



Mechanics of Promises

Understanding JavaScript Promise Generation & Behavior



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

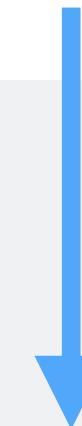
```
// Express & Sequelize!
Page.findOne({where: {name: 'Promises'}}).then(
  function (page) { res.json(page); },
  next
);
```

Why?



Async: promise

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





Break free from the async call!

```
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));
```

So, what is a promise?

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

— THE PROMISES/A+ SPEC

magic!
(no)

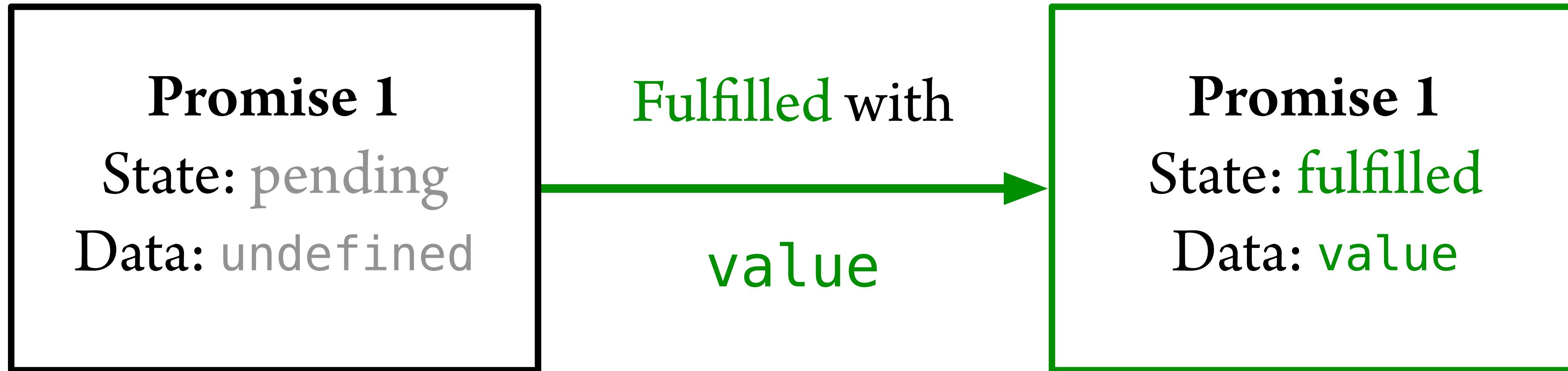
Promises are Objects

state (pending, fulfilled, or rejected)

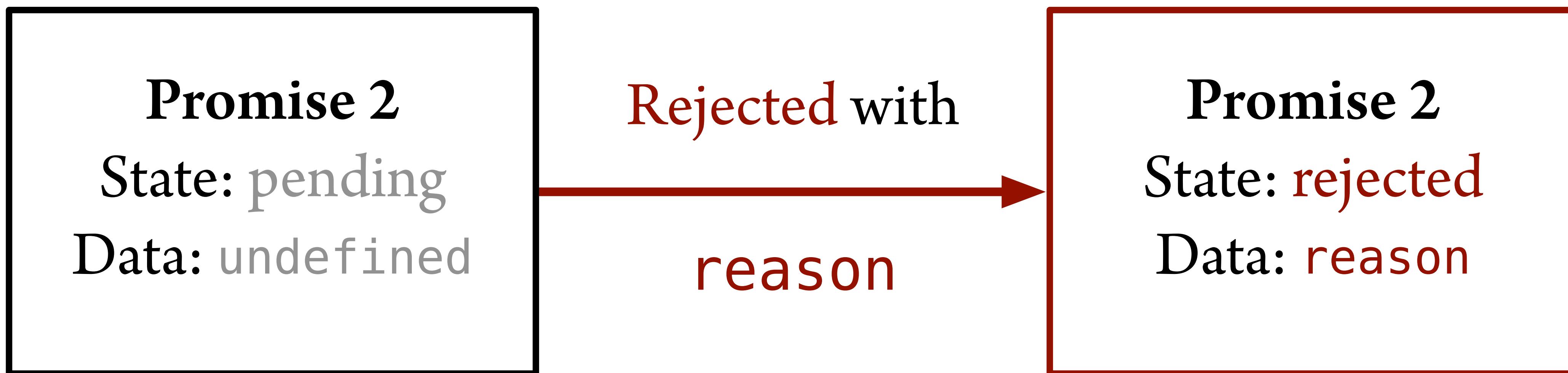
information (value or a reason)

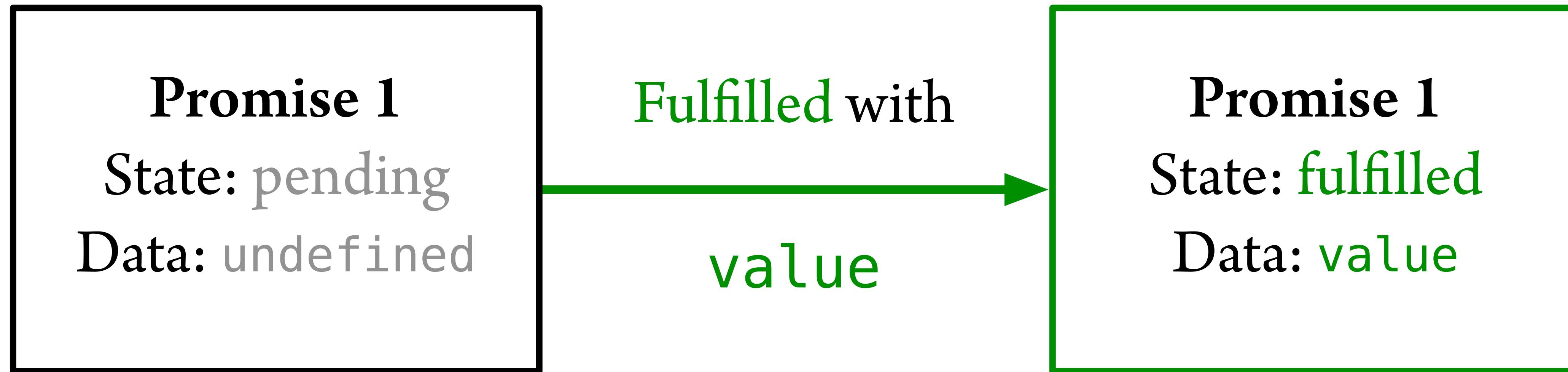
.then()

} (hidden if possible)
} (public property)

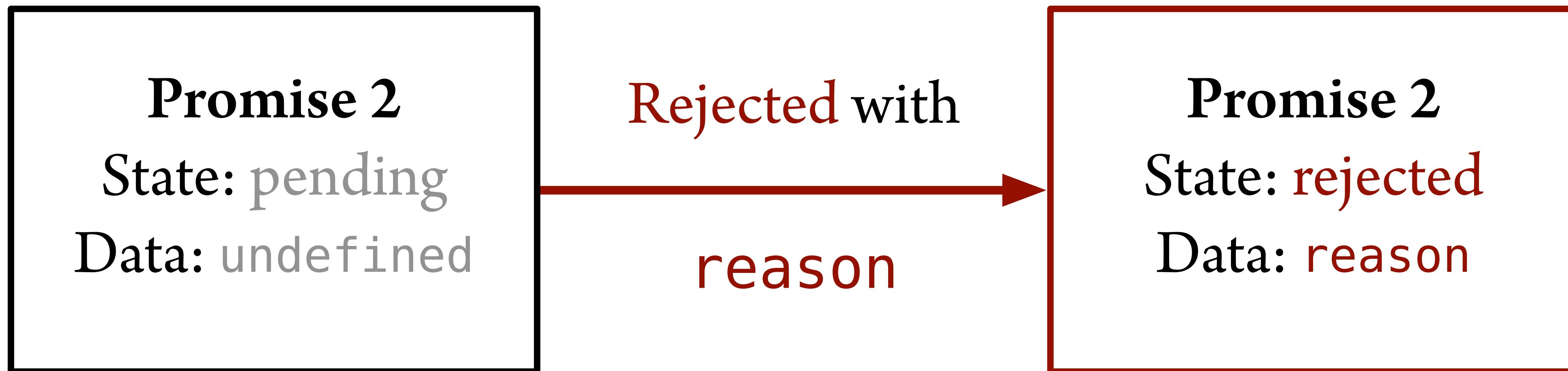


promises only change state while pending





`aPromise.then(successHandler, failureHandler)`



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

const 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

const 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);
});
```



Black Holes

you literally cannot return from a typical async callback

```
// This will not work!
```

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

```
// This also will not work

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

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

```
// Fantasy solution

const 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

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 P/A+

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 );
```



Minimal Examples of Promise Construction

```
const promiseFor123 = new Promise(resolve => {
  resolve( 123 );
});
```

```
const promiseFor000 = new Promise((resolve, reject) => {
  reject( 000 );
});
```



Promisification in Node.js

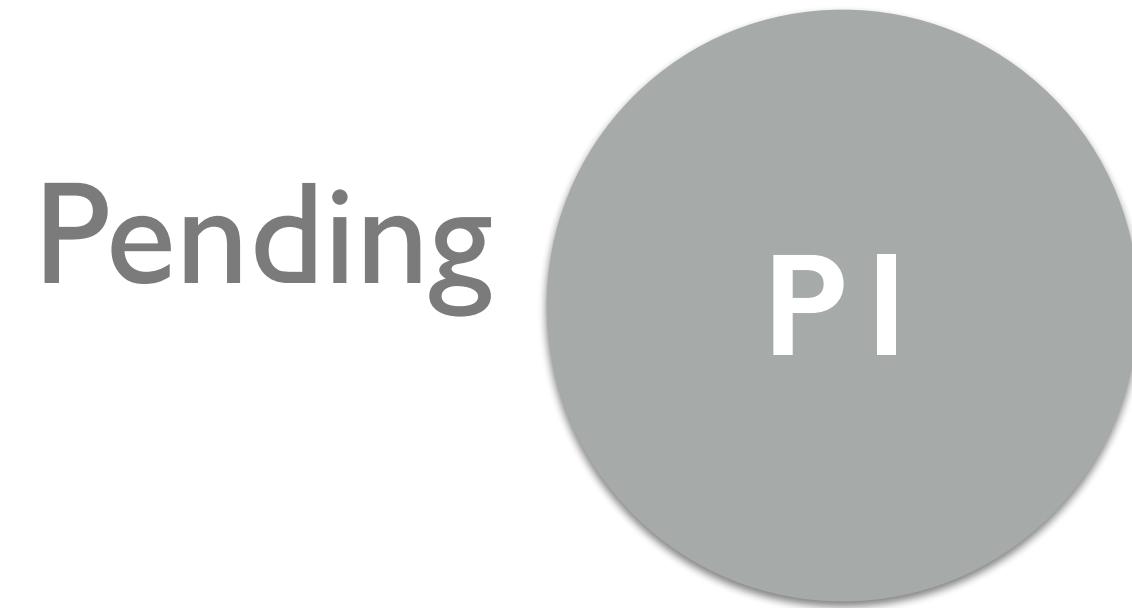
```
fs.readFile('foo.txt', 'utf-8', function (err, text) {  
  // use the text  
});
```

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

(Break)

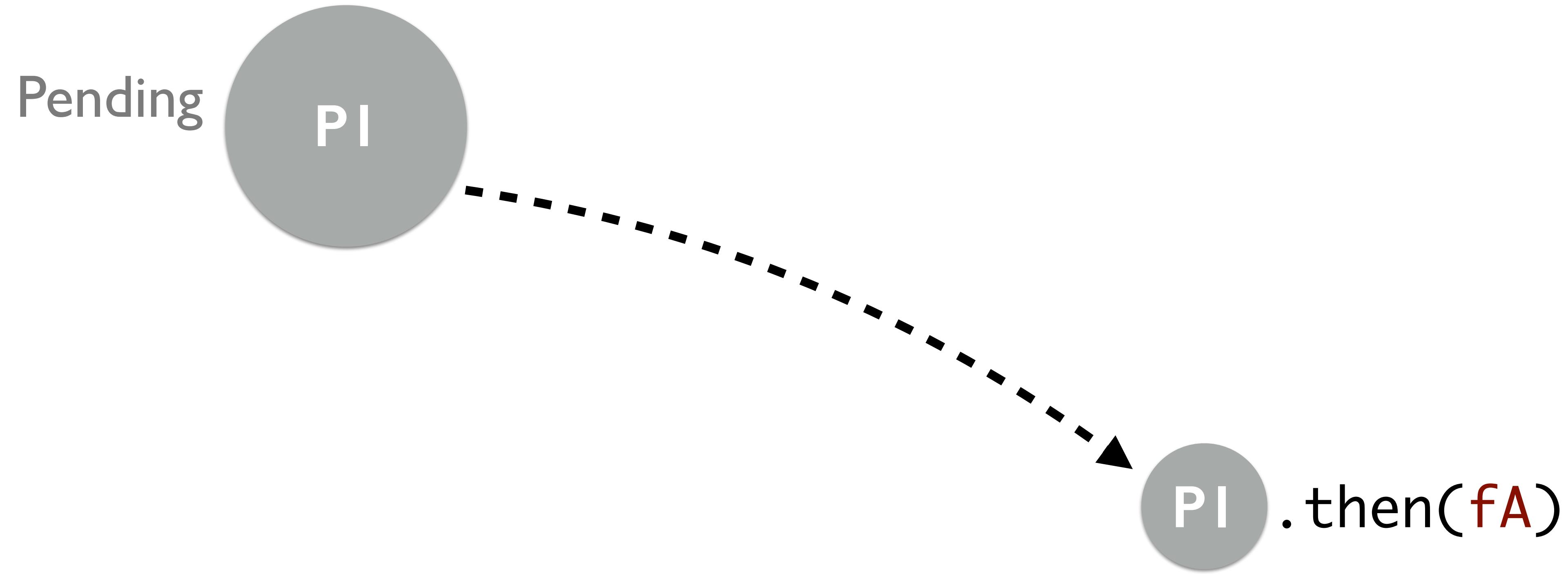


.then on same promise (not chaining!)



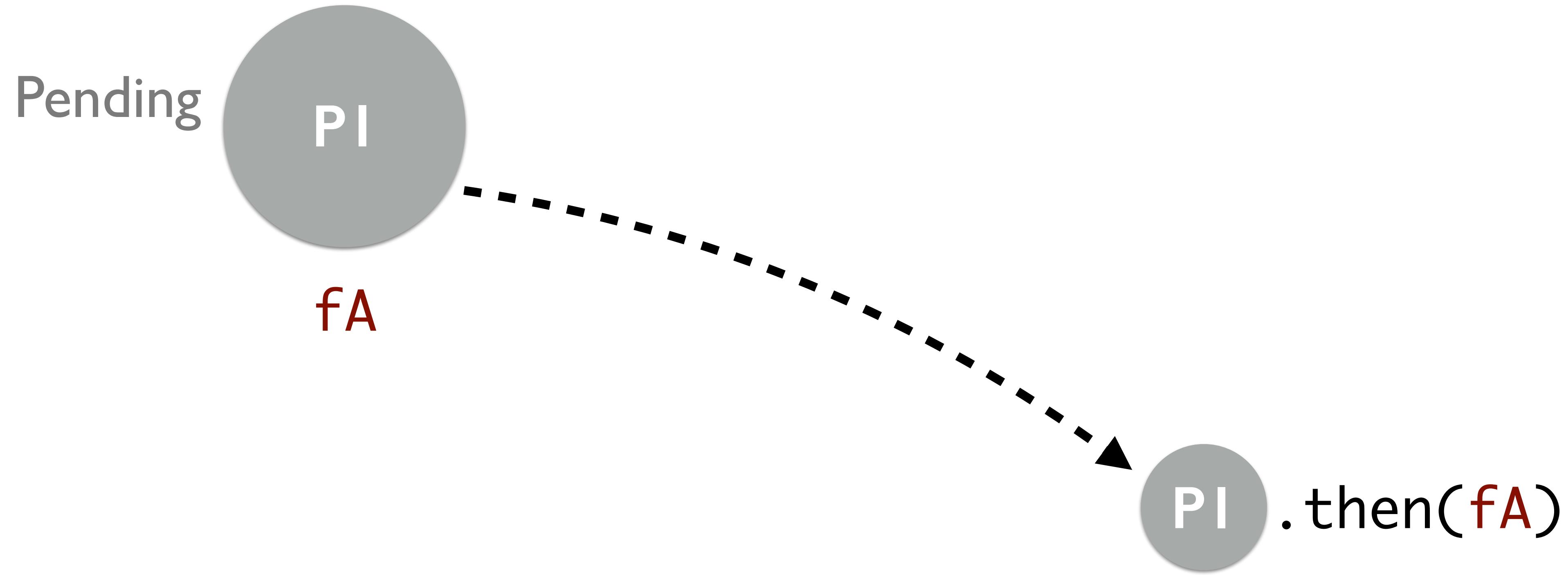


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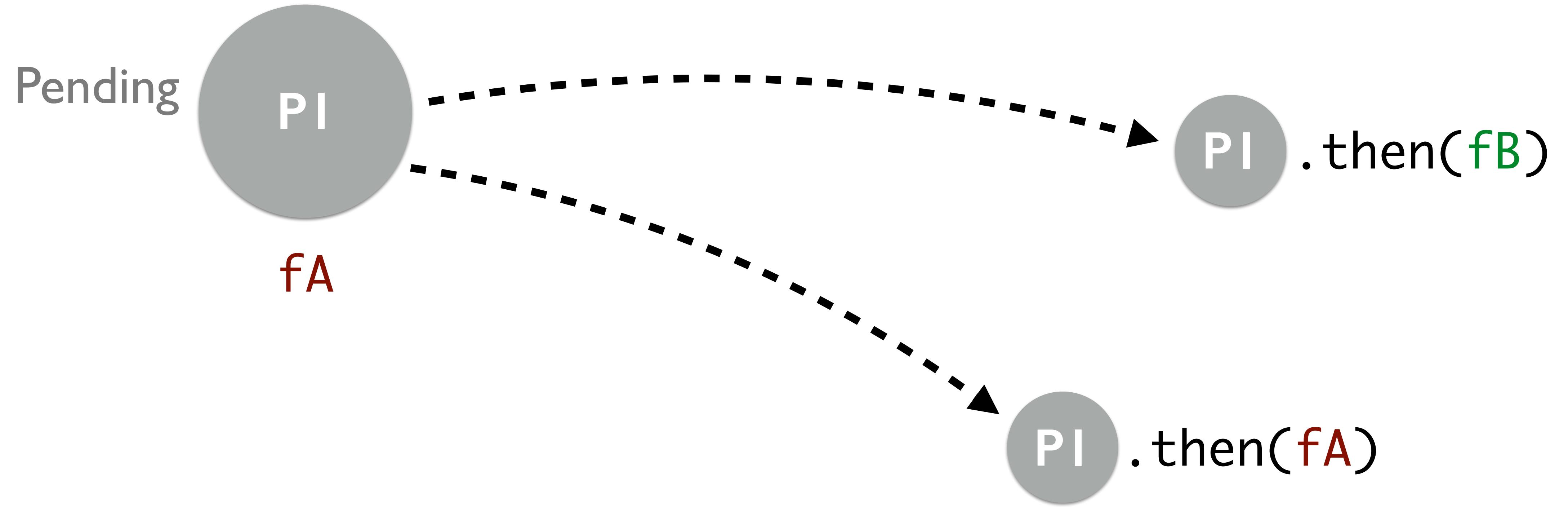


