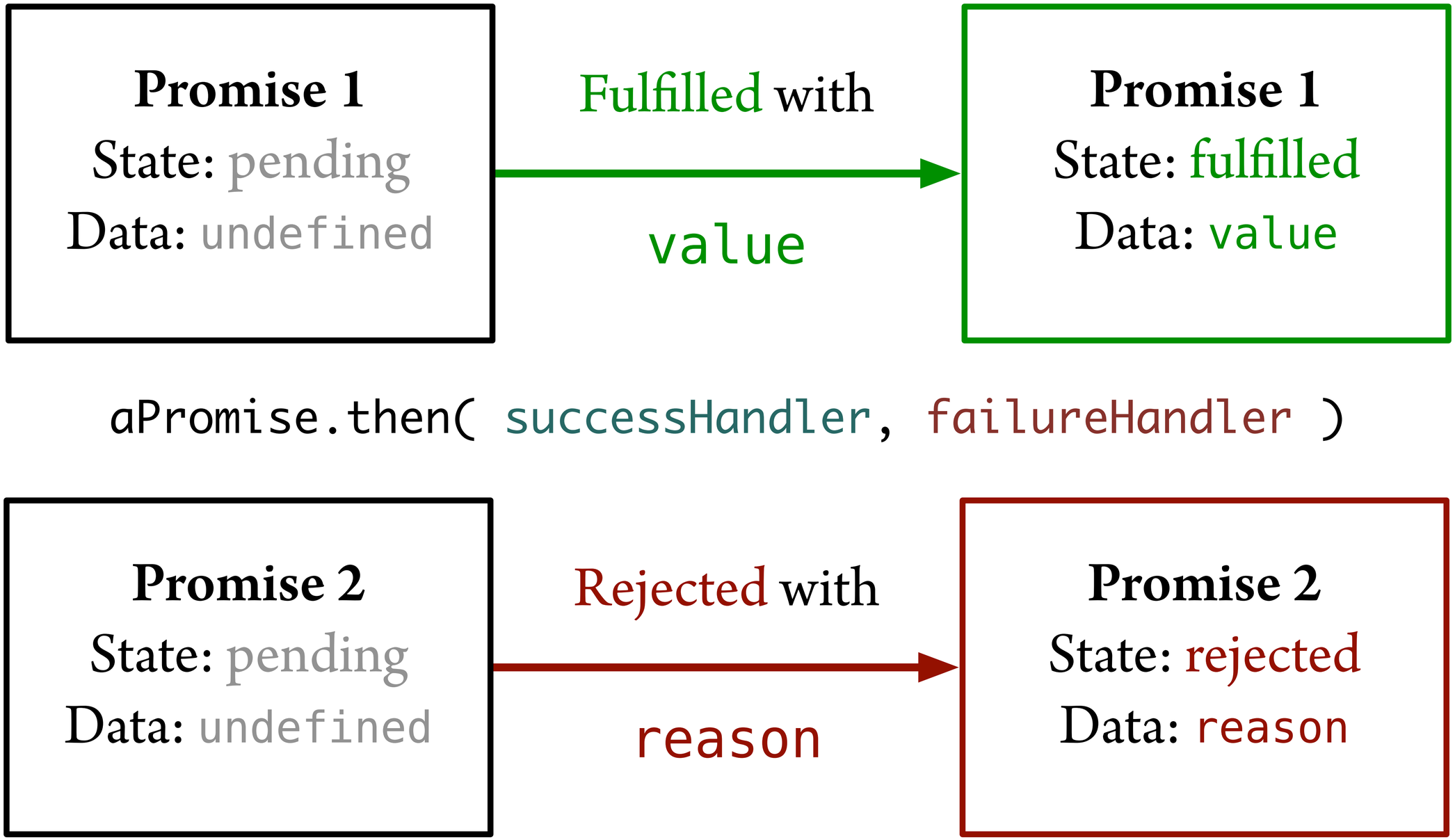
} (via closure)

.then() (property)



promises only change state while pending




Promise 1
State: pending
Data: undefined
Fulfilled with
value
Promise 1
State: fulfilled
Data: value
aPromise.then(successHandler, failureHandler)
Promise 2
State: pending
Data: undefined
Rejected with
reason
Promise 2
State: rejected
Data: reason

Timing-ambivalent

- 1. *Add handler*
  2. **promise settles**
  3. handler is called once
- 1. **Promise settles**
  2. *add handler*
  3. handler is called once
- Can attach handlers at multiple times (different modules even)

```
userPromise.then(welcomeUser);
```

```
userPromise.then(showCart);
```

What does this solve?

“The point of promises is to give us back functional composition and error bubbling in the async world.”

– DOMENIC DENICOLA, “YOU’RE MISSING THE POINT OF PROMISES”

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

var userID = 'a72jd3720h';
getUserData( userID, function got( userData ) {
  getMessage( userData.messageIDs[0], function got( message ) {
    getComments( message, function got( comments ) {
      console.log( comments[0] );
    });
  });
});
```

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

var userID = 'a72jd3720h';
getUserData( userID, function got( 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 got( 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);
  })
  .done();
```

Black Holes

you can literally not return from a typical async callback

```
// This will not work!

var person = asyncGetGroup( 123, function got( group ) {
  return group.users[0];
});
```

```
// This also will not work

var person;
asyncGetGroup( 123, function got( group ) {
  person = group.users[0];
});

// somewhere else
var headline = person.name; // might be undefined!
```

```
// Fantasy solution

var containerA = new Container();
asyncGetData( function got( data ) {
  containerA.save( data ); // once async completes
});

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

That's a promise

Complex landscape… but standardized

- Multiple proposed standards · CommonJS
- One leading standard · Promises/A+
- Upcoming native ES6 promises (already working in some browsers)

- Two different approaches for generating new promises
  - CommonJS-style *deferrals* (one extra entity)
  - ES6-style *constructors* (simplified)

- jQuery gurus beware! `$.Deferred` differs from current standards and is considered flawed. See Kris Kowal's guide.

So where do real promises come from?

- **Existing libraries may return promises**
  - Angular `$http`
  - Mongoose `.exec()`
- **Wrap async calls in promise-makers**
  - Q / `$q` *deferral*
  - ES6 / `Bluebird` *constructor*
- **Promise libraries can wrap for us, e.g. in Node**
  - `Q.denodeify(fs.readFile)`
  - `Bluebird.promisifyAll(fs)`

Promisification in Node.js

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

```
var readFile = Q.denodeify( fs.readFile );
readFile('foo.txt', 'utf-8').then(function (text) {
  // use the text
});
```

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

Making Promises: Deferral? Constructor?

Constructor-style promise generation

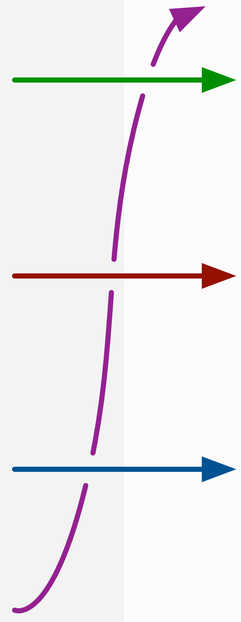
```
var myPromise = new Promise( function (resolve, reject) {
  someAsyncCall( function (err, data) {
    if (err) reject( err );
    else resolve( data );
  });
});

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

Deferral-style promise generation

```
var myDeferral = $q.defer();
someAsyncCall( function (err, data) {
  if (err) myDeferral.reject( err );
  else myDeferral.resolve( data );
});
var myPromise = myDeferral.promise;

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

A deferral controls its promise's state. Promises attach callbacks to an eventual value.