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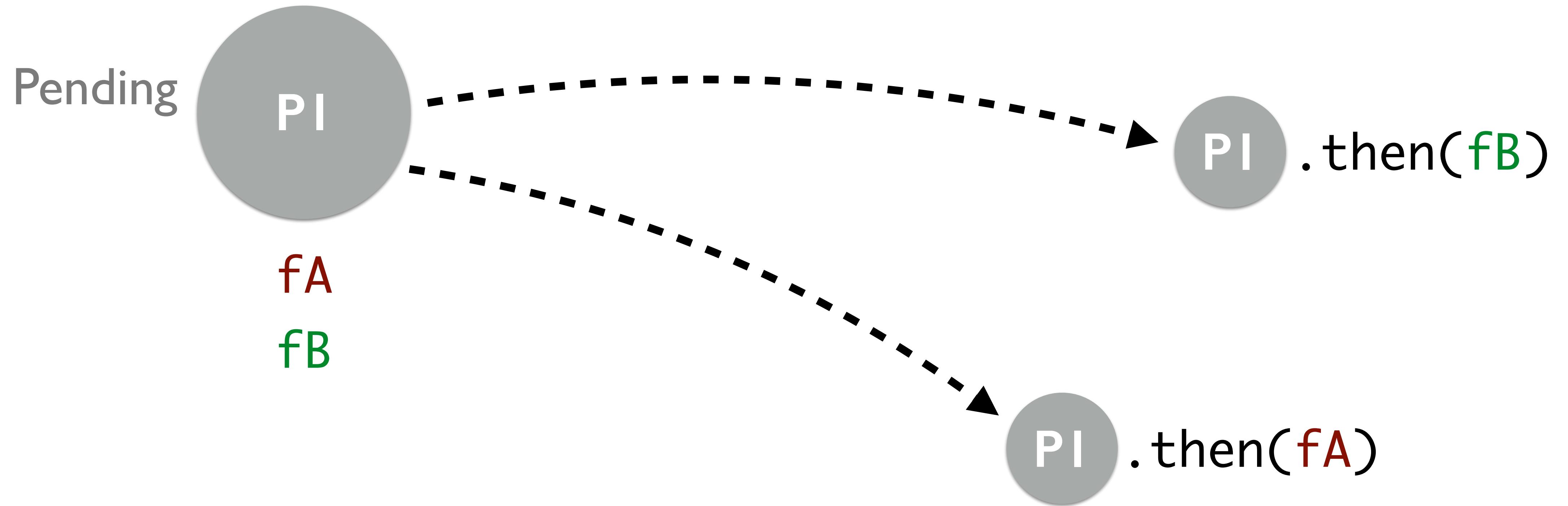


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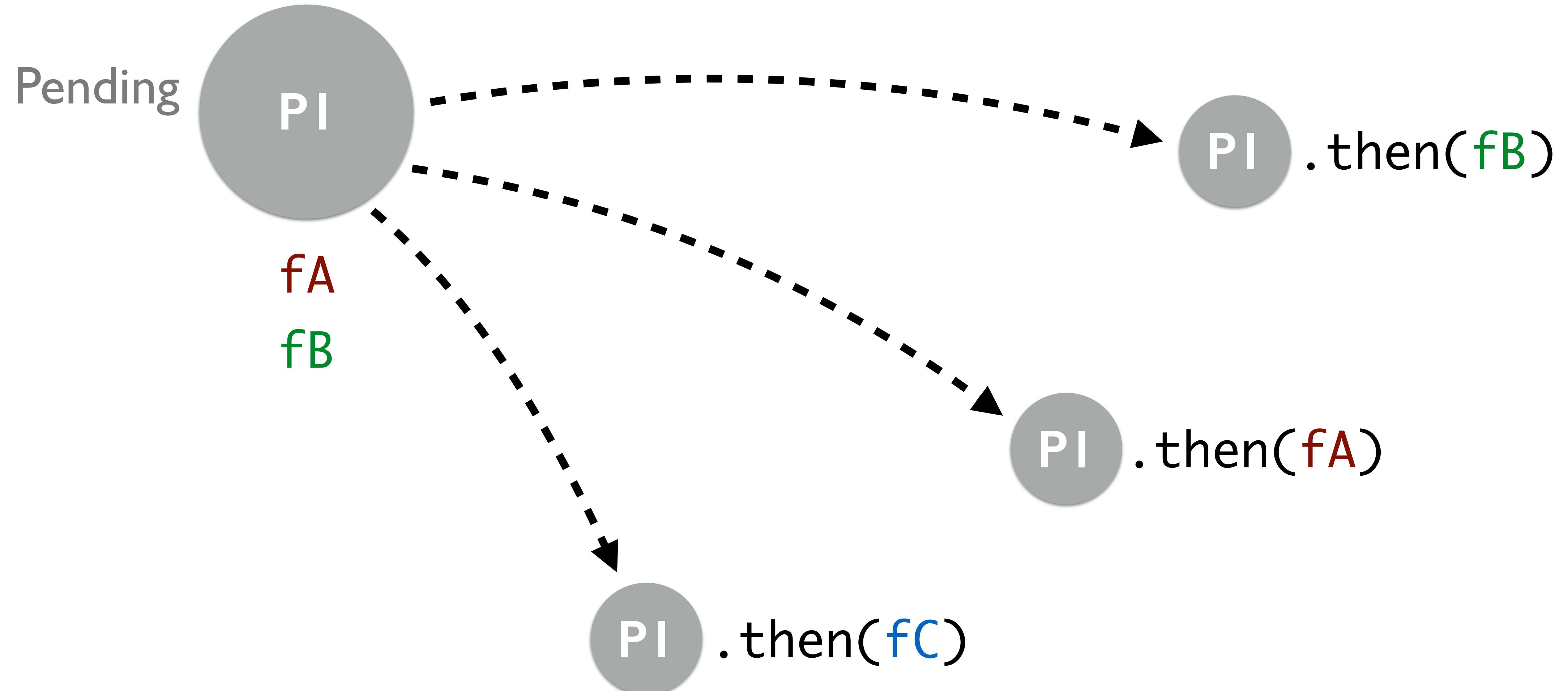


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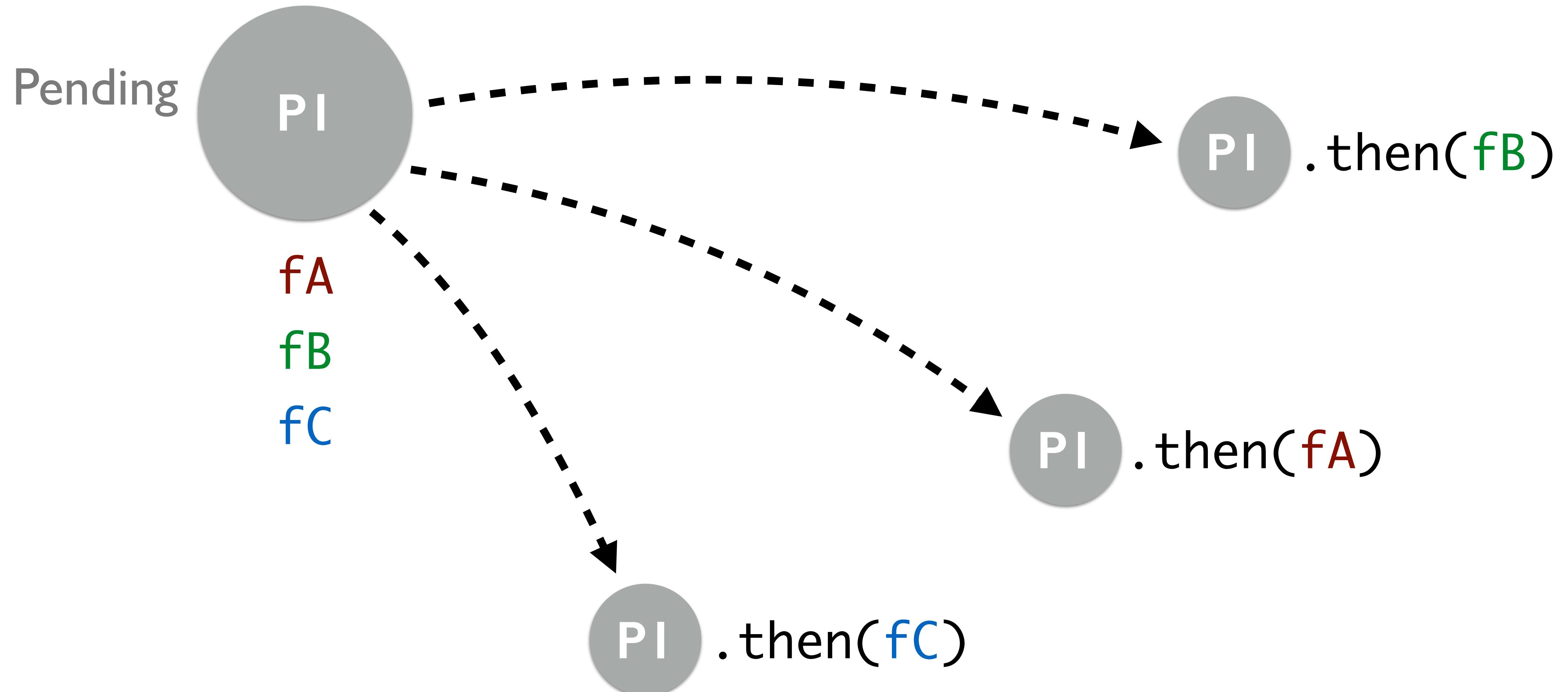


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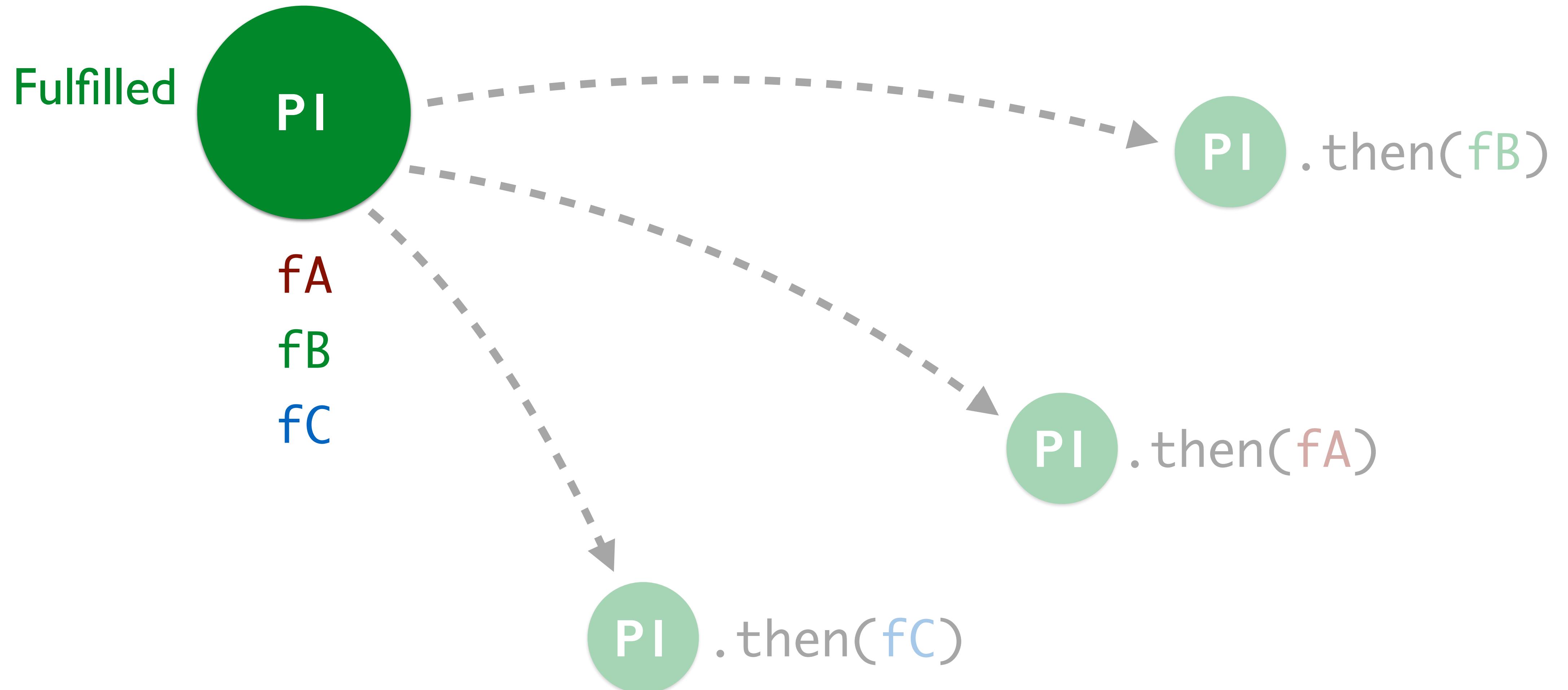


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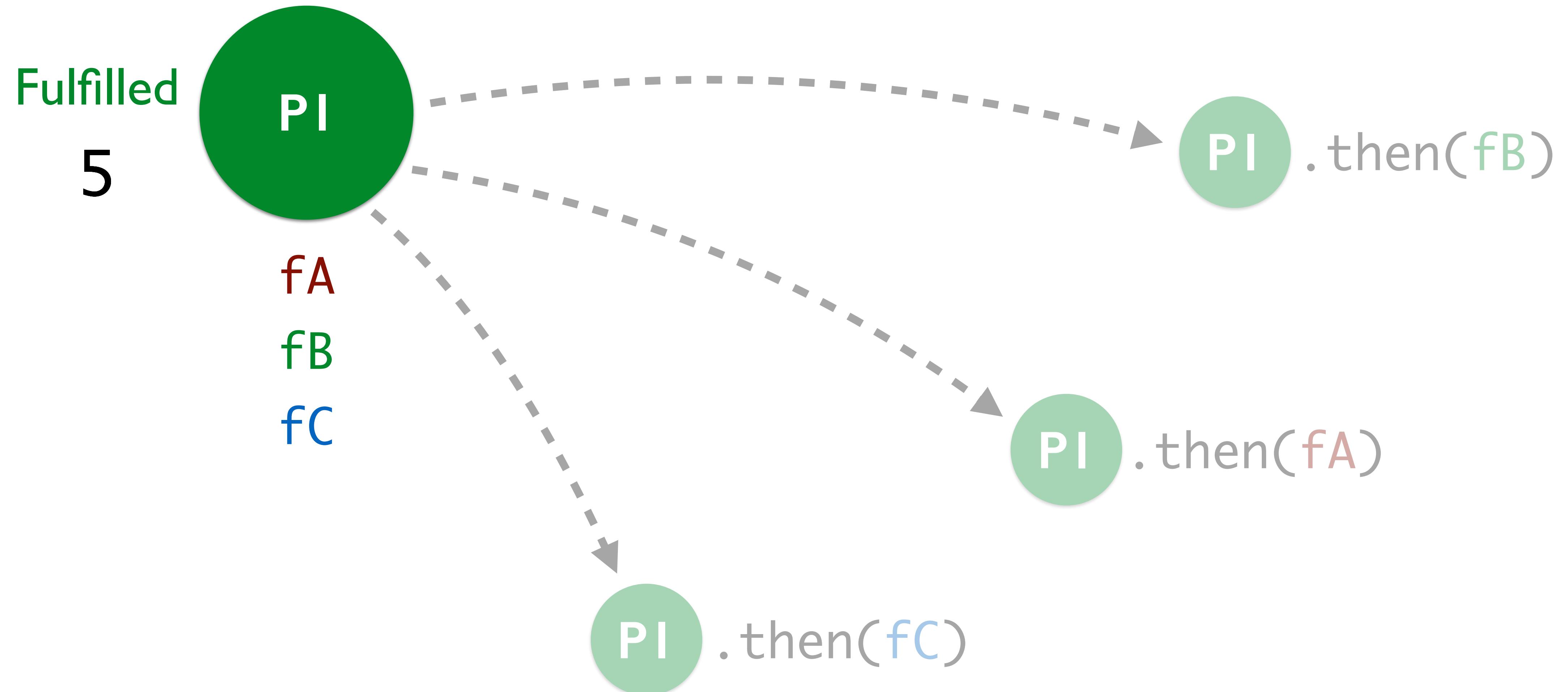


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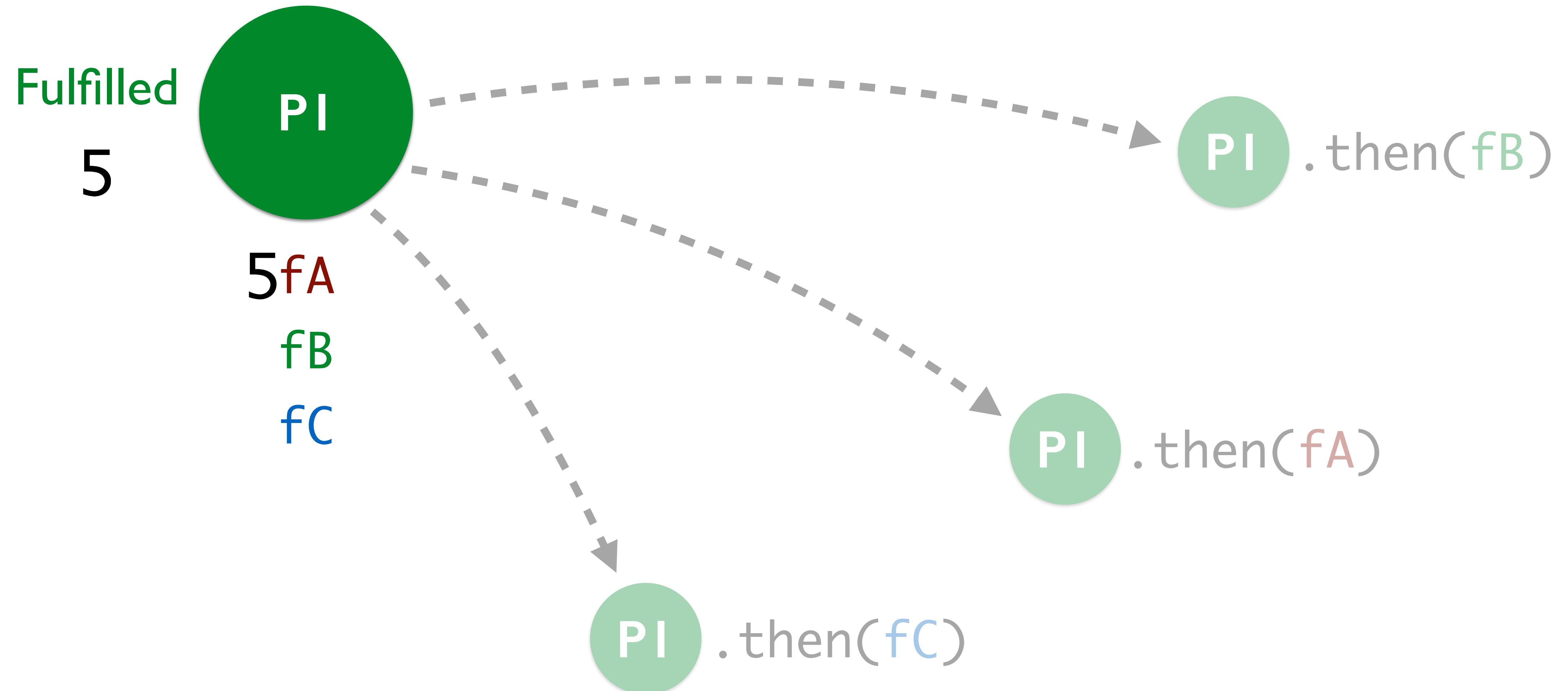


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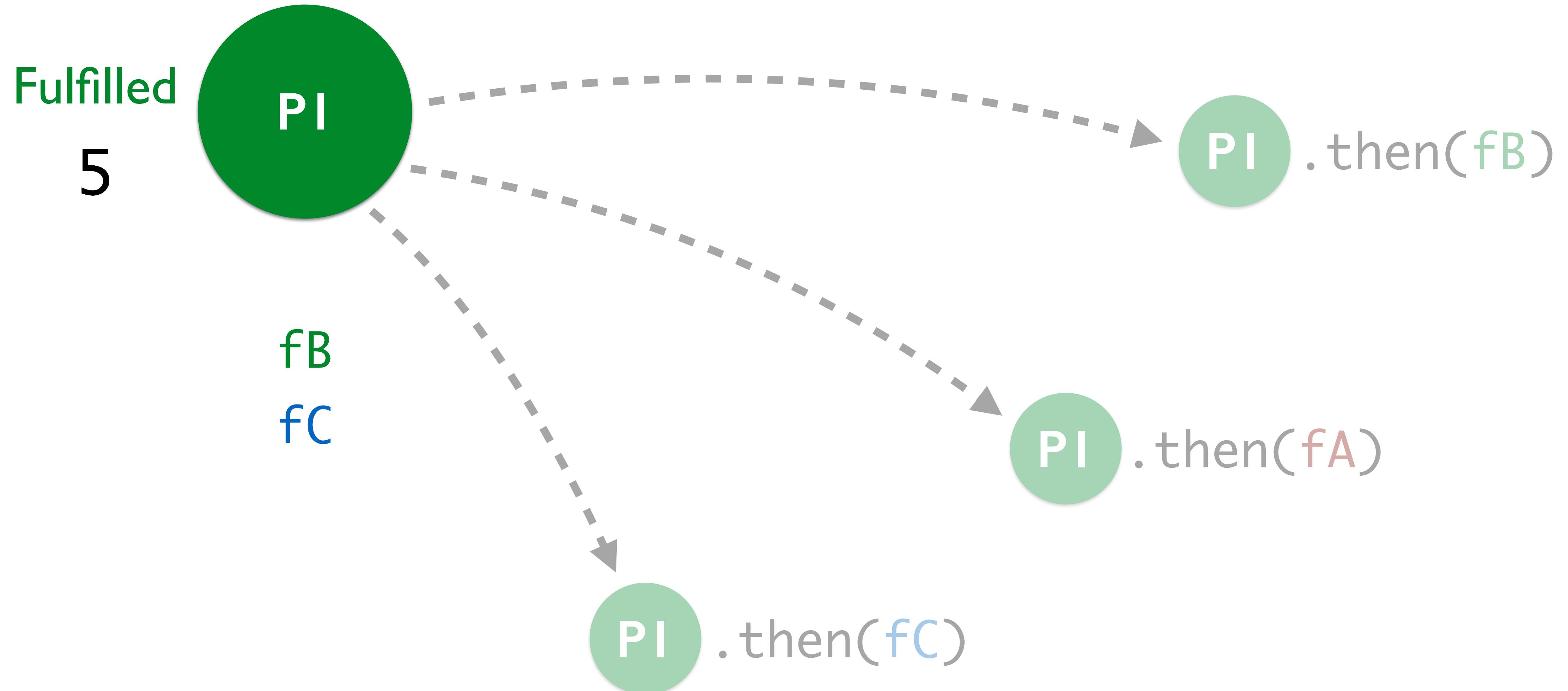


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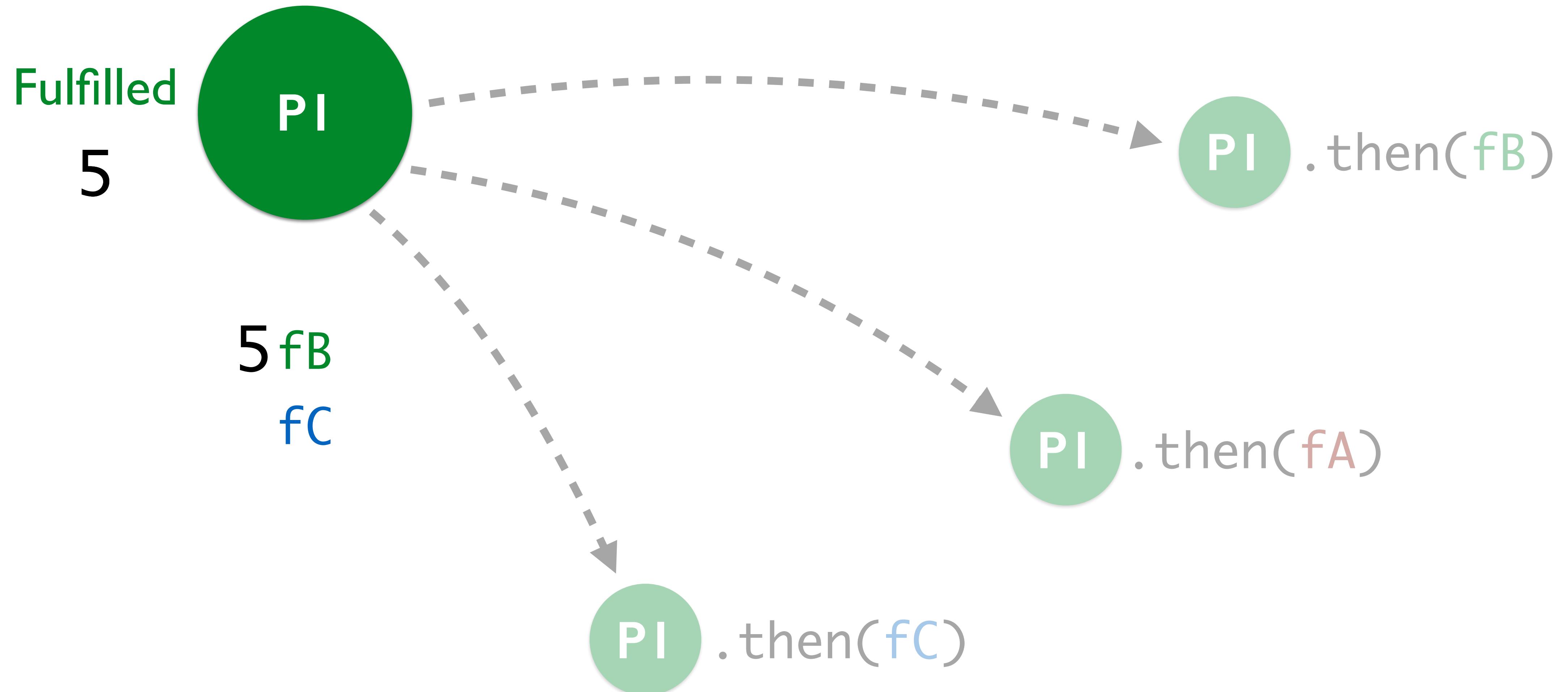


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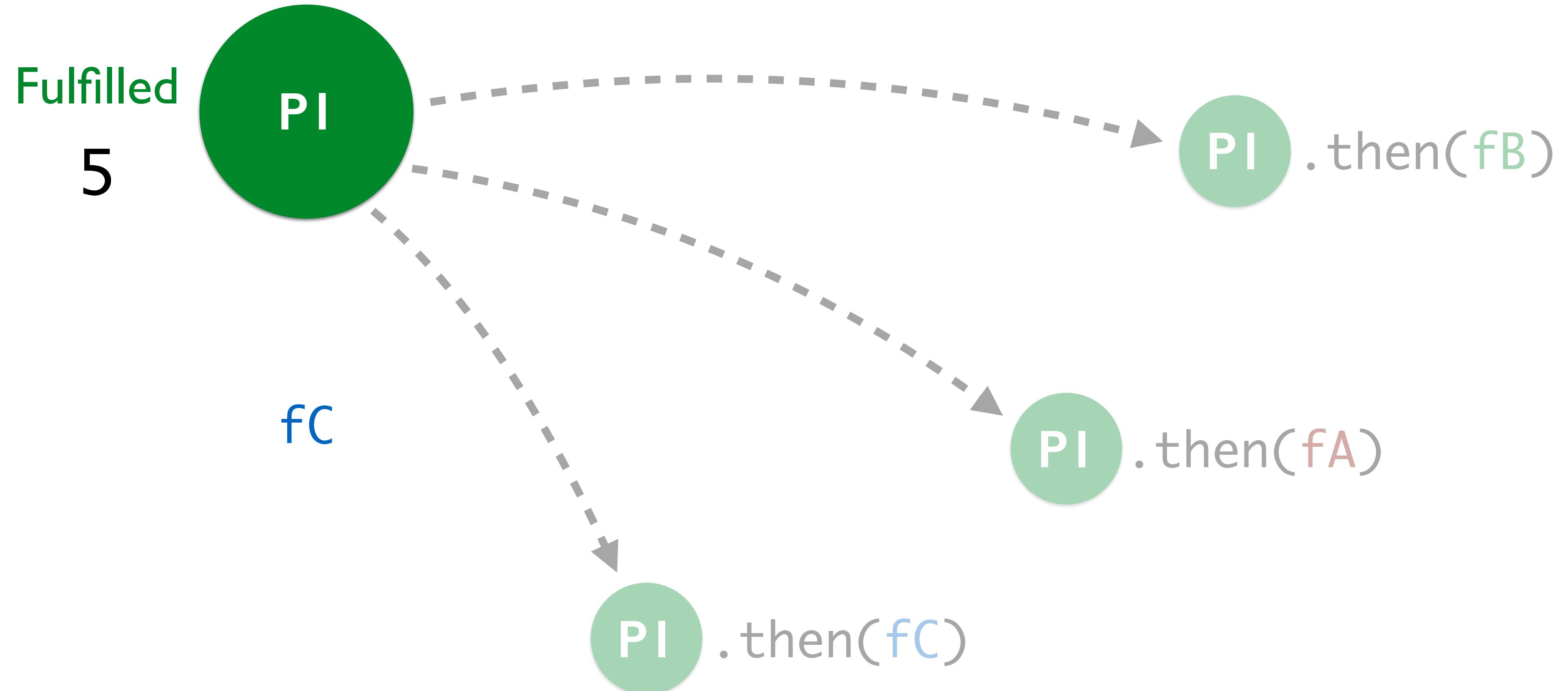


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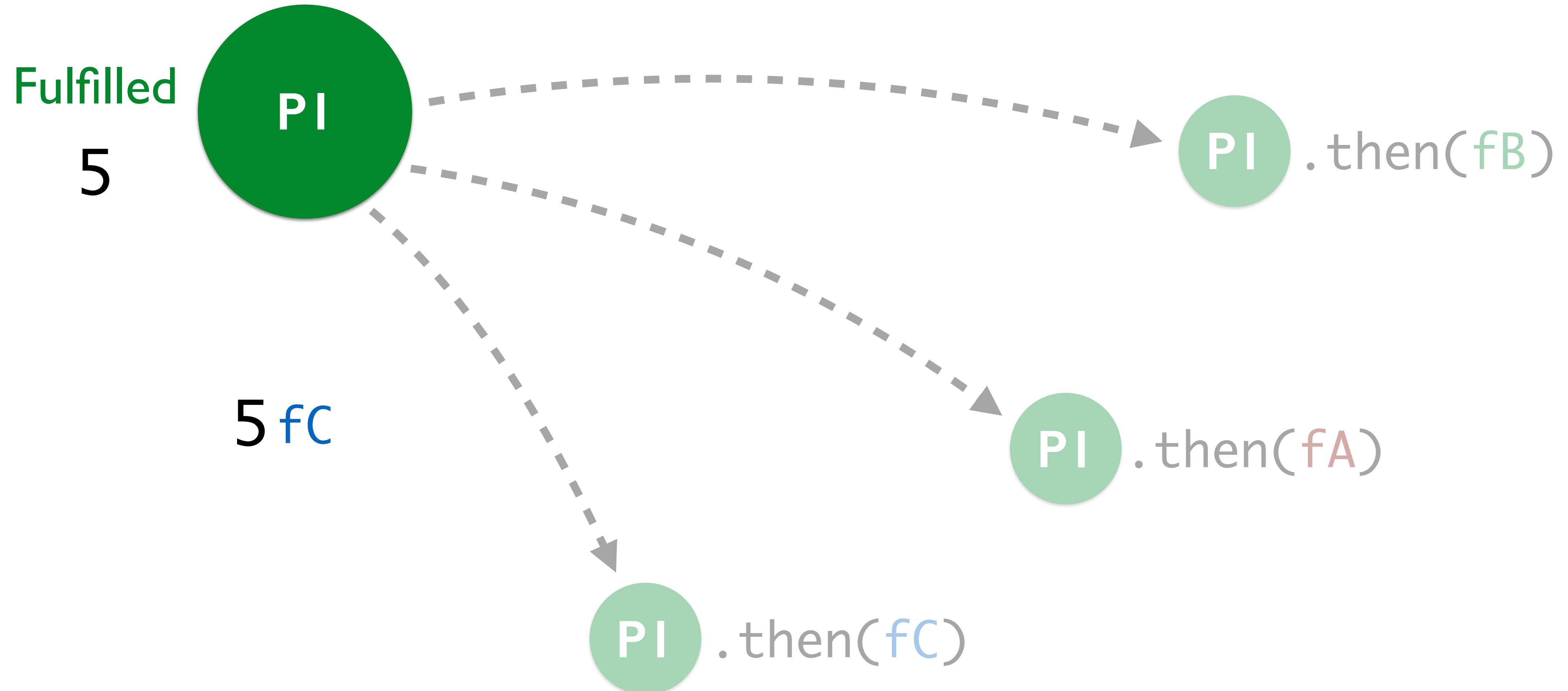


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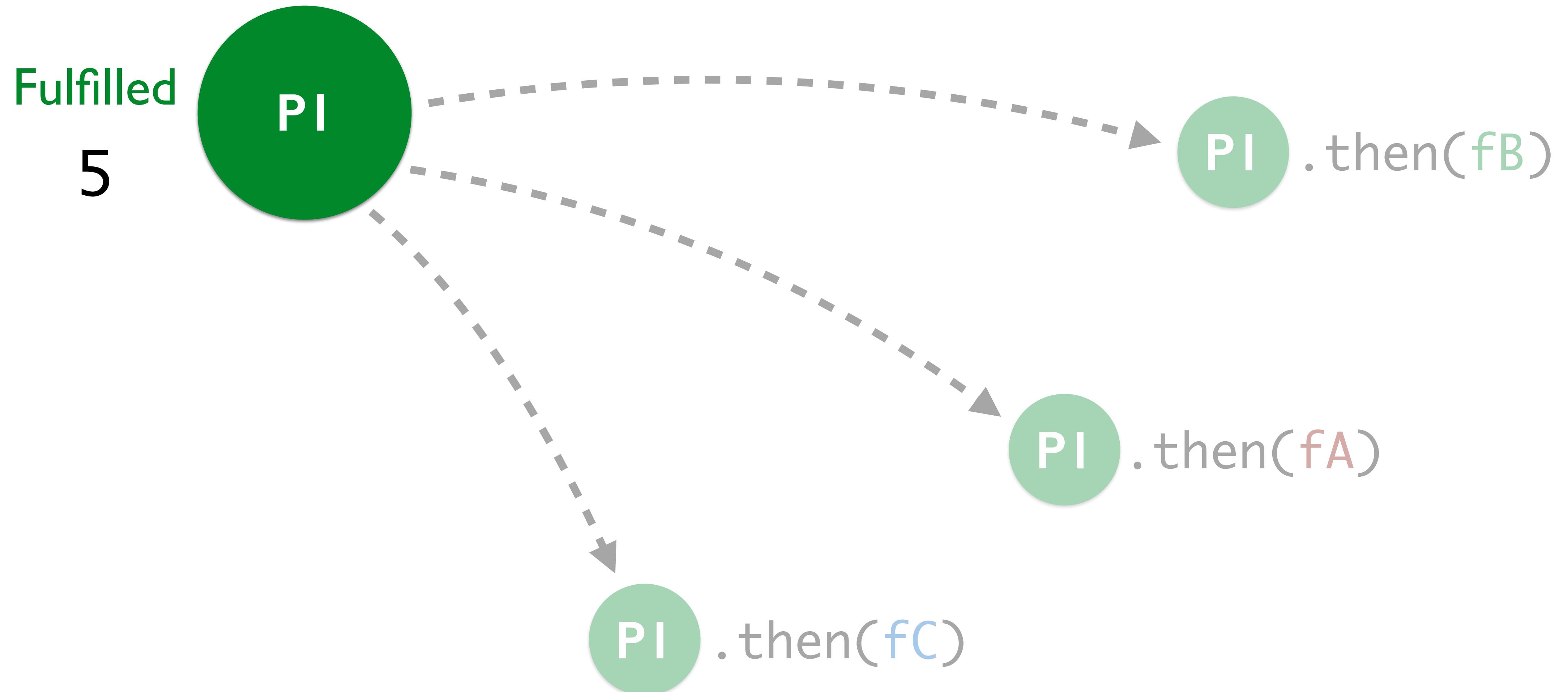