```
var myDeferral = $q.defer();

// async code that produces myData…
myDeferral.resolve( myData );


// …or instead produces myReason…
myDeferral.reject( myReason );


// …and meanwhile produces myInfo
myDeferral.notify( myInfo );


return myDeferral.promise
```



```
promiseForData.then(

  function handleSuccess( someData ) {
    // do stuff with someData
  },

  function handleError( someReason ) {
    // do stuff with someReason
  },

  function handleUpdate( someInfo ) {
    // do stuff with someInfo
  }

);
```

The async code can exist in a service…

…and return a promise for myData to a controller!

(Break)

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)`

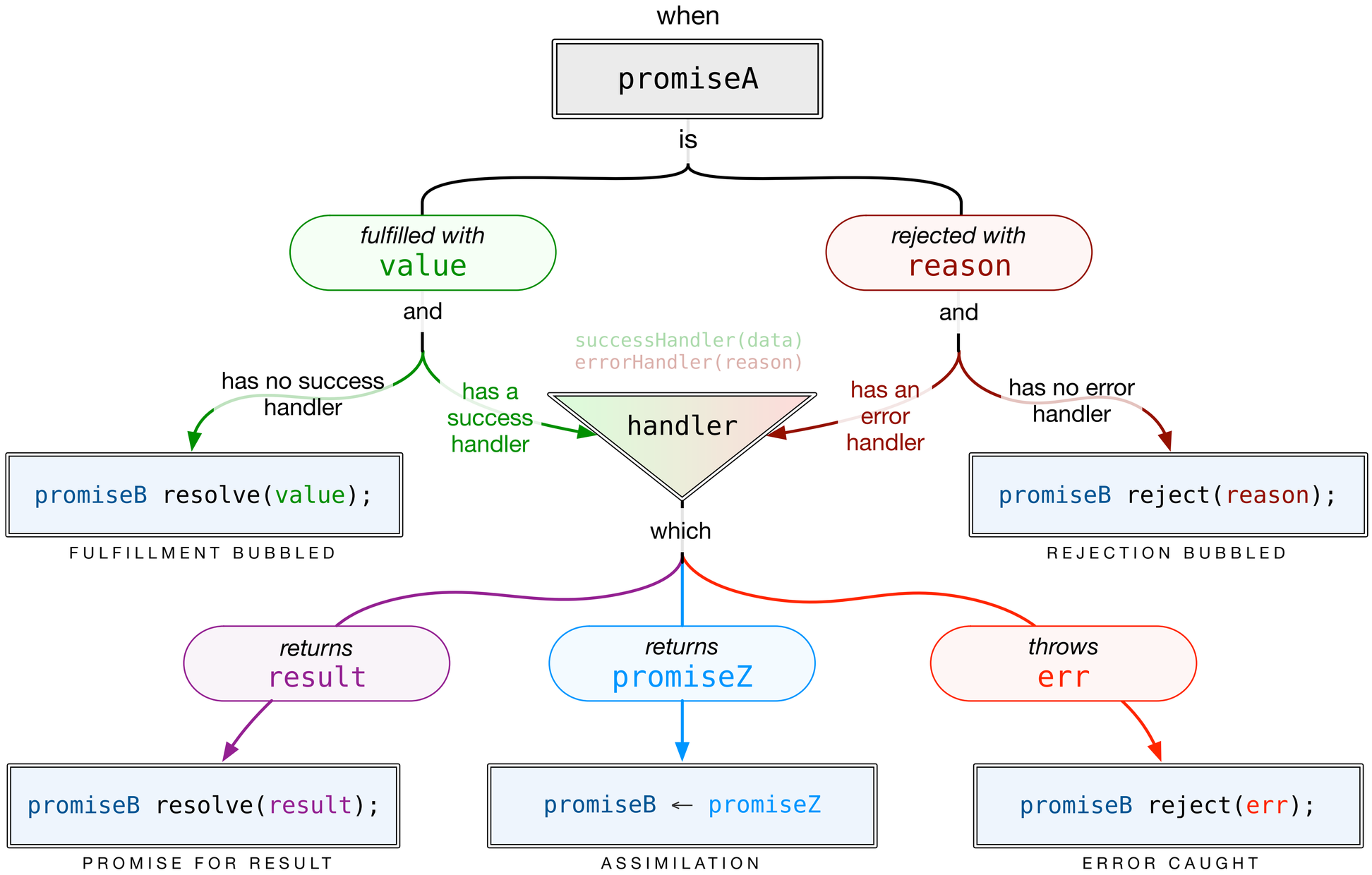
And why we can return from a handler