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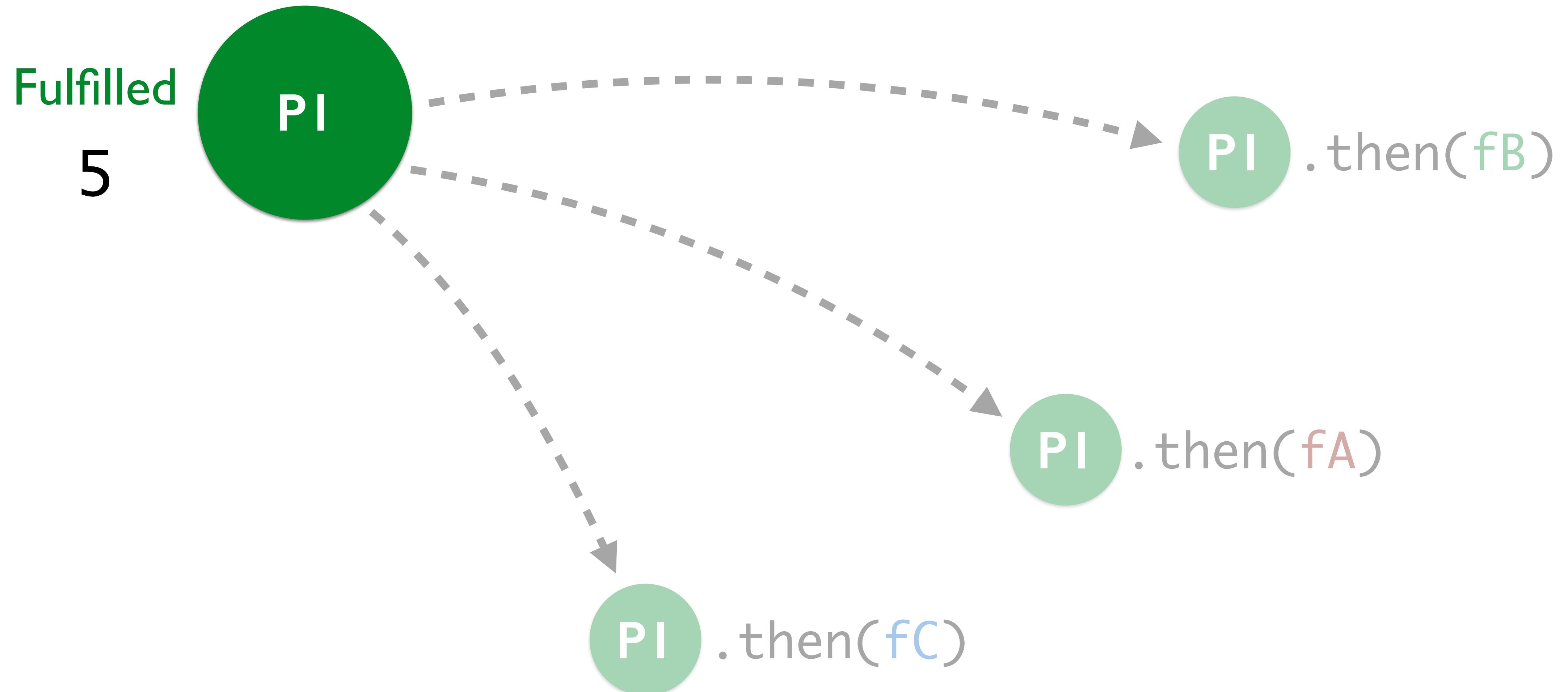


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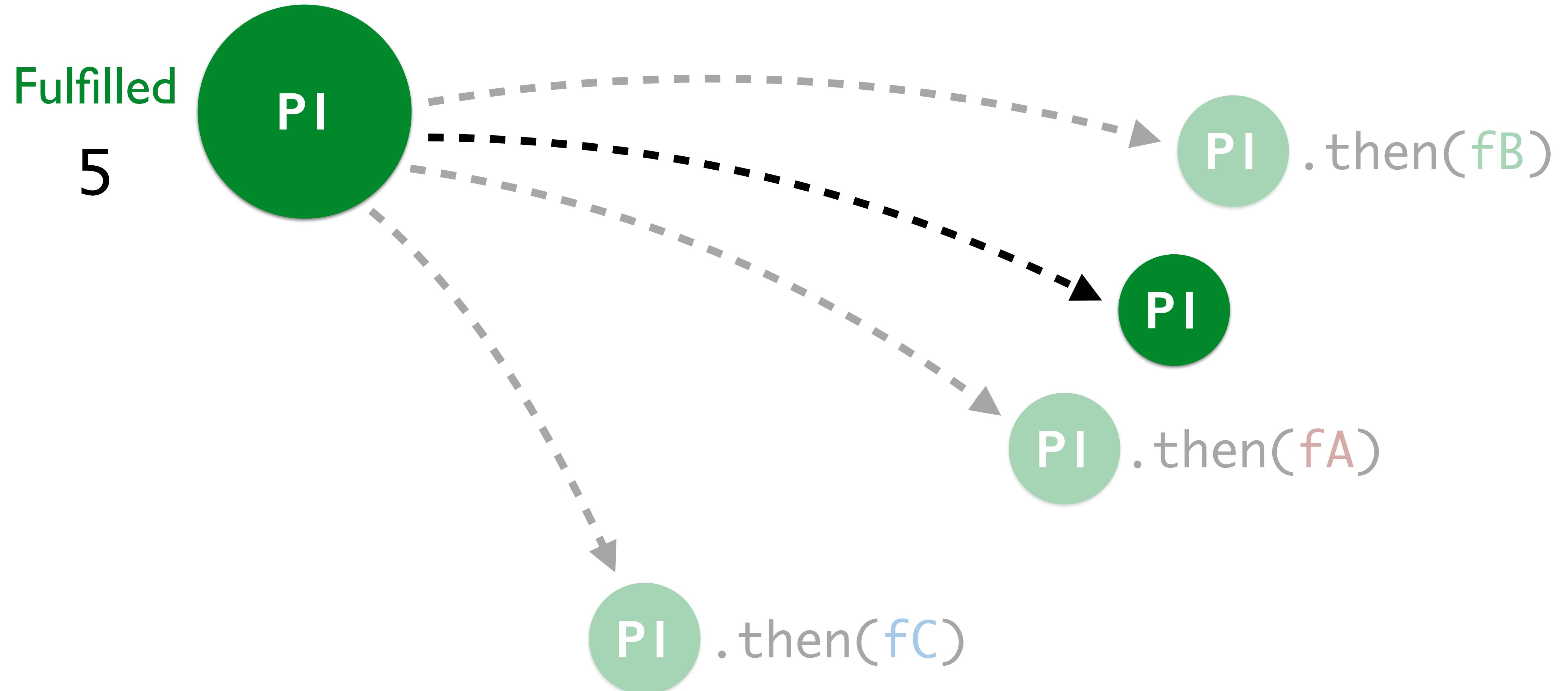


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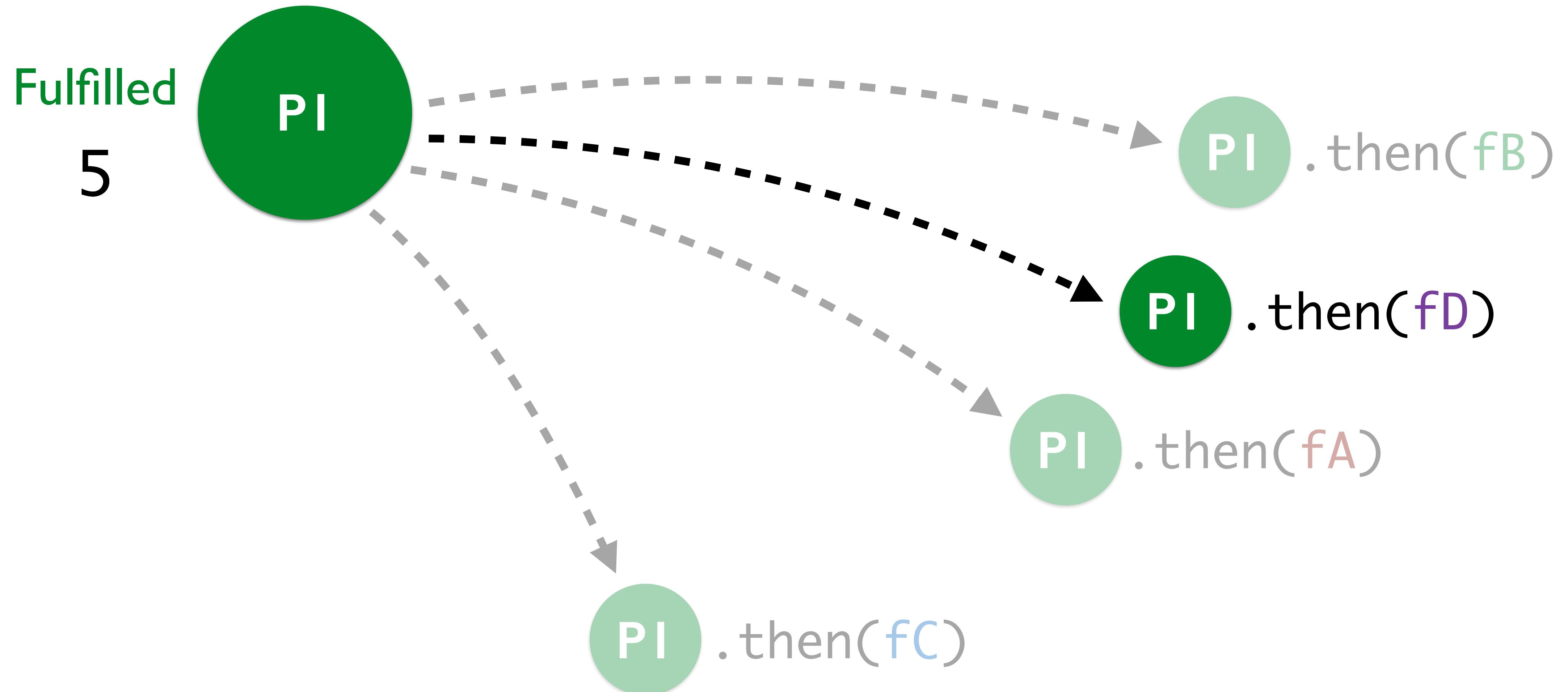


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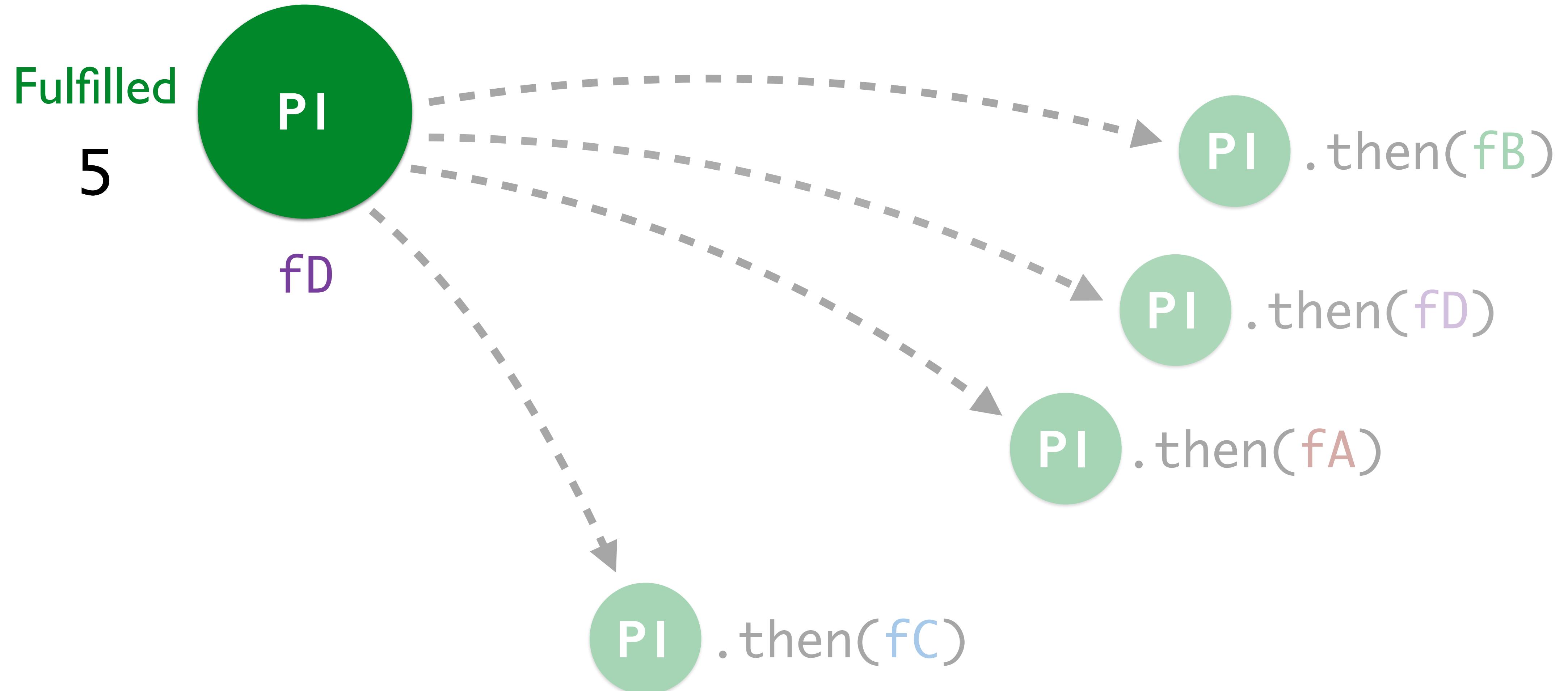


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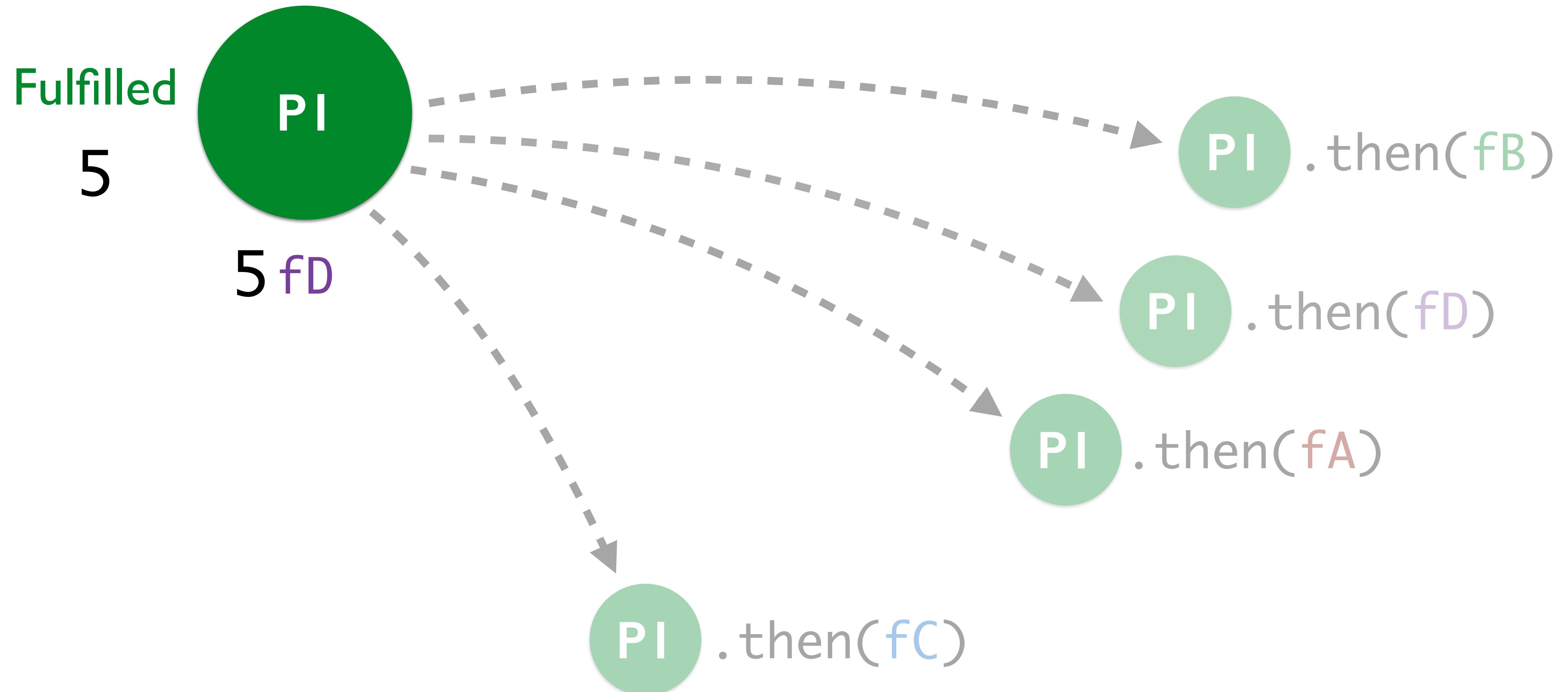


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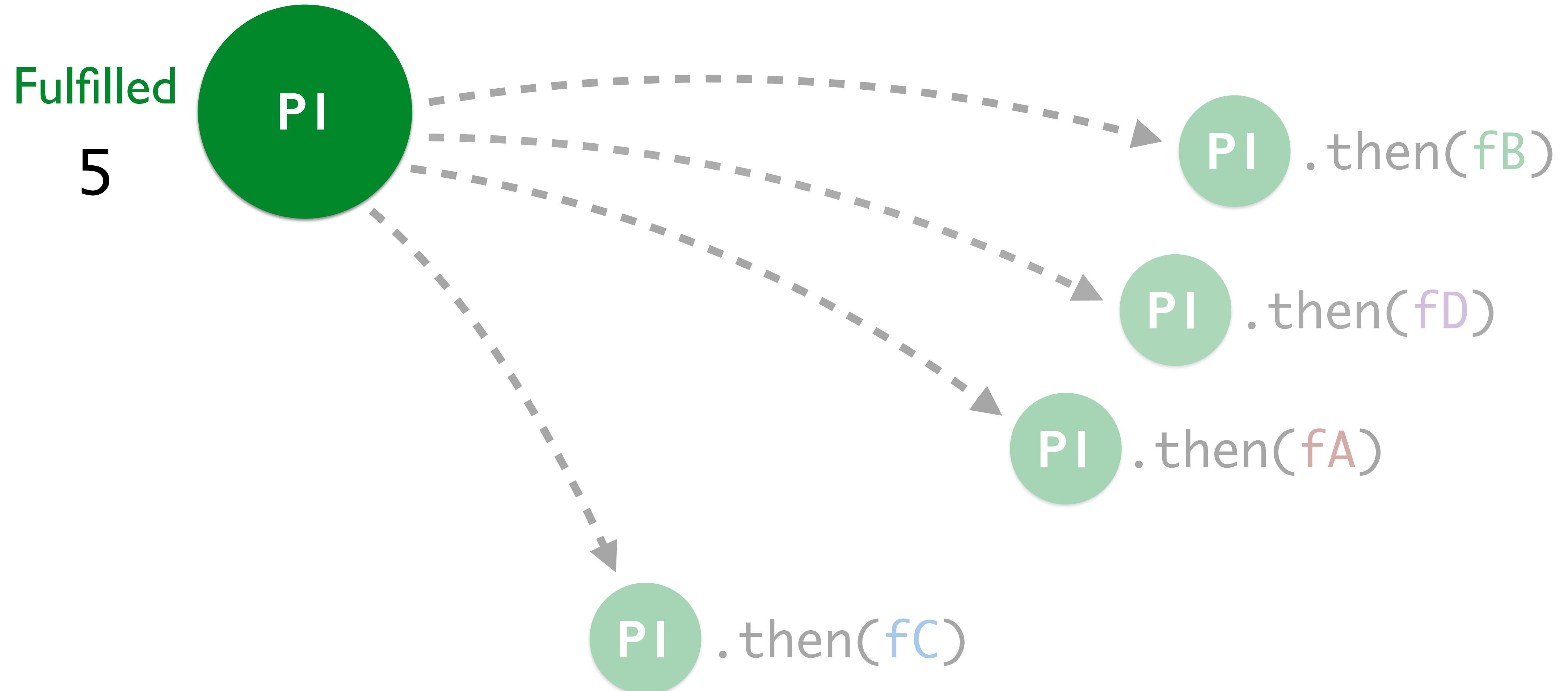


.then on same promise (not chaining!)





.then on same promise (not chaining!)





the magic: .then returns a new promise

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



This is why we can chain .then

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

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



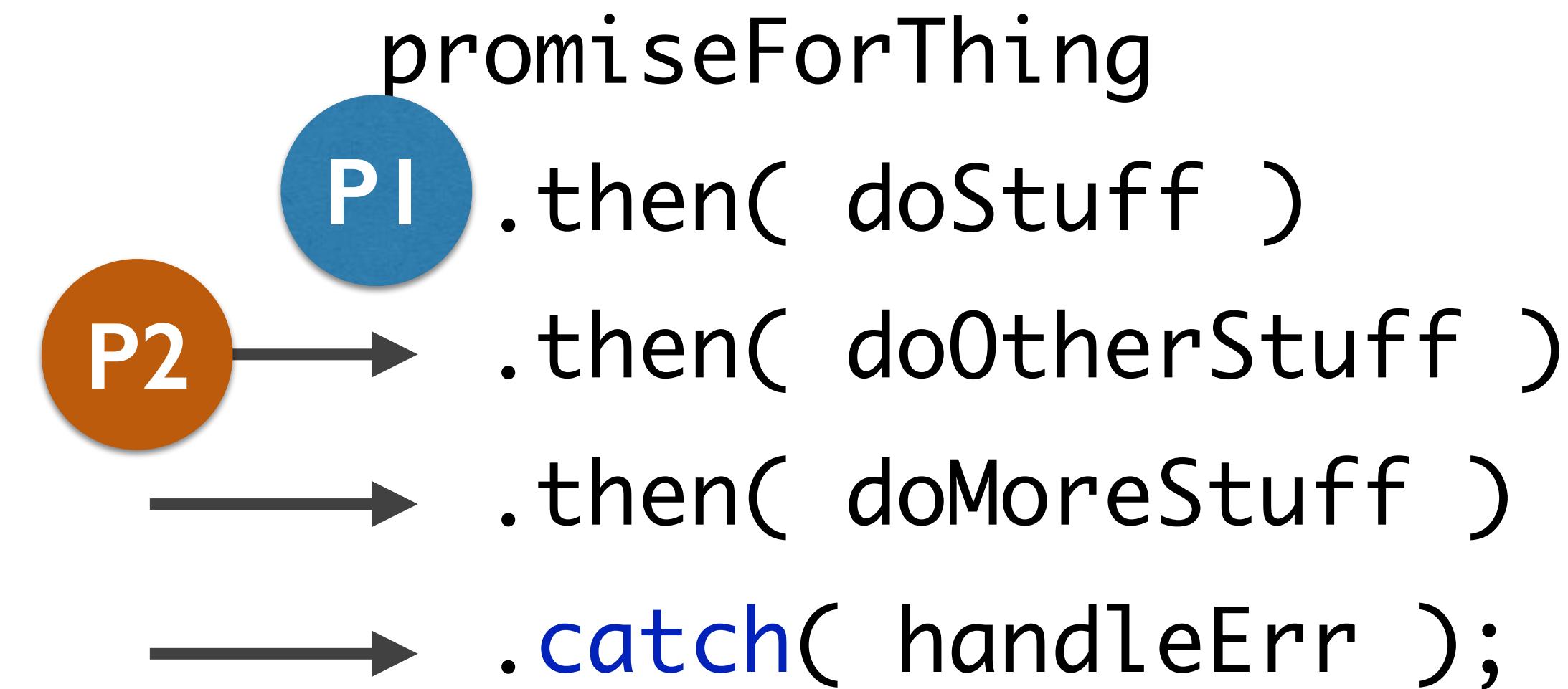
This is why we can chain .then

```
promiseForThing  
P1 .then( doStuff ) P2  
→ .then( doOtherStuff )  
→ .then( doMoreStuff )  
→ .catch( handleErr );
```

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



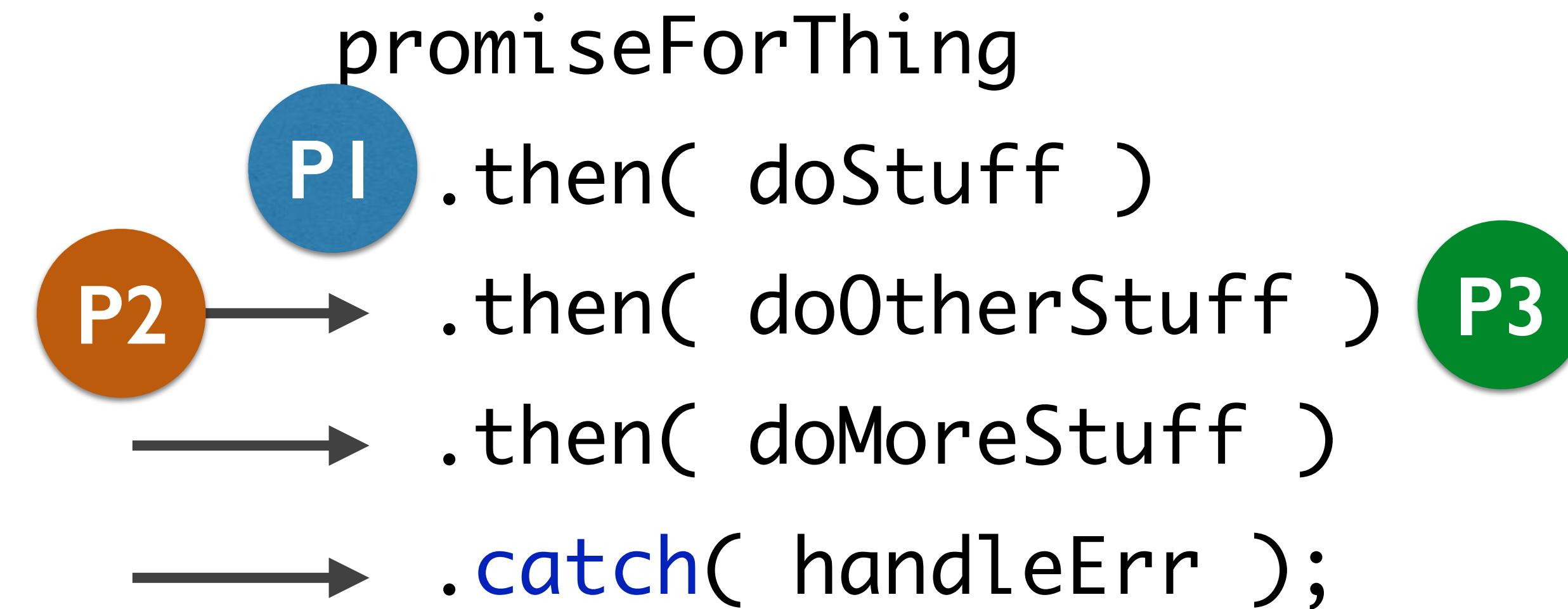
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`.catch(handleErr)` is equivalent to `.then(null, handleErr)`



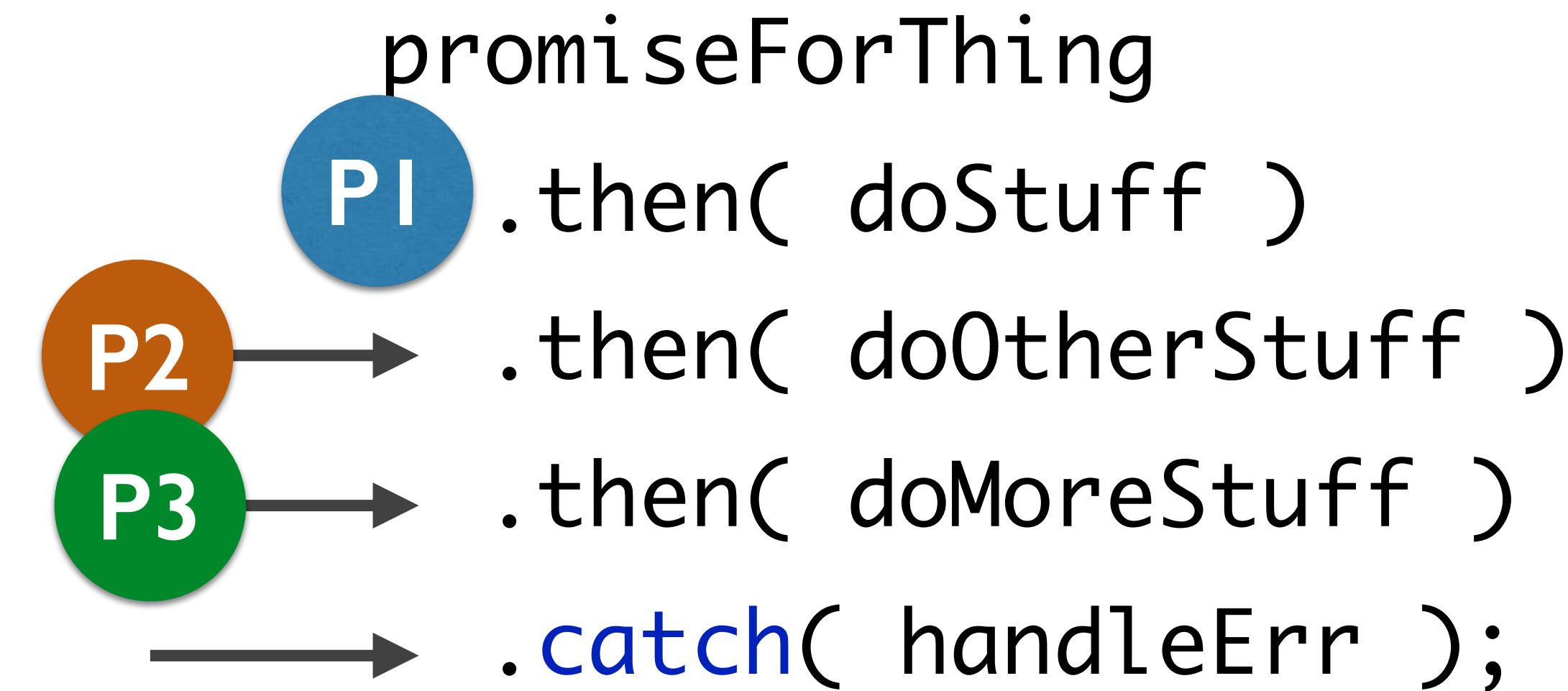
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`.catch(handleErr)` is equivalent to `.then(null, handleErr)`



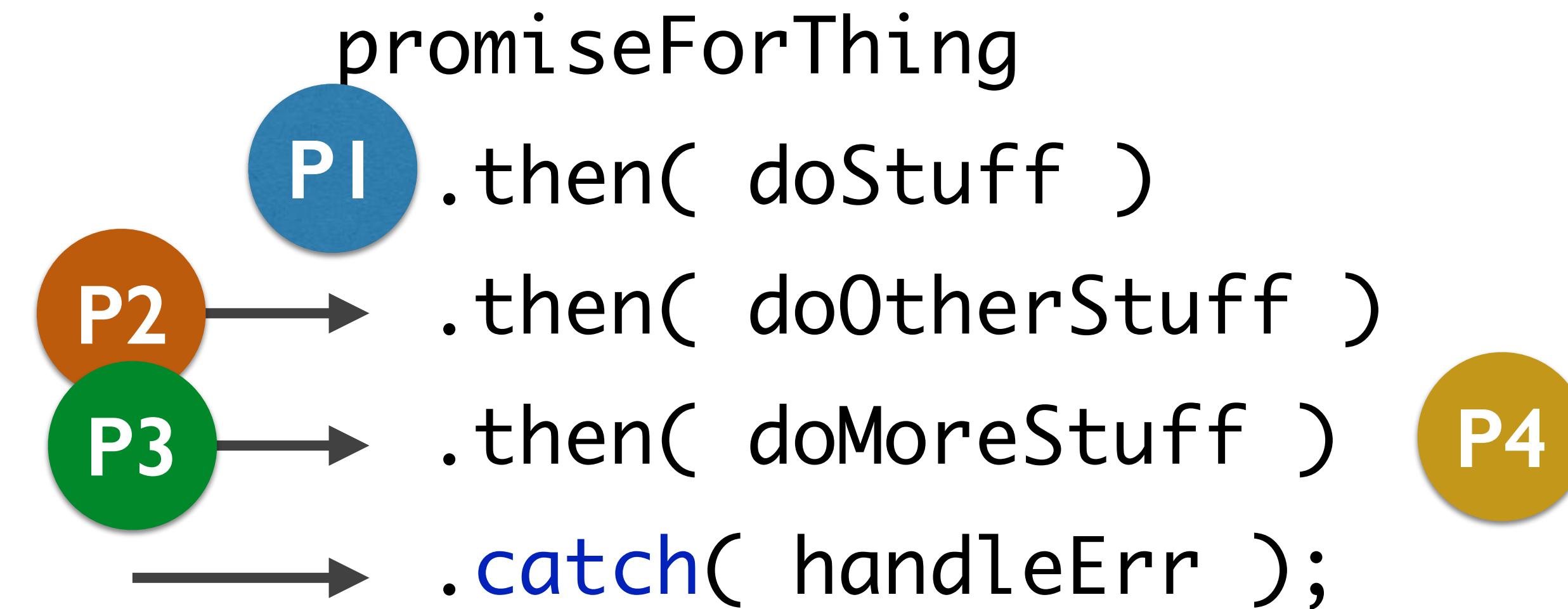
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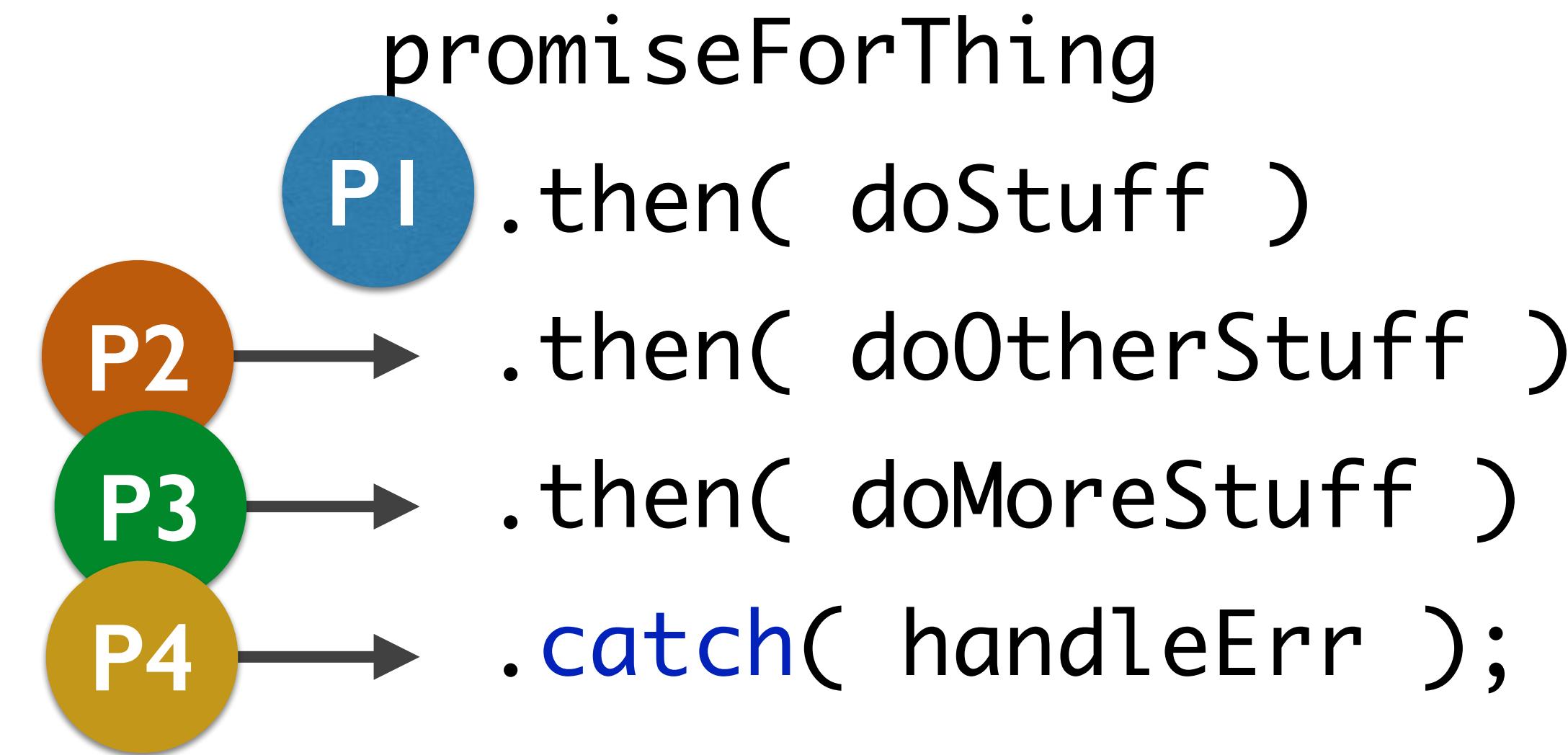
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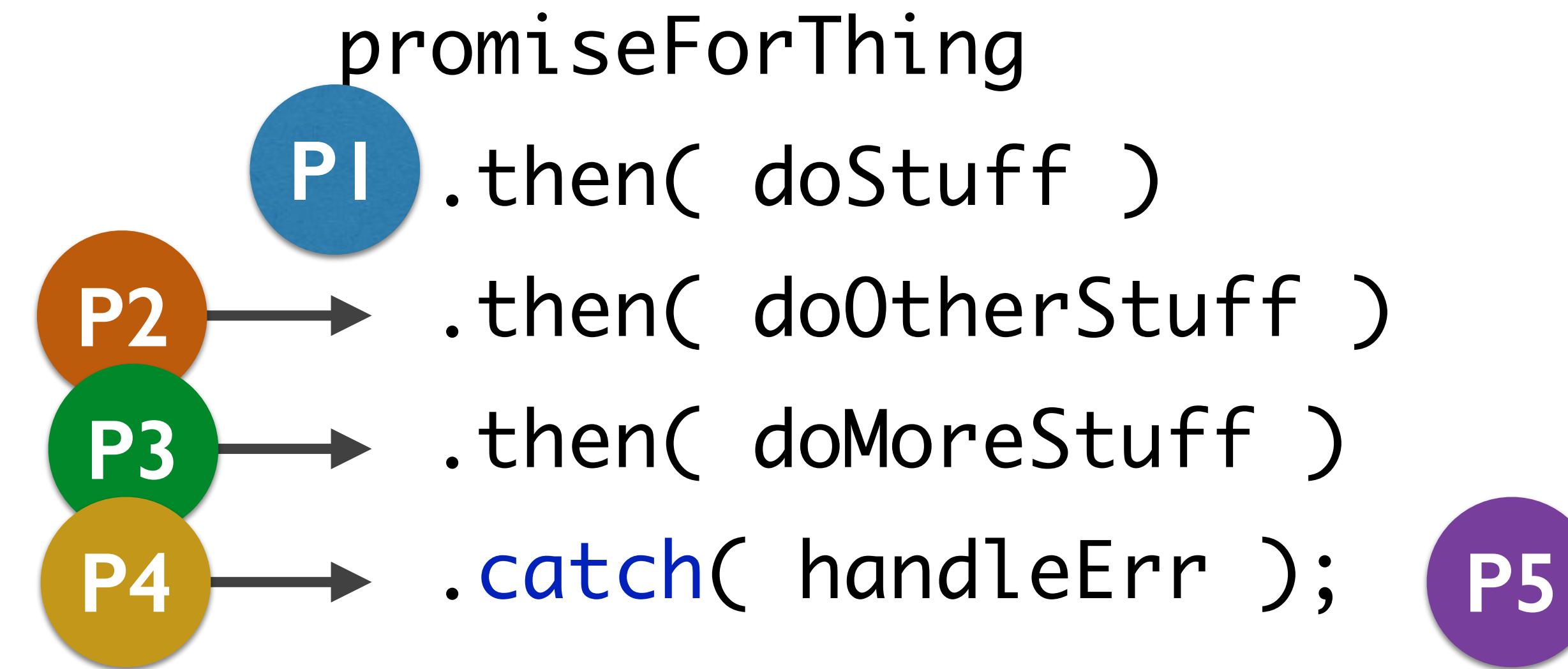
This is why we can chain .then