```
var promiseForThingB = promiseForThingA
  .then( function thingSuccess (thingA) {
    // run some code
    return thingB;
  })
```

What is promiseB a promise for?

Brace yourselves...

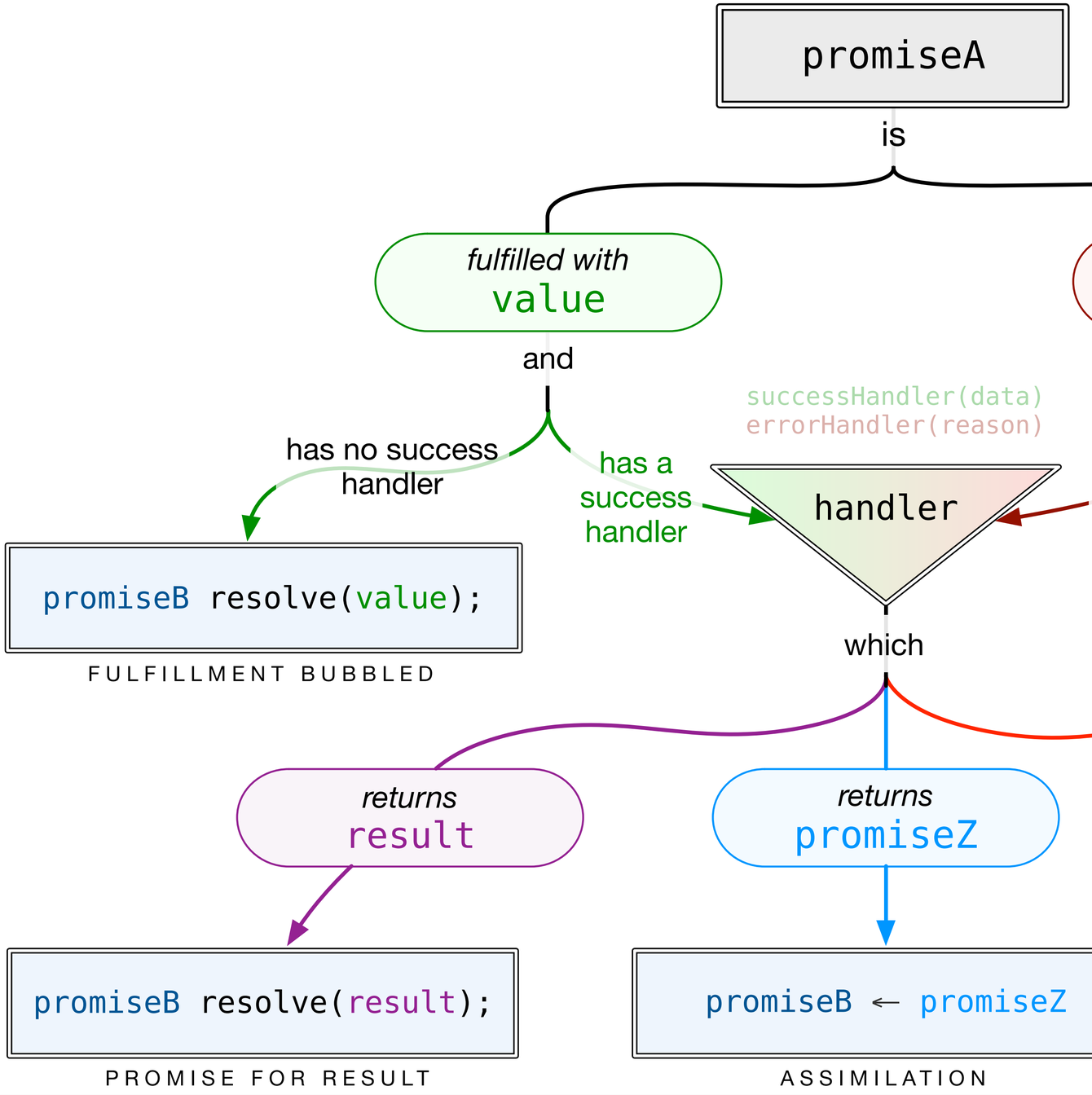
```
promiseB = promiseA.then( [successHandler], [errorHandler] );
```



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

promise0
   .then() // -> p1
   .then() // -> p2
   .then() // -> p3
   .then() // -> p4
   .then() // -> p5
   .then(console.log);
```

Fulfillment bubbled down to first available success handler:

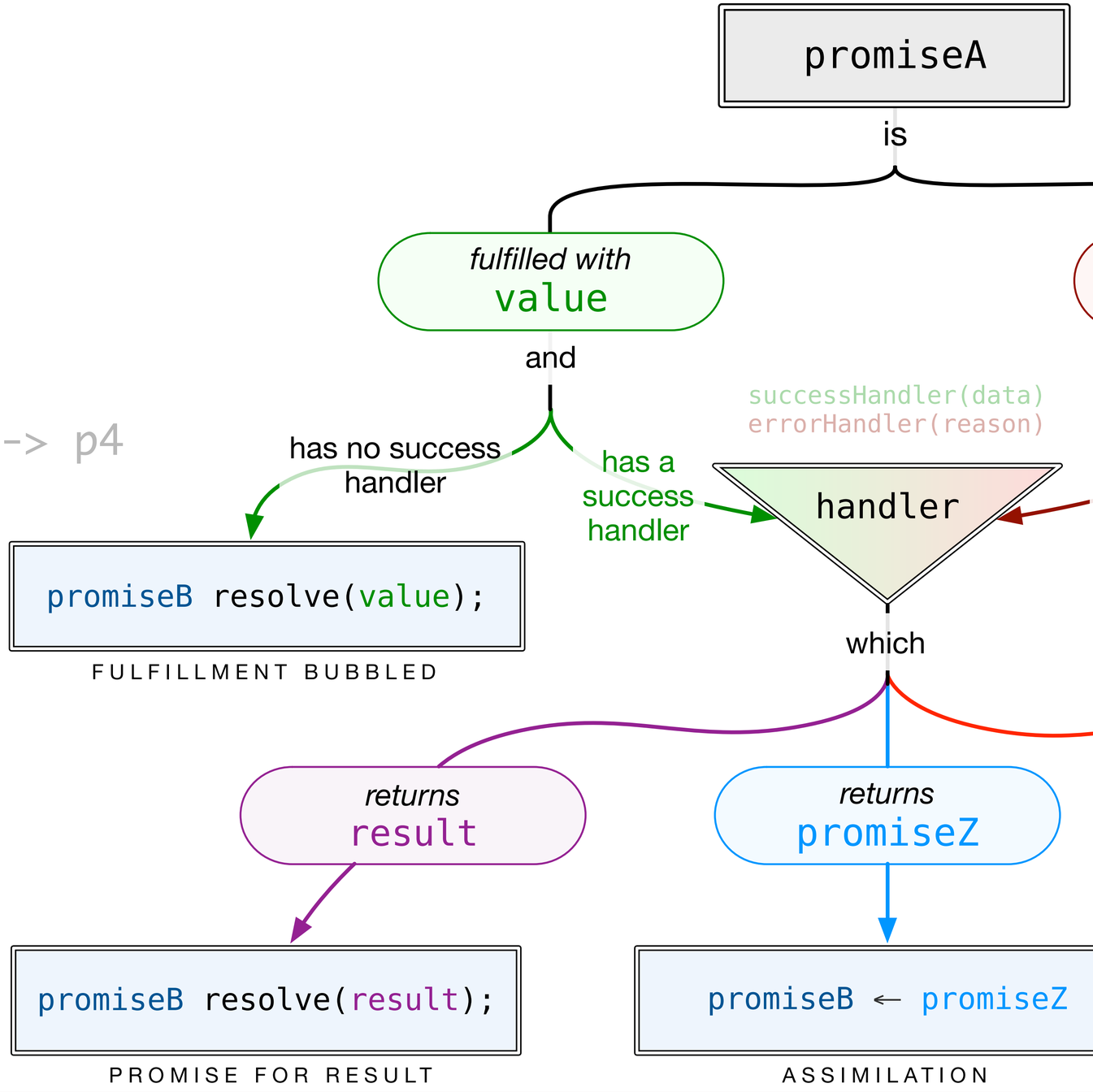
Console log reads “Hello.”

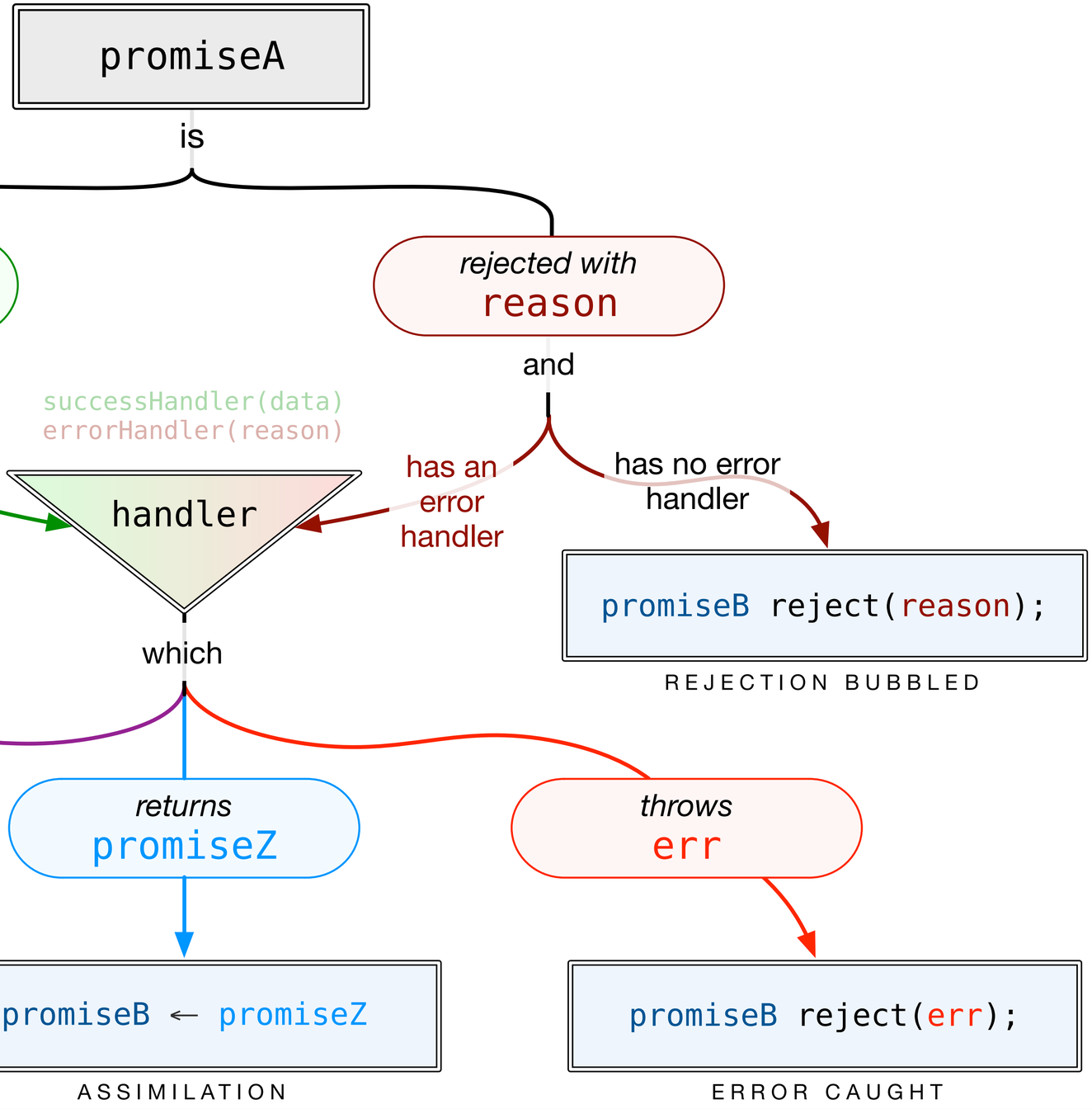


```
// promise0 fulfills with 'Hello.'

promise0
   .then(null, warnUser) // -> p1
   .then() // -> p2
   .then() // -> p3
   .then(null, null, setLoadBar) // -> p4
   .then() // -> p5
   .then(console.log);
```

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

Console log reads “Hello.”

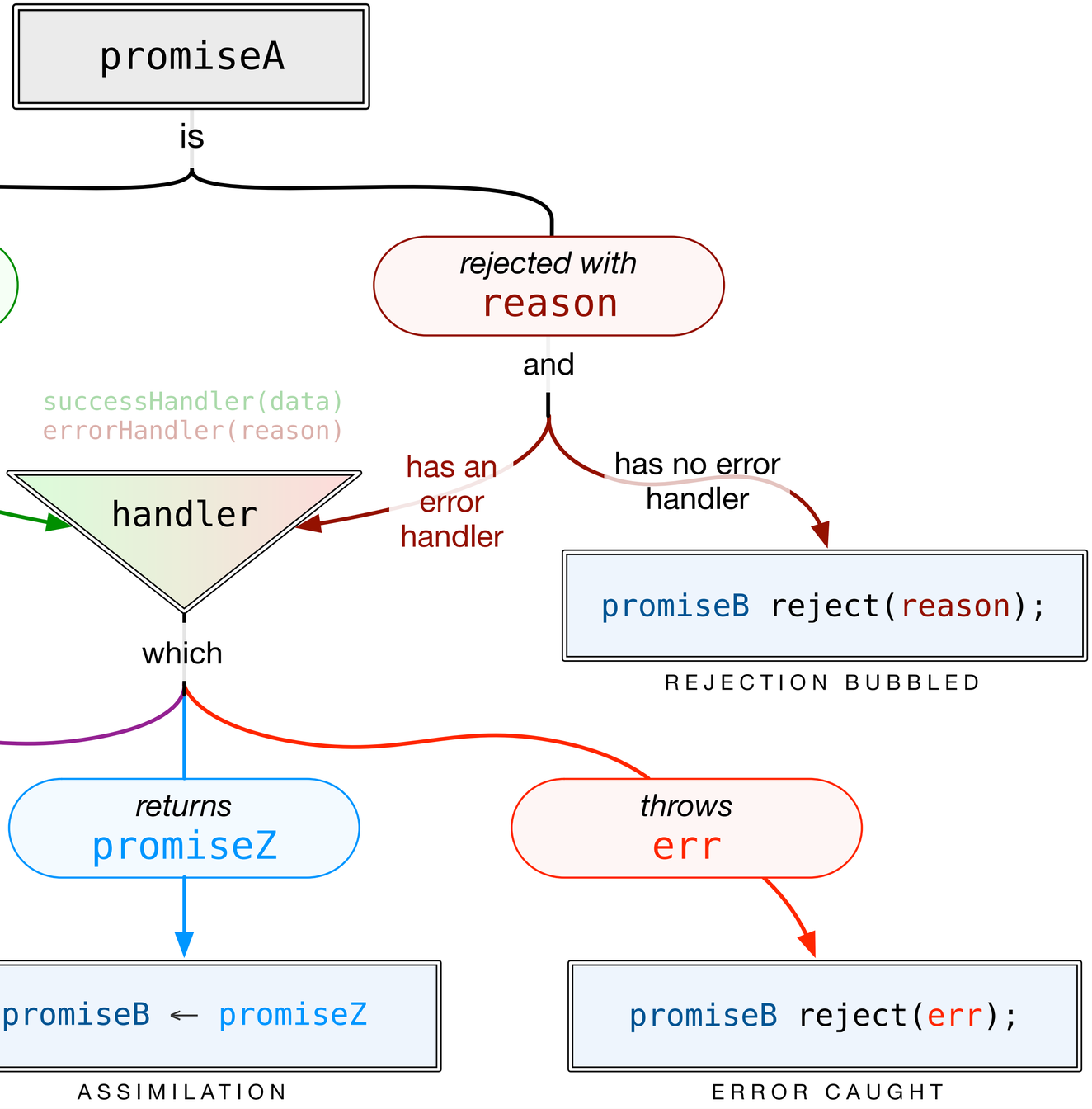





```
function logYell (input) {
  console.log(input+'!');
}

// promise0 rejected with 'Sorry'

promise0
  .then() // -> p1
  .then() // -> p2 and so on
  .then()
  .then(null, console.log);
```