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



This is why we can chain .then



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



And why we can `return` in a handler

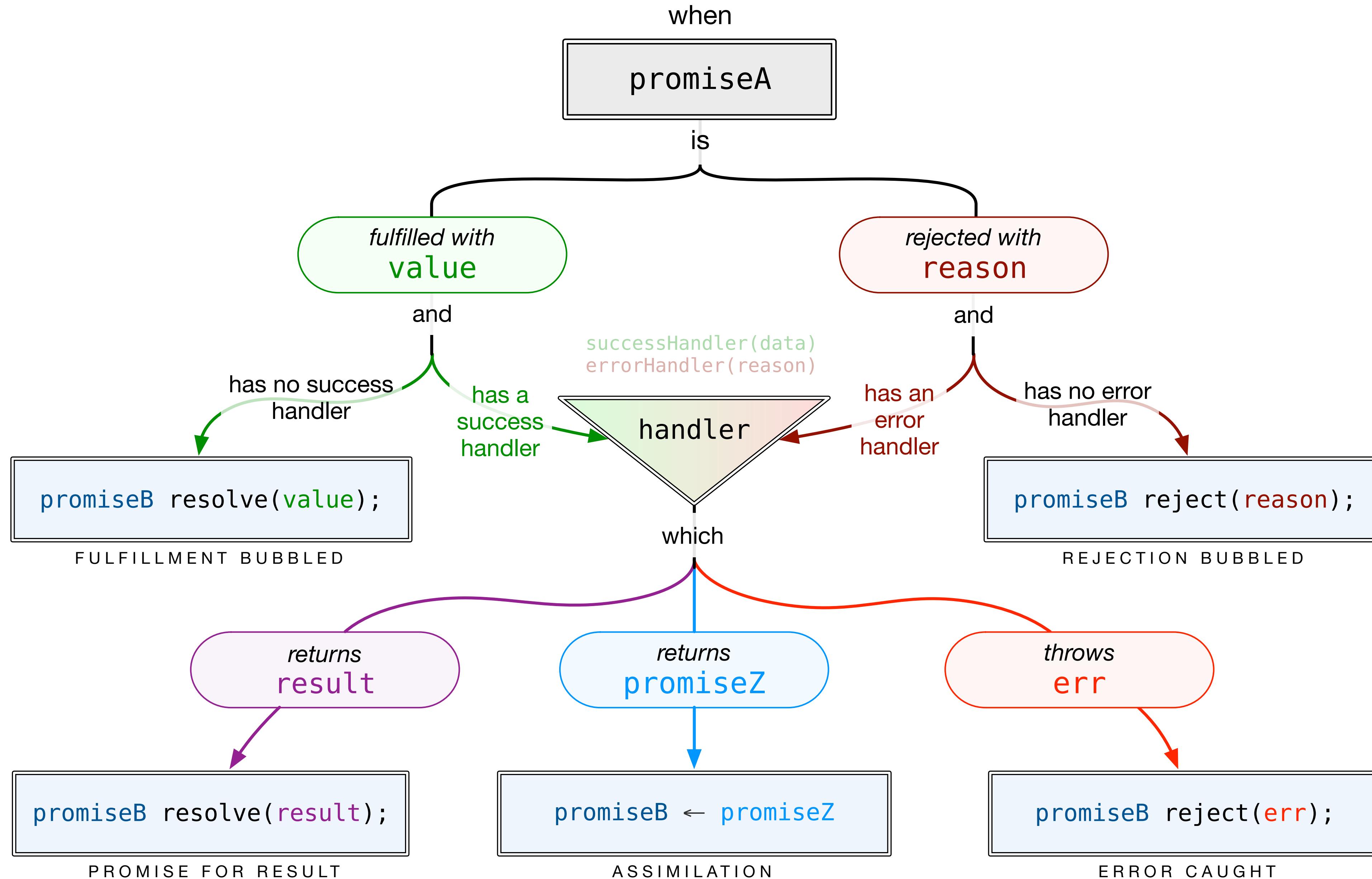
```
const promiseForThingB = promiseForThingA
  .then(function thingSuccess (thingA) {
    // run some code
    return thingB;
})
```

What is promiseB a promise for?



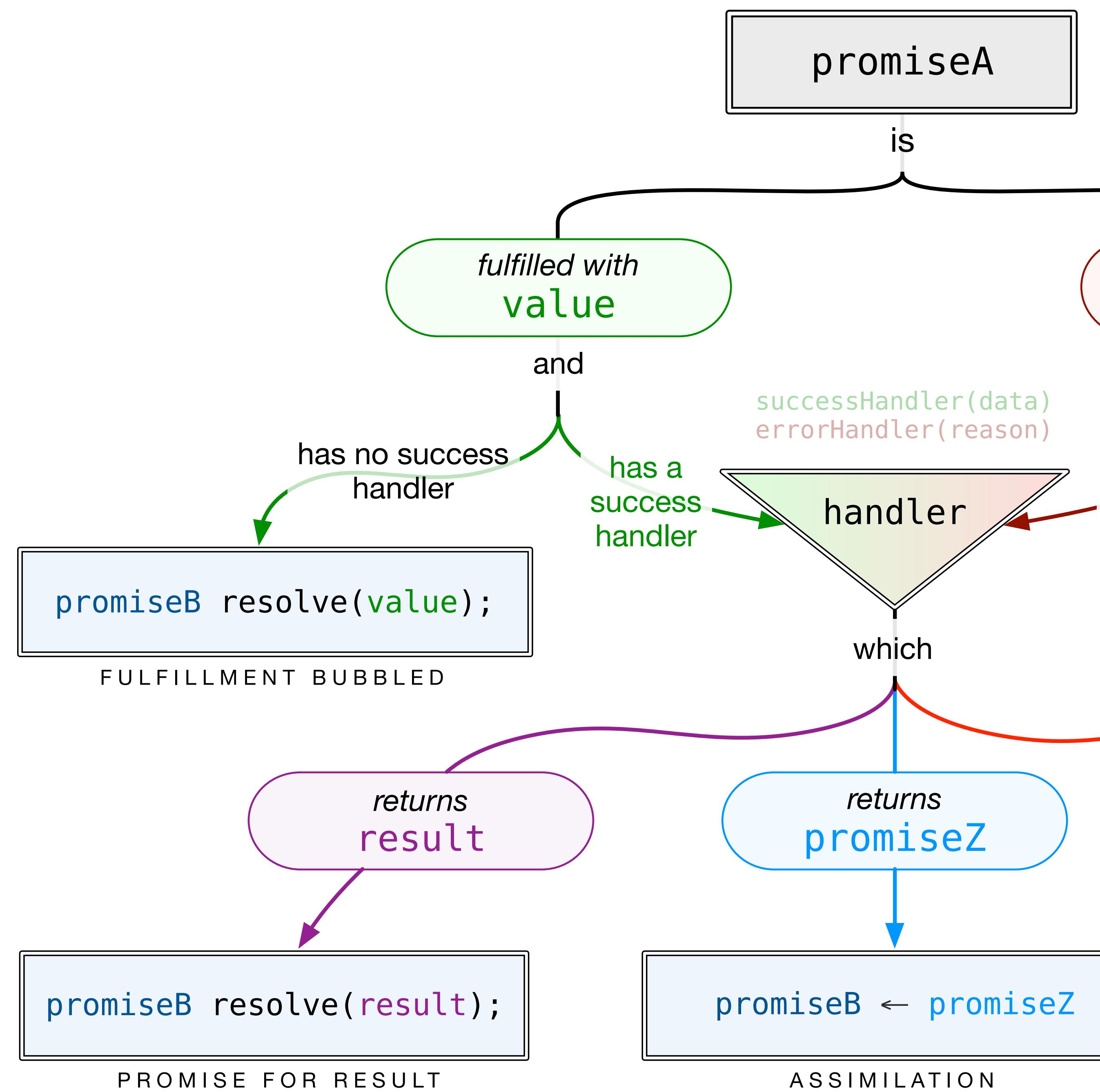
Brace yourselves...

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



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

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

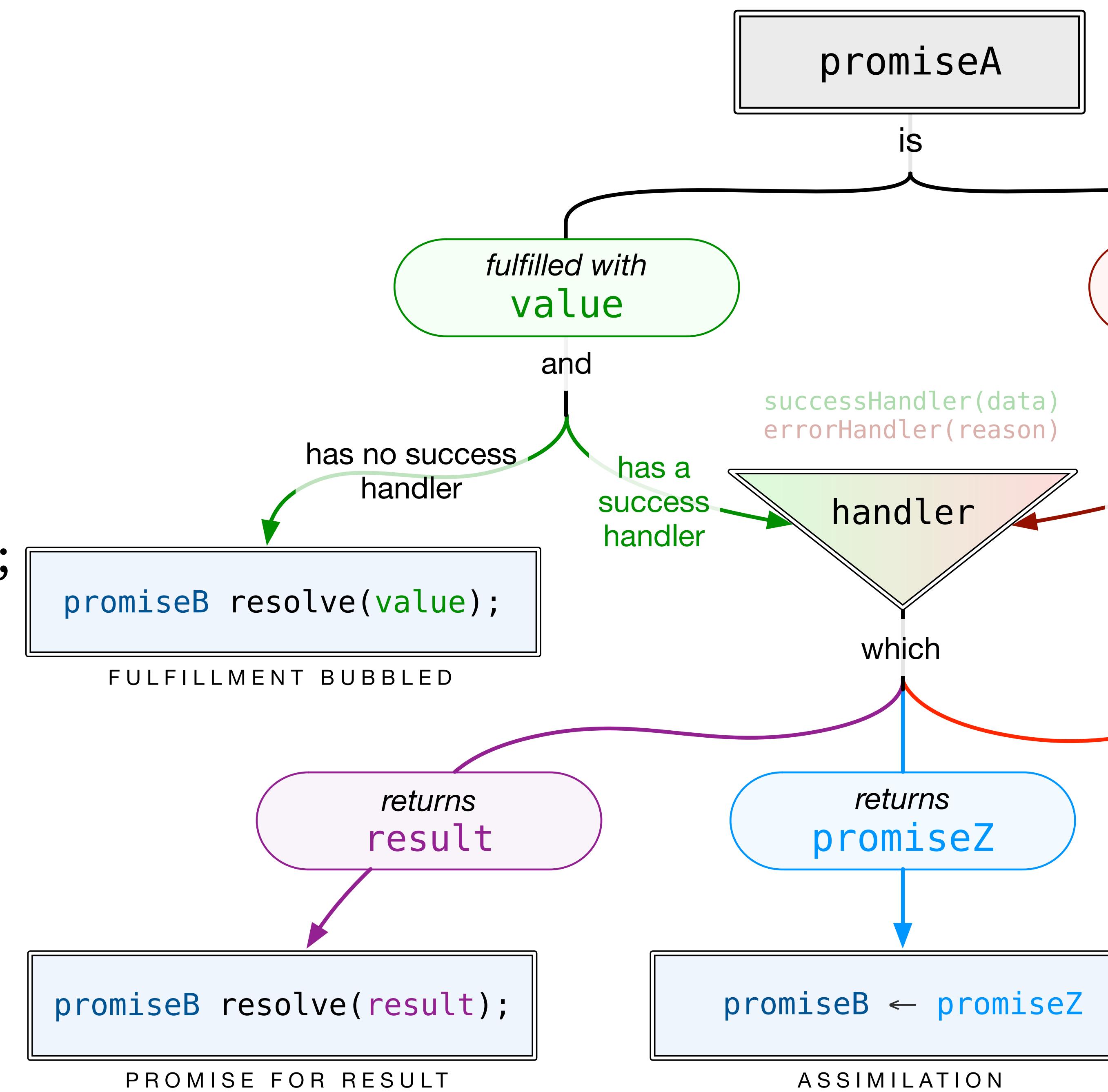


```
// promise0 fulfills with 'Hello.'
```

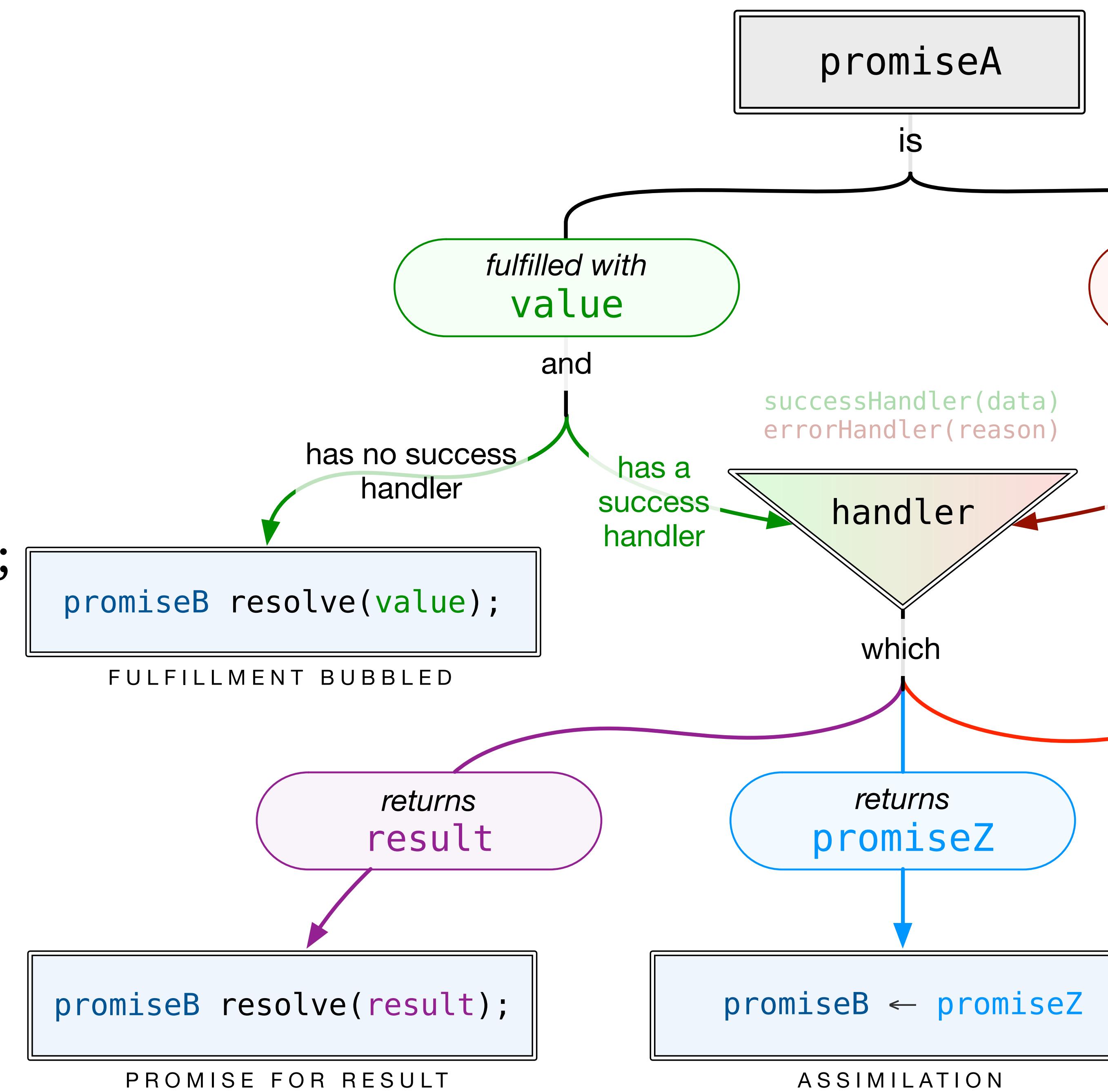
```
promise0
  .then() // -> p1
  .then() // -> p2
  .then() // -> p3
  .then() // -> p4
  .then() // -> p5
  .then(console.log.bind(console));
```

Fulfillment bubbled down to first available success handler:

Console log reads “Hello.”