Rejection bubbles down to the first available error handler.

Console log is “Sorry”.



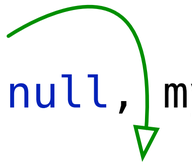

```
function logYell (input) {
  console.log(input+'!');
}

// promise0 rejected with ‘Sorry'

promise0
  .then(console.log) // -> p1
  .then() // -> p2 and so on
  .then(null, null, console.log)
  .then(null, logYell);
```

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

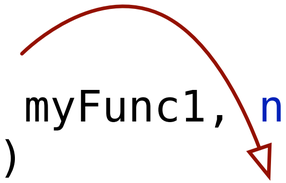
Console log is “Sorry!”

Review: Success & Error Bubbling

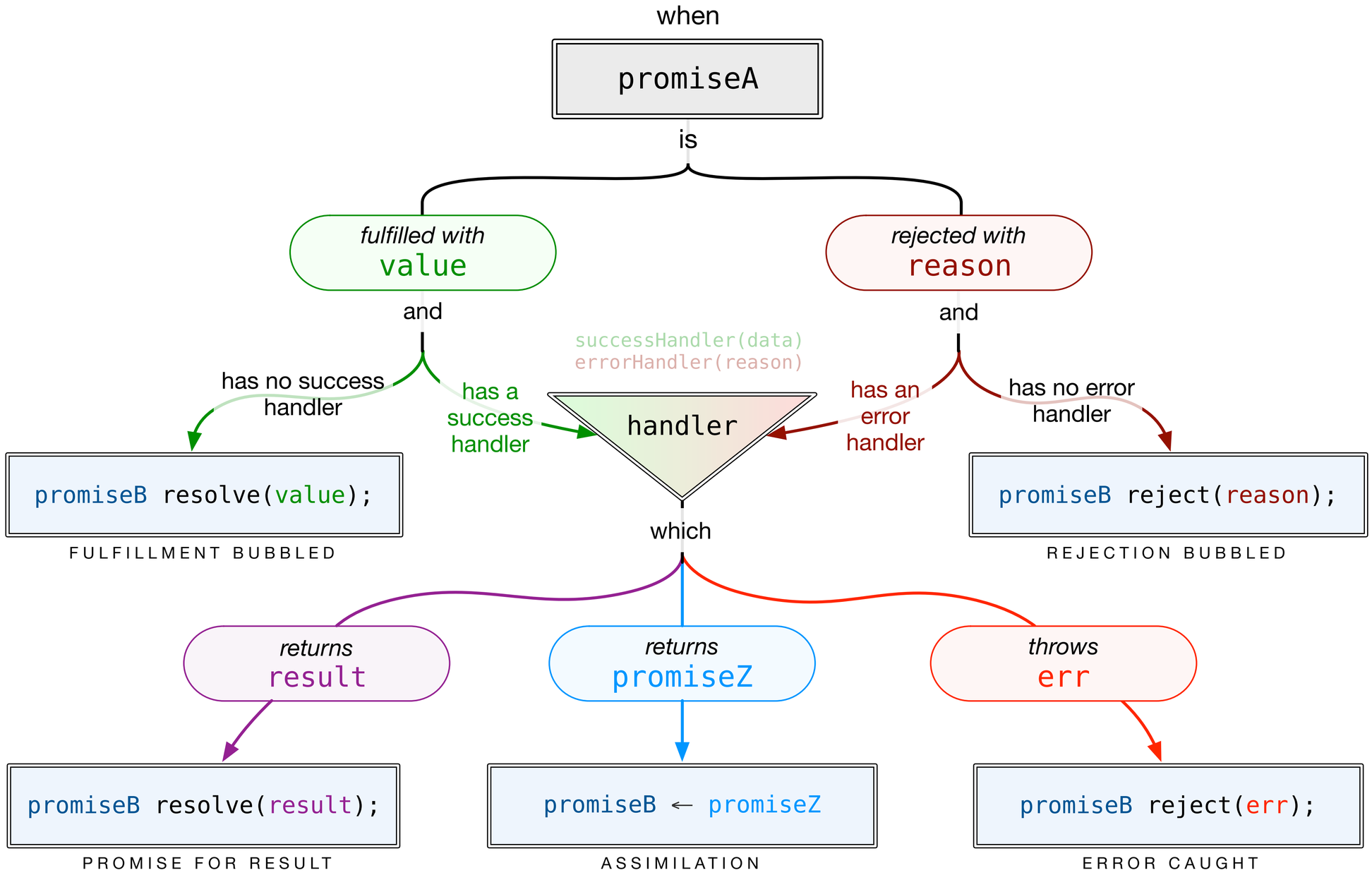
```
// promiseA is fulfilled with 'hello'

promiseA
  .then( null, myFunc1, myFunc2 )
  .then()
  .then( console.log );

// result: console shows 'hello'
// fulfill bubbled to success handler
```



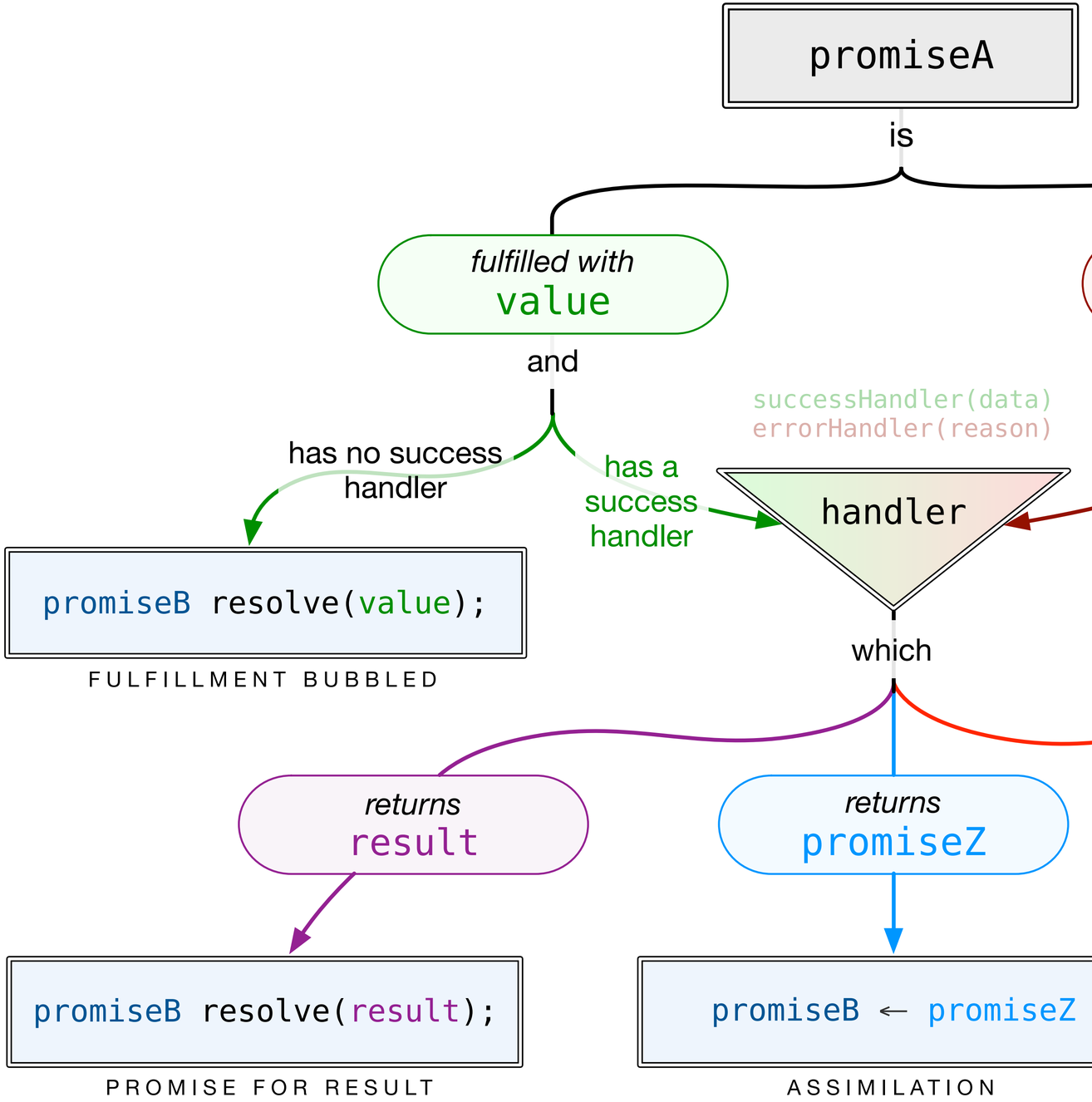
```
// promiseA is rejected with 'bad request'

promiseA
  .then( myFunc1, null, myFunc2 )
  .then()
  .then( null, console.log );

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



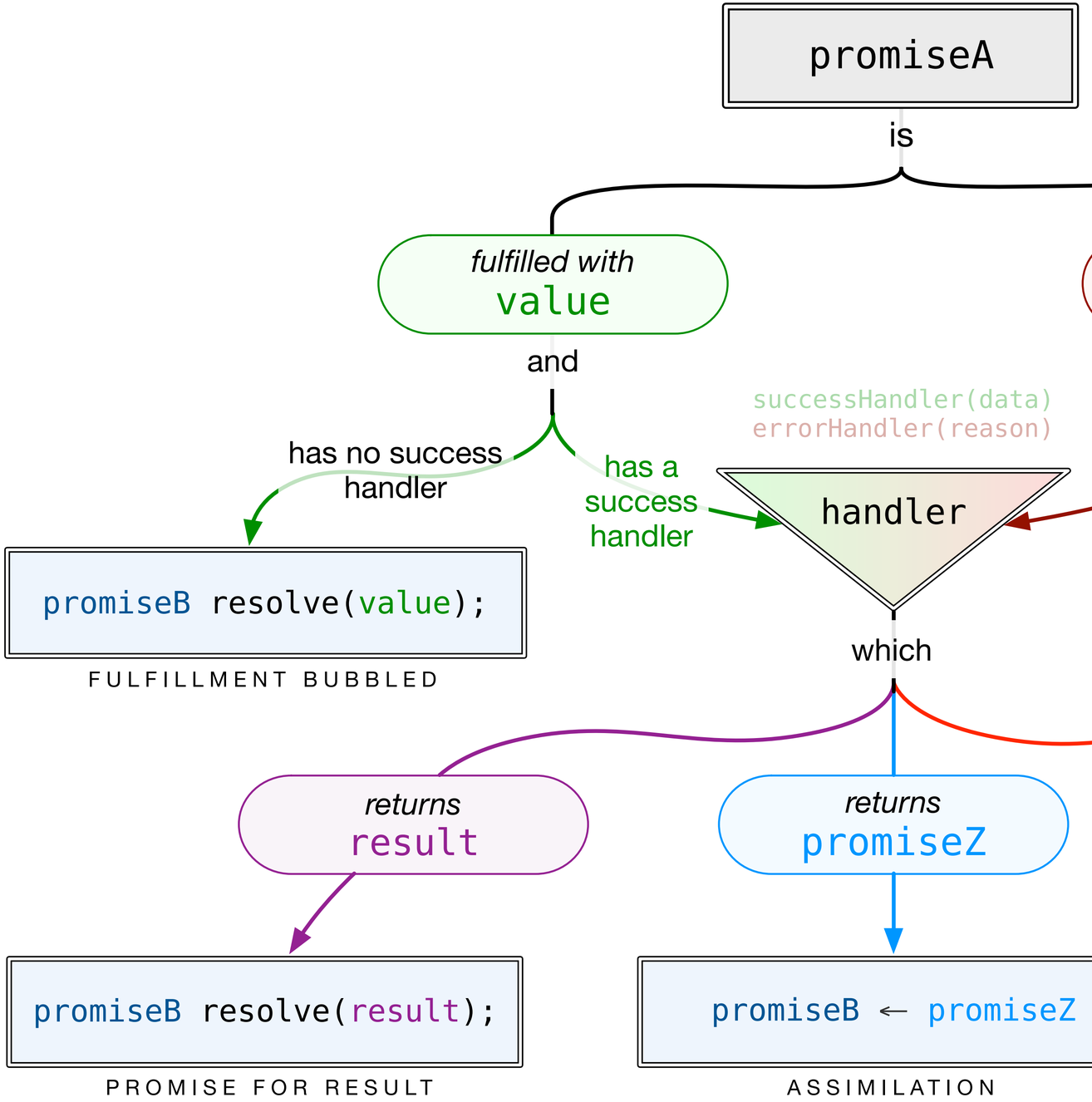
```
promiseB = promiseA.then( [successHandler], [errorHandler] );
```