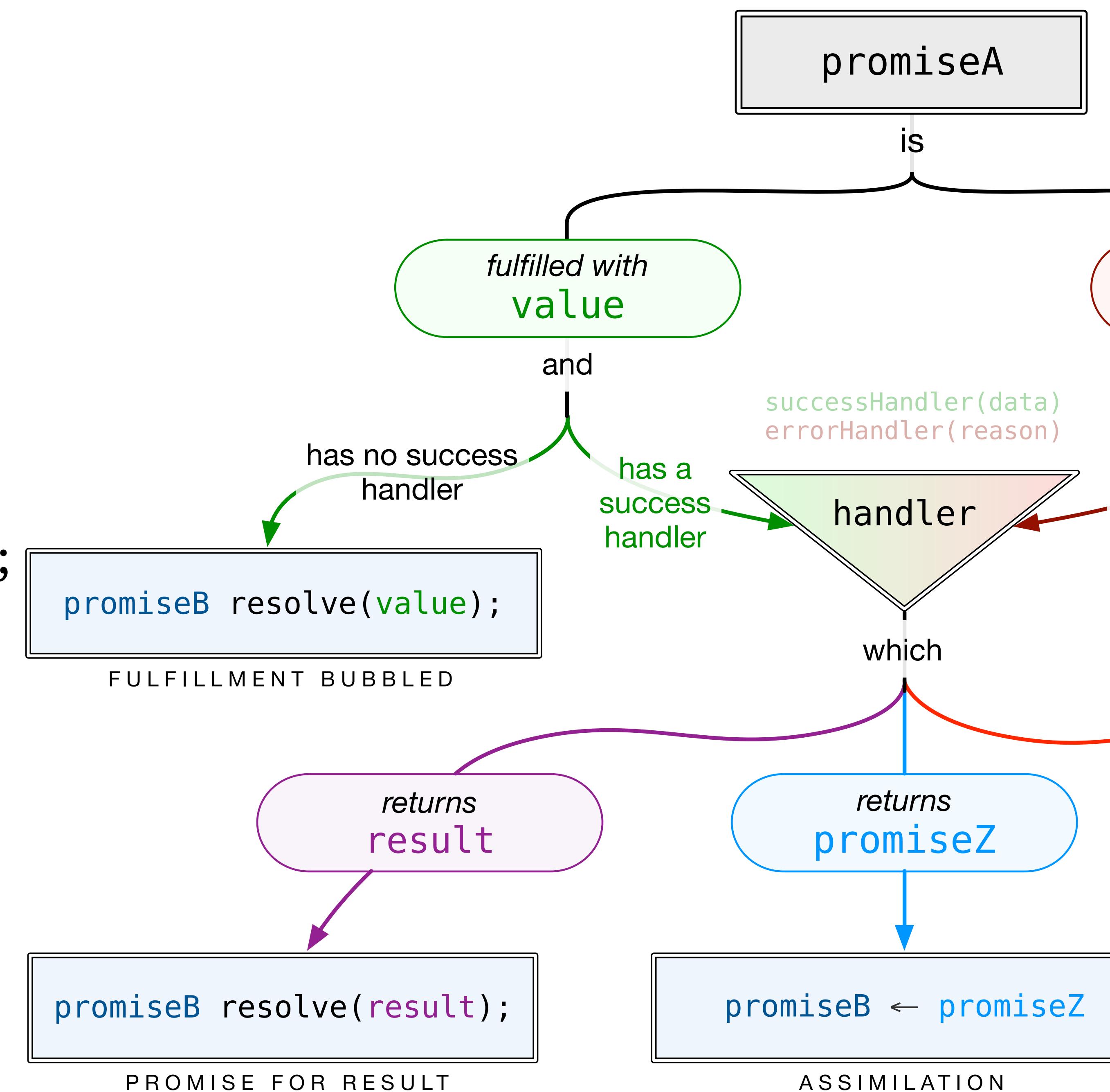
```
// promise0 fulfills with 'Hello.'
promise0
  .then(null, warnUser) // -> p1
  .then() // -> p2
  .then() // -> p3
  .then(null, null) // -> p4
  .then() // -> p5
  .then(console.log.bind(console));
```

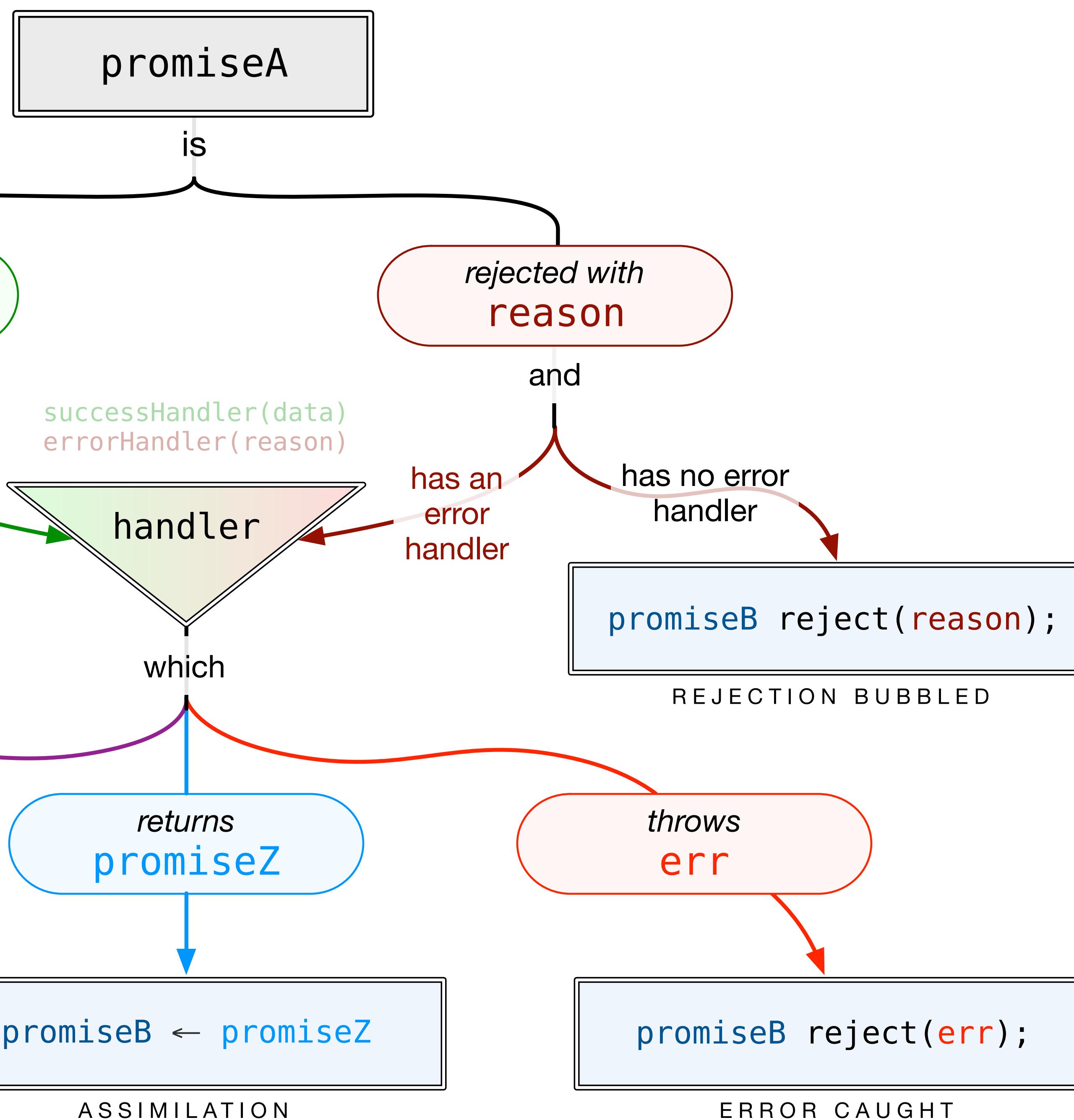


```
// promise0 fulfills with 'Hello.'
promise0
  .then(null, warnUser) // -> p1
  .then() // -> p2
  .then() // -> p3
  .then(null, null) // -> p4
  .then() // -> p5
  .then(console.log.bind(console));
```

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.”





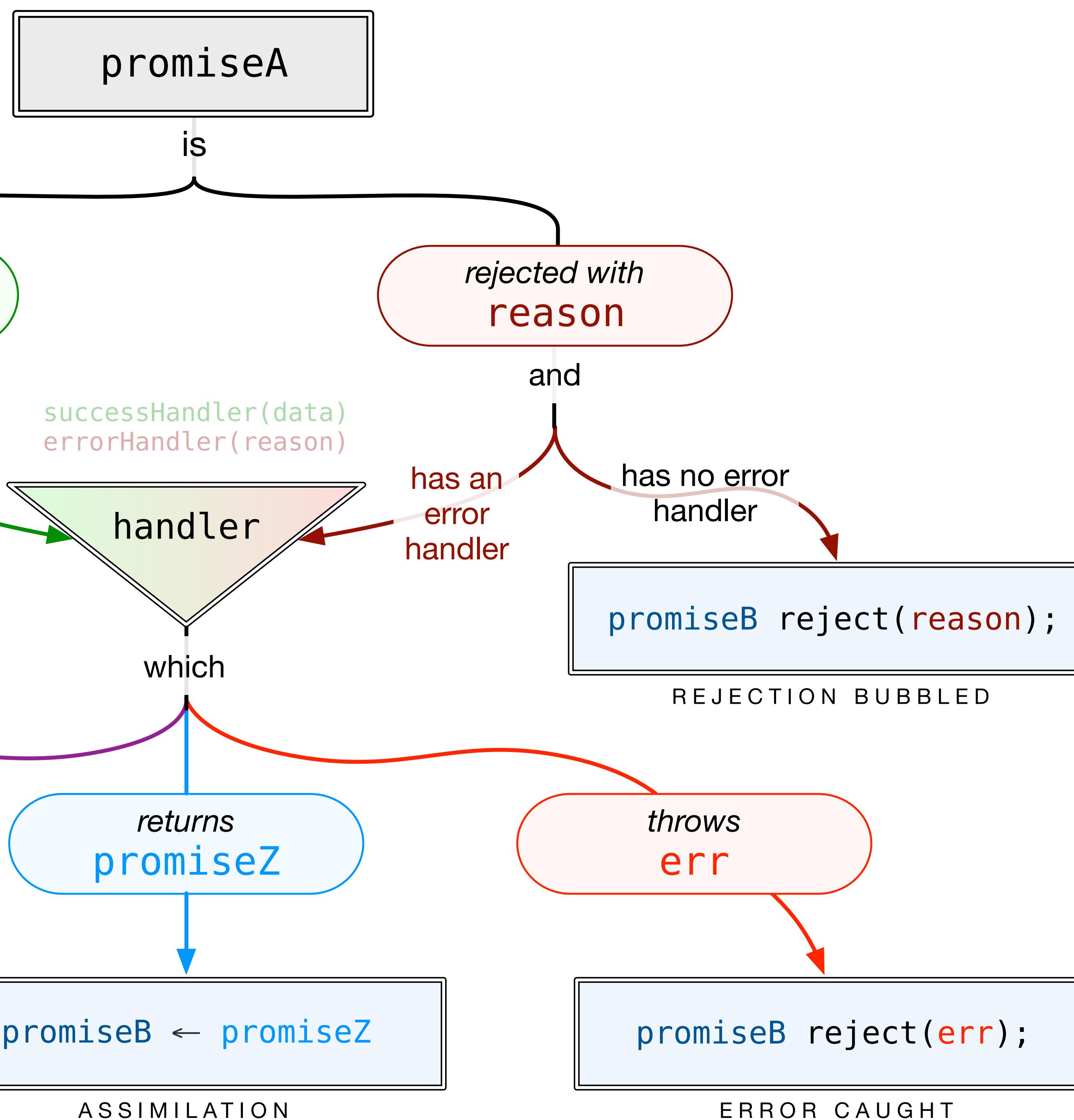
```

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

// promise0 rejected with 'Sorry'

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

```



```

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

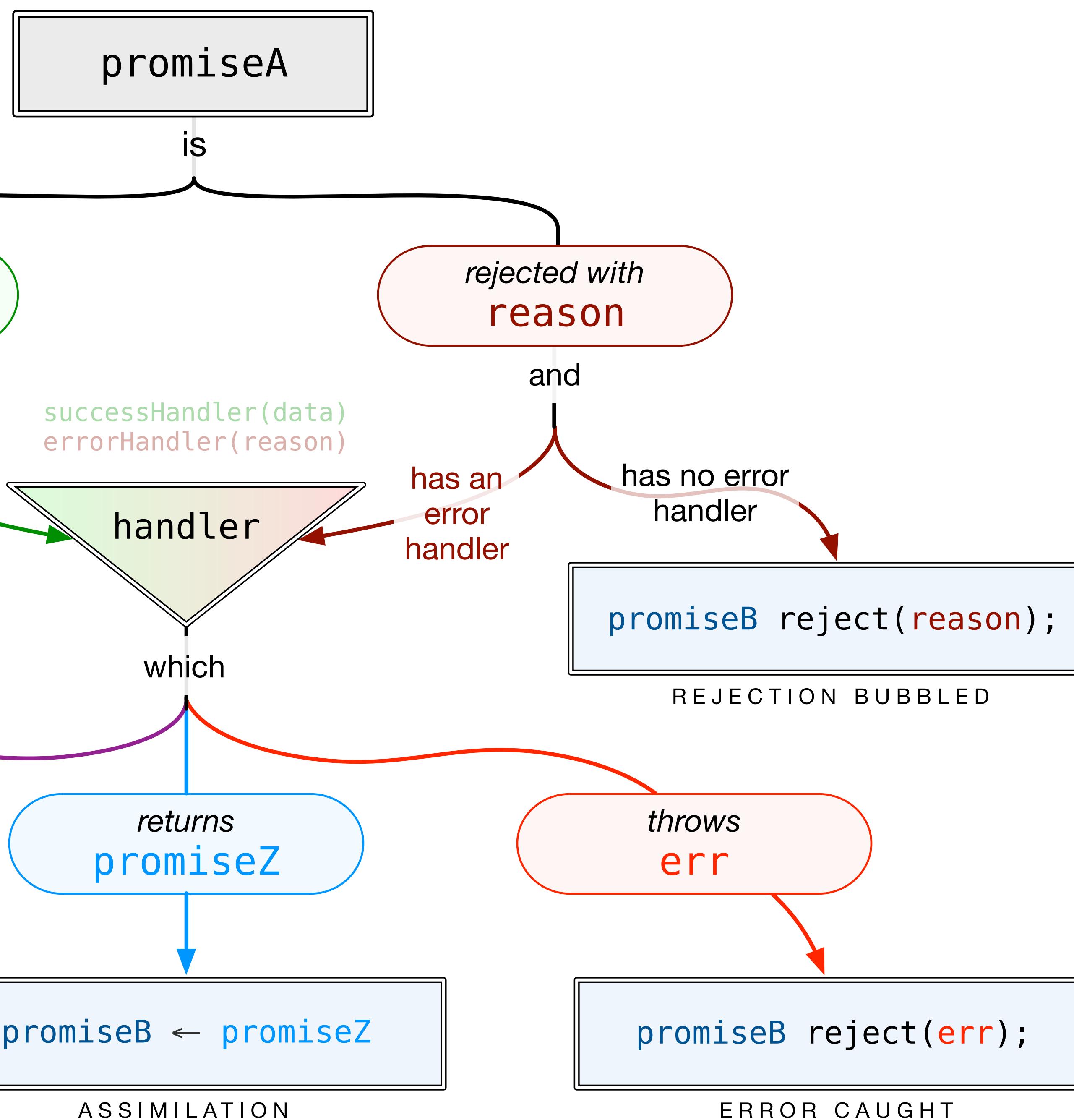
// promise0 rejected with 'Sorry'

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

```

Rejection bubbles down to the first available error handler.

Console log is “Sorry”.

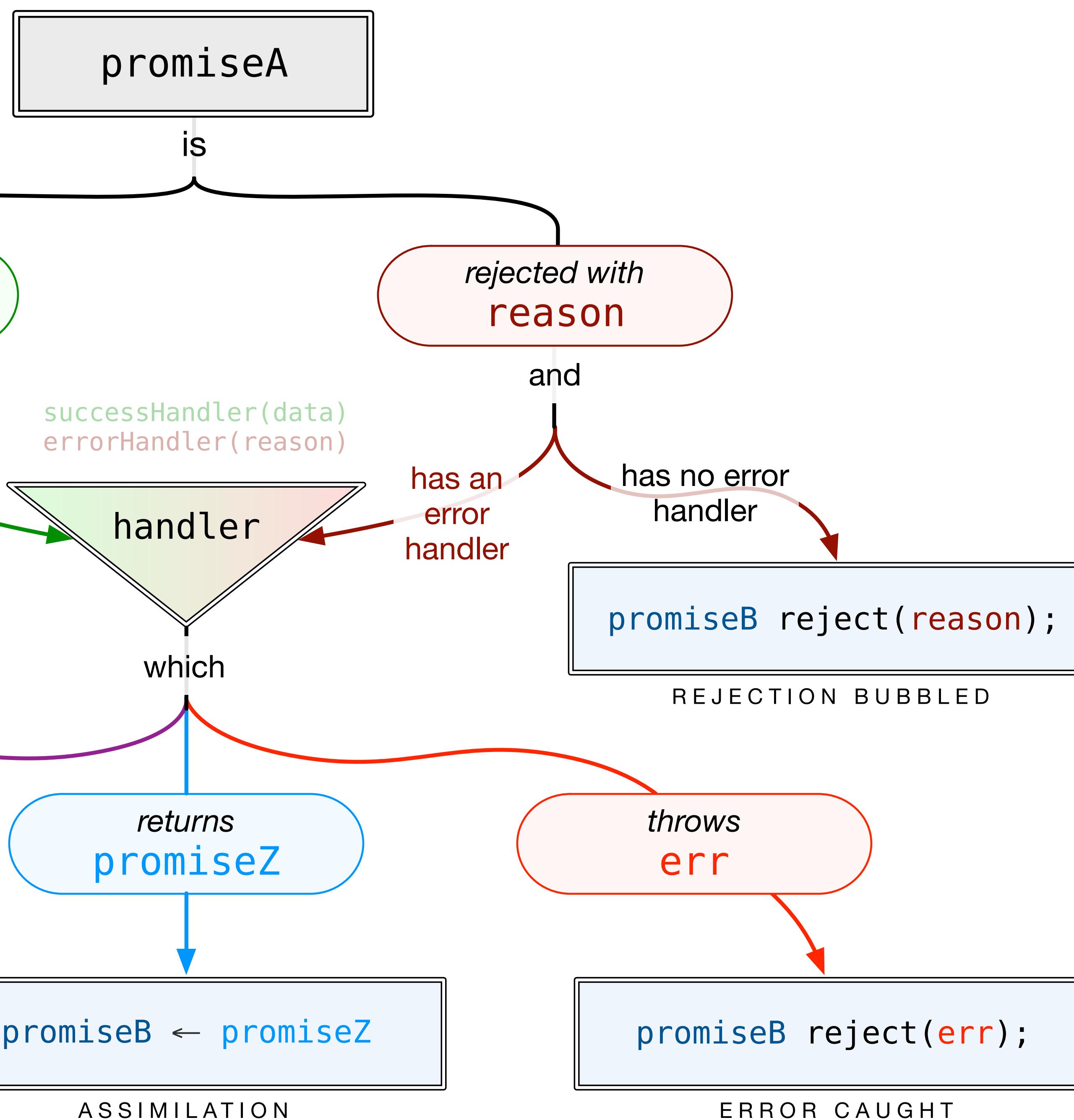


```
function logYell (input) {
  console.log(input + ' ! ');
}
```

// promise0 rejected with 'Sorry'

promise0

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



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

// promise0 rejected with ‘Sorry’

promise0

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

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

Console log is “Sorry!”