```
// output promise is for returned val

promiseForVal2 = promiseForVal1
  .then( function success (val1) {
    val2 = ++val1;
    return val2;
  });

// same idea, shown in a direct chain:

promiseForVal1
  .then( function success (val1) {
    // do some code to make val2
    return val2;
  })
  .then( function success (val2) {
    console.log( val2 );
  });
```



```
// output promise “becomes” returned promise

promiseForMessages = promiseForUser
  .then( function success (user) {
    // do some code to get a new promise
    return promiseForMessages;
  });

// same idea, shown in a direct chain:

promiseForUser
  .then( function success (user) {
    // do some code to get a new promise
    return promiseForMessages;
  })
  .then( function success (messages) {
    console.log( messages );
  });
```

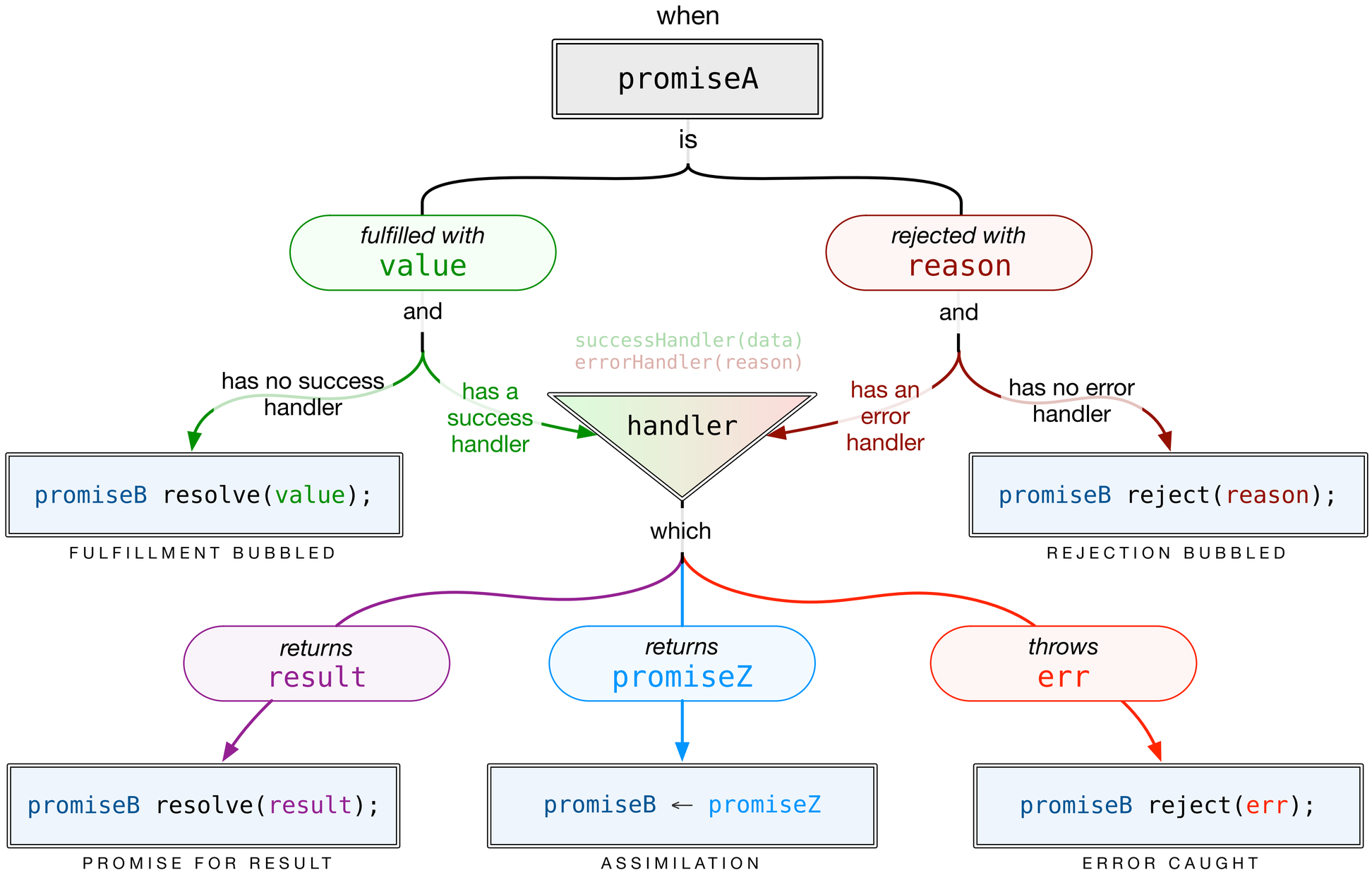


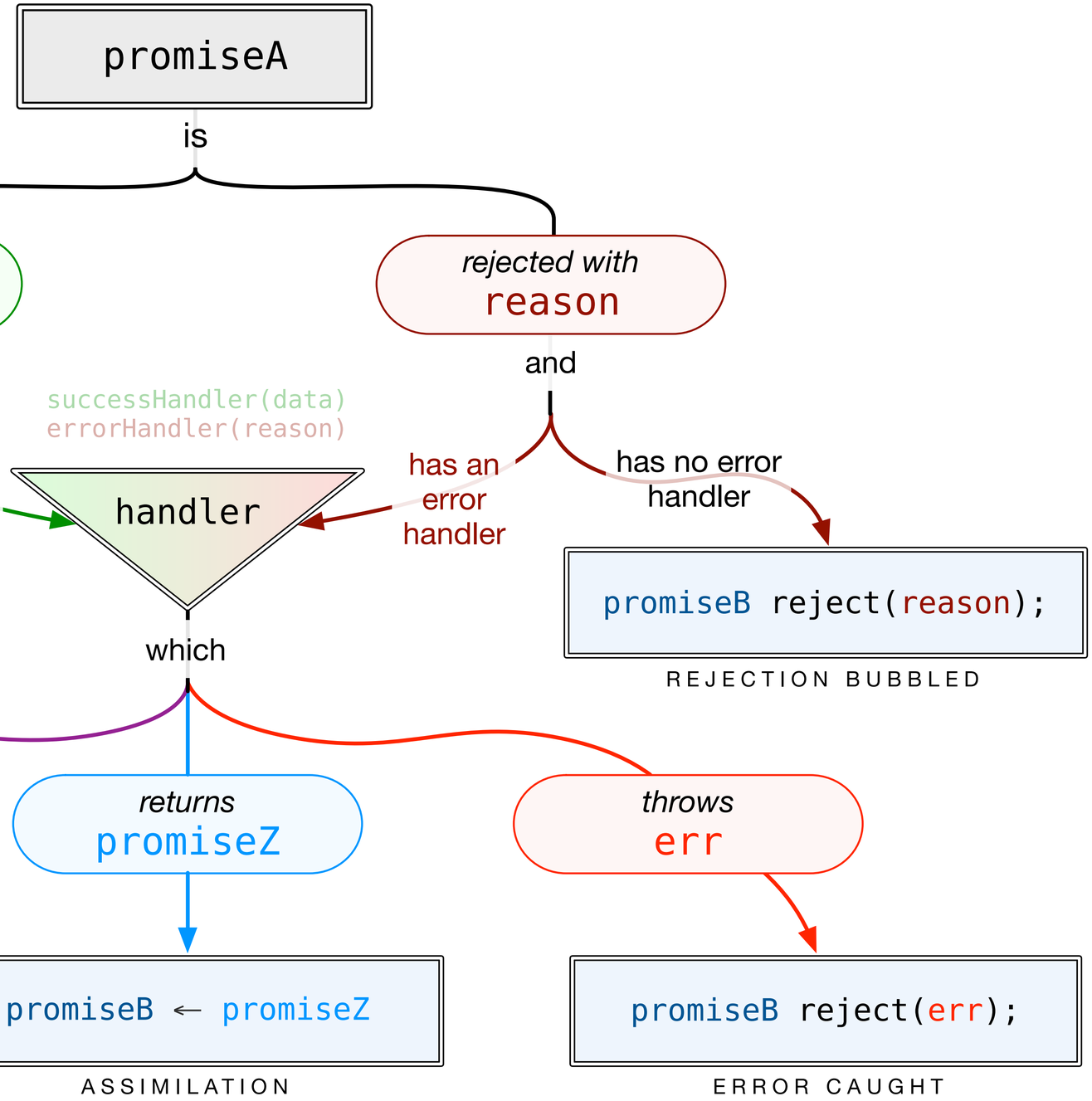
Review: Returning from Handler

```
// output promise is for returned val

promiseForVal2 = promiseForVal1
  .then( function success (val1) {
    val2 = ++val1;
    return val2;
  });

// same idea, shown in a direct chain:

promiseForVal1
  .then( function success (val1) {
    // do some code to make val2
    return val2;
  })
  .then( function success (val2) {
    console.log( val2 );
  });
```

```
// output promise "becomes" returned promise

promiseForMessages = promiseForUser
  .then( function success (user) {
    // do some code to get a new promise
    return promiseForMessages;
  });

// same idea, shown in a direct chain:

promiseForUser
  .then( function success (user) {
    // do some code to get a new promise
    return promiseForMessages;
  })
  .then( function success (messages) {
    console.log( messages );
  });
```

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






```
// output promise will be rejected with error

promiseForVal2 = promiseForVal1
  .then( function success (val1) {
    // THROWN ERROR '404' trying to make val2
    return val2;
  });

// same idea, shown in a direct chain:

promiseForVal1
  .then( function success (val1) {
    // THROWN ERROR '404' trying to make val2
    return val2;
  })
  .then( null, function failed (err) {
    console.log('Oops!', err);
  });
```

Danger: Silent Errors

```
myPromise
  .then(function (data) {
    use(data);
  })
  .catch(function (err) {
    doSomethingRiskyWith(err);
  })
  .done();
```

- Since .then (also .catch) always returns a new promise, it never throws an error, but instead rejects the outgoing promise
- Therefore, end promise chains in a .done or .finally, which do not export a new promise; any errors will be thrown as normal

that was .then

```
// array of API calls to make
var 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:
var thingsPromise = $q.all( apiCallPromises );
// use it:
thingsPromise.then( function got (results) {
  results.forEach( function print (result) {
    console.log(result);
  });
});
```

Extra: MEAN Promises

Node.js promise libraries: Q & Bluebird

```
npm install q --save

var Q = require('q');
```

```
npm install bluebird --save

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

Mongo (via Mongoose) Promises

```
var userPromise = User.find({ age: 30 }).exec();

var userPromise = User.create({ name: 'Gandalf' });

var userPromise = User.populate('friends');
```

Example: Mongoose findOrCreate

```
function findOrCreate(model, properties) {
  return model.findOne(properties).exec().then(function(instance){
    if (instance) return instance; // --> promise for found instance
    return model.create(properties); // --> promise for created instance
  });
}

findOrCreate(User, {role: 'president'}).then(
  function (president) { res.json(president); }
).catch(
  function (err) { res.status(404).json(err); }
);
```

AngularJS

- Uses many promises internally, via the $q service (based on Q)

```
var promiseForDate = $timeout(function(){
  return +new Date();
}, 1000);

var promiseForUser = $http.get('/users/1');
```

- You can inject $q to use its .all function or make new promises

```
angular.module('myApp').service('myService', function ($q) { … });
```

AngularJS $http: use .then, not .success

https://github.com/angular/angular.js/issues/10508

```
$http.get('/users/1')
  .success(function(data, status, heads, cfg) {
    // use data
  })
  .error(function(data, status, heads, cfg) {
    // handle it
  });
```

```
$http.get('/users/1')
  .then(function(response) {
    // use response.data
  })
  .catch(function(err) {
    // handle err
  });
```

Why? Because .success & .error both return the ORIGINAL PROMISE,
not a new promise based on return value!

External Resources for Further Reading

- AngularJS documentation for $q
- Kris Kowal & Domenic Denicola: Q (the library $q mimics; great examples & resources)
- The Promises/A+ Standard (with use patterns and an example implementation)
- HTML5 Rocks: Promises (deep walkthrough with use patterns)
- Xebia: Promises and Design Patterns in AngularJS
- AngularJS Corner: Using promises and $q to handle asynchronous calls
- DailyJS: Javascript Promises in Wicked Detail (build an ES6-style implementation)
- MDN: ES6 Promises (upcoming native functions)
- Promise Nuggets (use patterns)
- Promise Anti-Patterns
- AngularJS / UI Router / Resolve