Review: Success & Error Bubbling

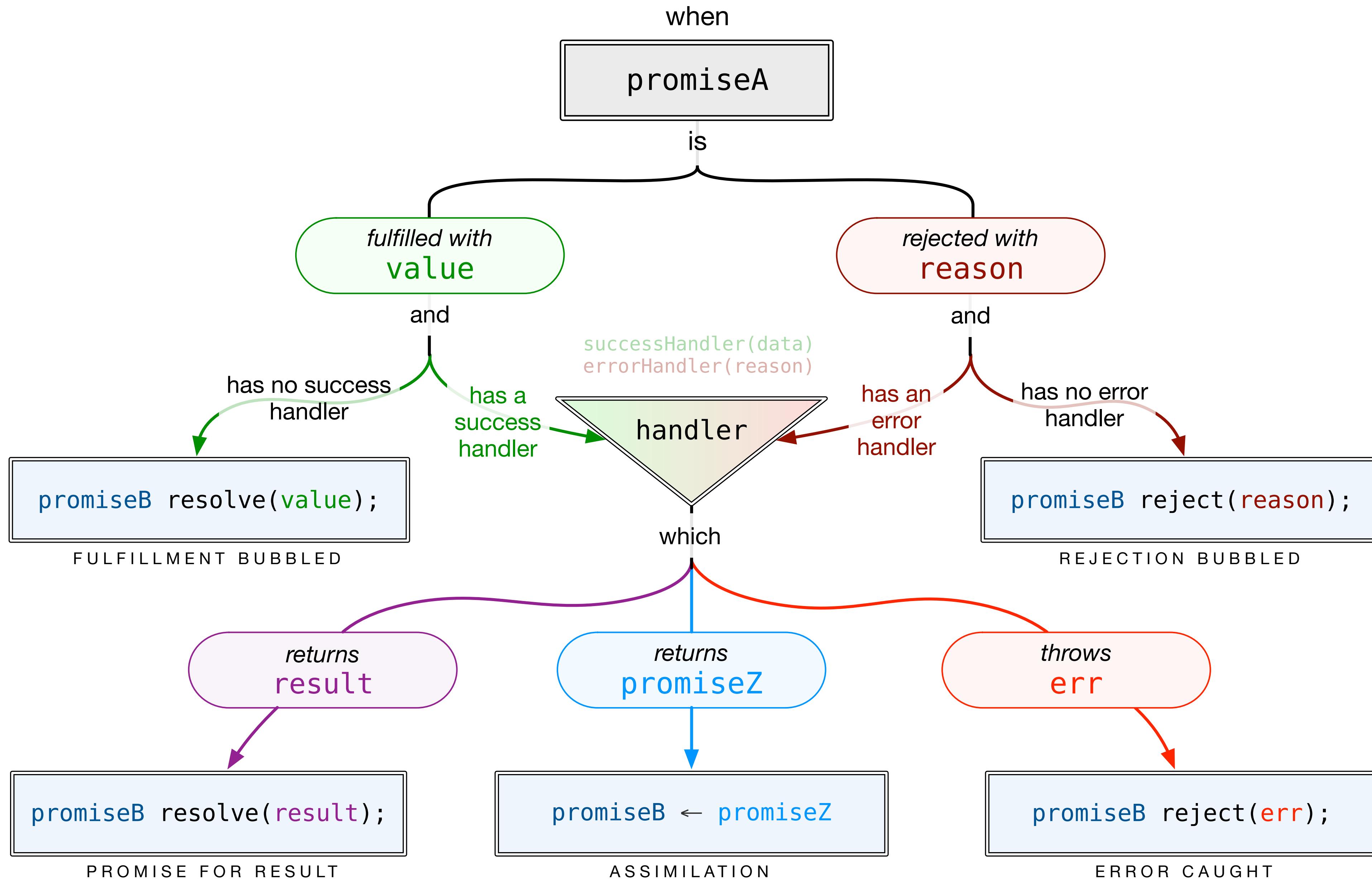
```
// promiseA is fulfilled with 'hello'  
promiseA  
  .then( null, myFunc1, myFunc2 )  
  .then()  
  .then( console.log );
```

*// 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
```

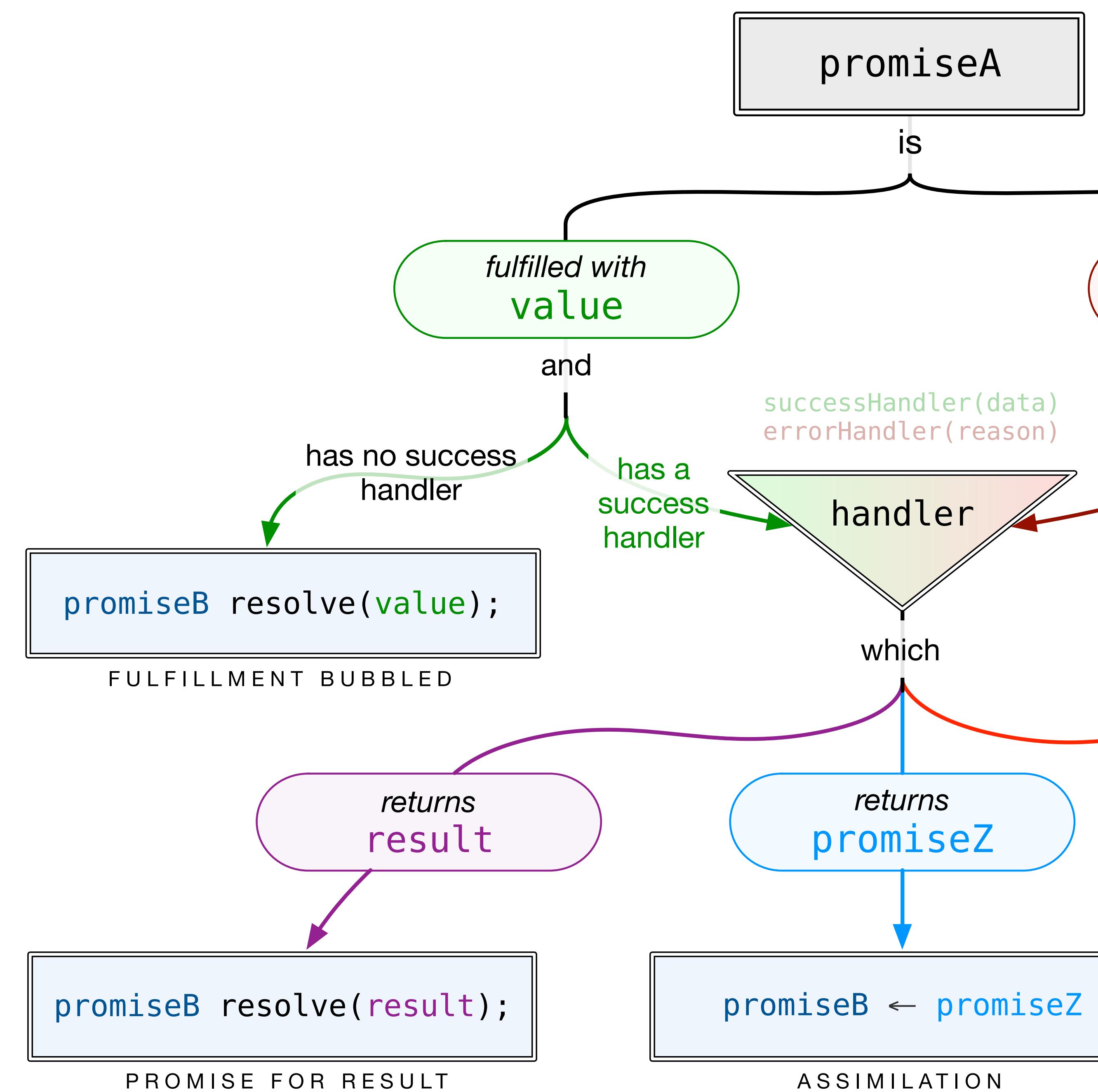
```
promiseForVal2 = promiseForVal1
  .then( function success (val1) {
    val2 = ++val1;
    return val2;
  });

```

```
// 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 );
  });

```

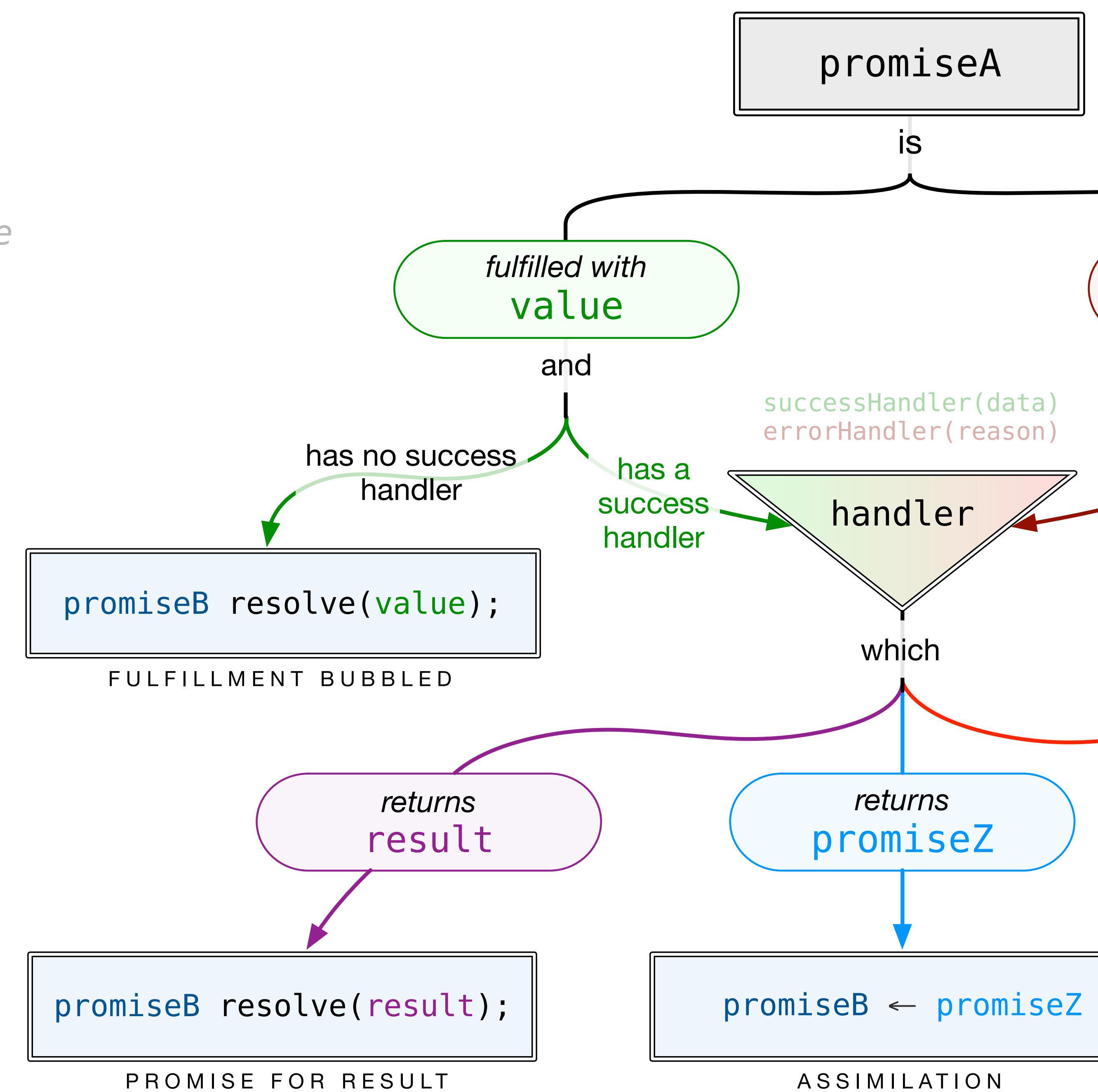


// output promise "becomes" returned promise

```
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;
  });

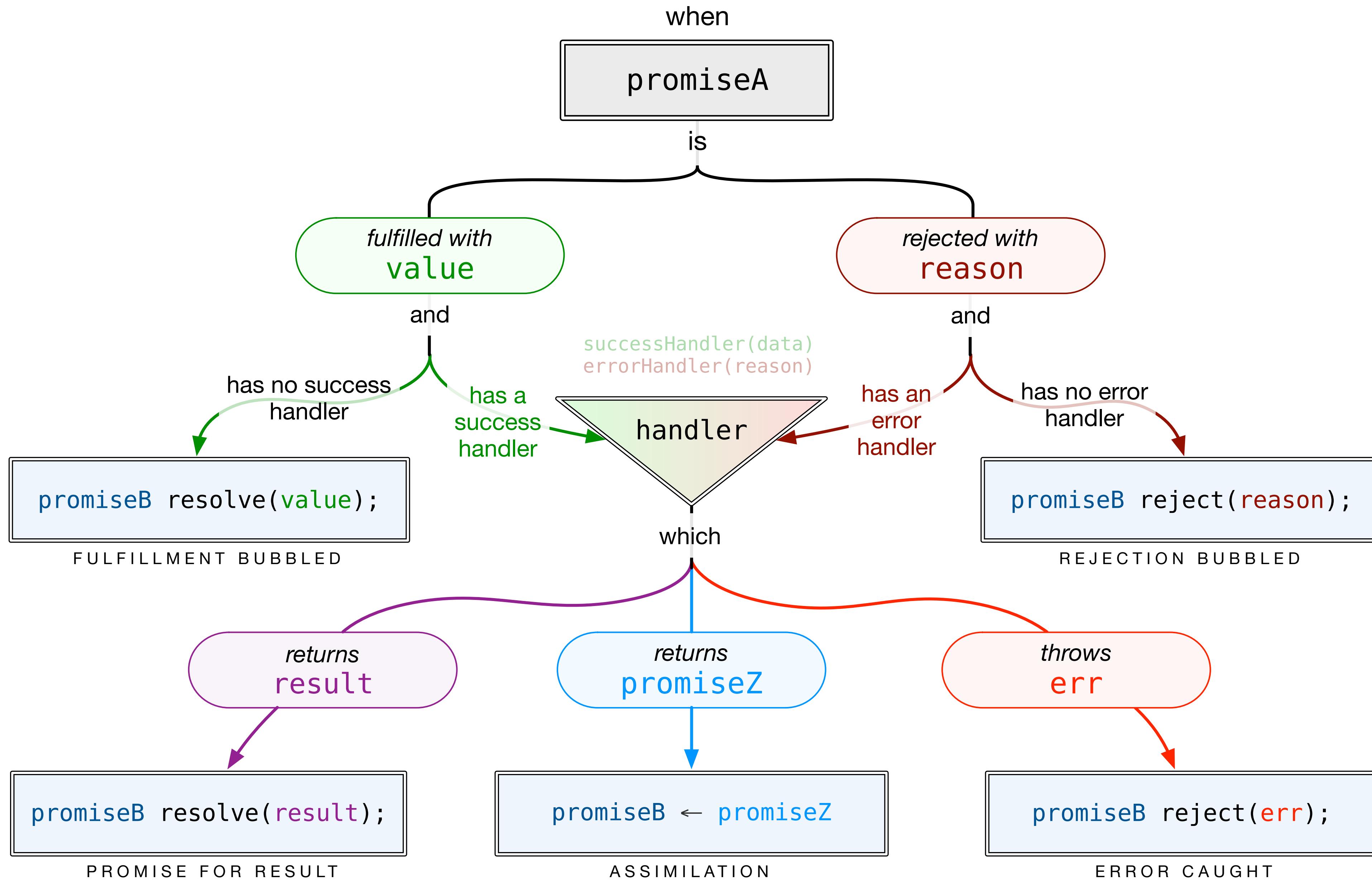
```

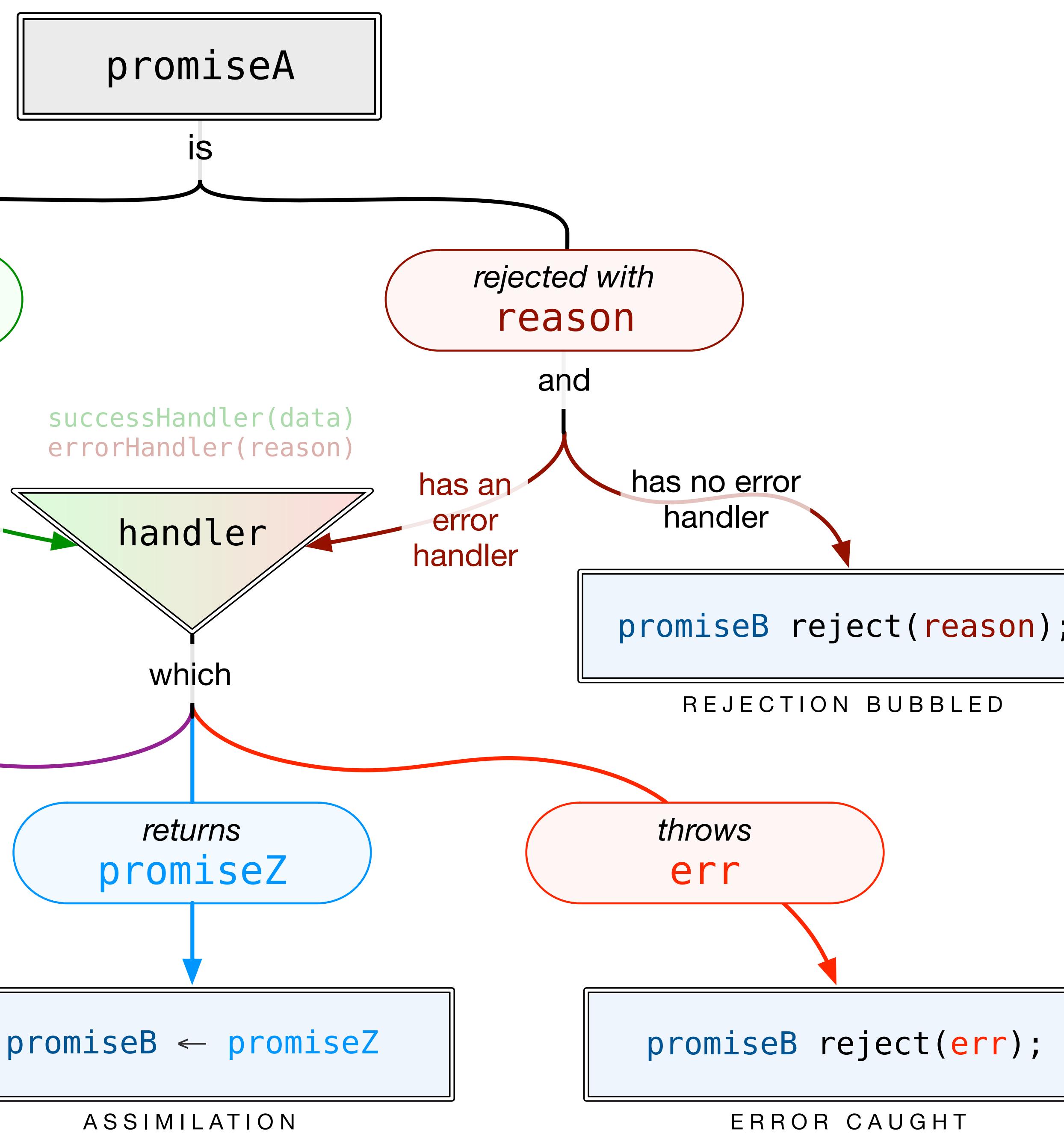
// same idea, shown in a direct chain:

```
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);
});
```

- ➊ Since `.then` (also `.catch`) always returns a new promise, it never throws an error, but instead rejects the outgoing promise.
- ➋ This used to be a problem, but these days, promise libraries are “smart” and give warnings.
- ➌ In the future, unhandled rejections might throw errors!

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](#)