Double the Beyoncé

Navigating Numbers in JavaScript

Meggan Turner - Software Engineer @ Jaxsta

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YOU READY?

What’s a number?

Count

Measure

Label

Identify

Classification

Natural	1, 2, 3, 4…
Integer	-2, -1, 0, 1, 2…
Rational	½, ⅓, ¼…
Irrational	π, √2…
Real	1, ½, 0.7, π, √2…

Complex

Transcendental

Imaginary

Infinity (& −infinity)

Infinitesimals

Surreal …

¯_(ツ)_/¯

Representation

8

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आठ

Base 10	1234567
Binary	0b100101101011010000111
Octal	0o4553207
Hexadecimal	0x12D687
Scientific Notation	1.234567e+06 (or $1.234567 * 10^6$)

What's a number in JavaScript?

Standards

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IEEE-754

IEEE Standard for Floating Point Arithmetic

Or why
0.1 + 0.2 !== 0.3

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- Specifies the implementation of floating-point arithmetic in JavaScript (how we represent decimal points in binary)

- Allows us to represent real numbers as an **approximation**, to support a trade off between *range* & *precision*

Range

-9007199254740991 — +9007199254740991

Precision

17 decimal places (e.g. 0.30000000000000004)

01001000 01100101 01101100 01101100
01101111 00101100 00100000 01010011
01101001 01101110 01100111 01100001
01110000 01101111 01110010 01100101
00100001

Hello, Singapore!

We can’t have *decimal* points in binary

Floating-point arithmetic tries to account for this

1234567

01000001001100101101011010000111
00000000000000000000000000000000

64 bits

1 bit	11 bits	52 bits
0	10000010011	0010110101101000011100000000000000000000000000000000
Sign	Exponent	Significand / Mantissa

$$+ \; 1.23 \; * \; 10^{6}$$

```
> 0.1 + 0.2
<- 0.30000000000000004
```

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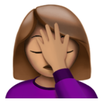
Integers

-2, -1, 0, 1, 2

Fractions

½, ⅓, ¼, ⅕…



⅓ = 0.333…

0.33 + 0.33 + 0.33 !== 1.0

0.1 (decimal)

0.0001100110011001100110011001100110011001
1001100110011001100110011001101 (binary)

0.1000000000000000555 (decimal)

How big a problem is this really?

```
> 0.1 + 0.2
< 0.30000000000000004
```

0.00000000000000004cm

= 0.0000000003 times as long as a Glucose Molecule

0.00000000000000004km

= 0.000000000000000000001 times as long as The Distance from Earth to the Moon

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0.00000000000000004ly

= 38.38cm, or about the height of a standard bowling pin

In most cases - this degree of accuracy is not going to be that important

Size really does matter

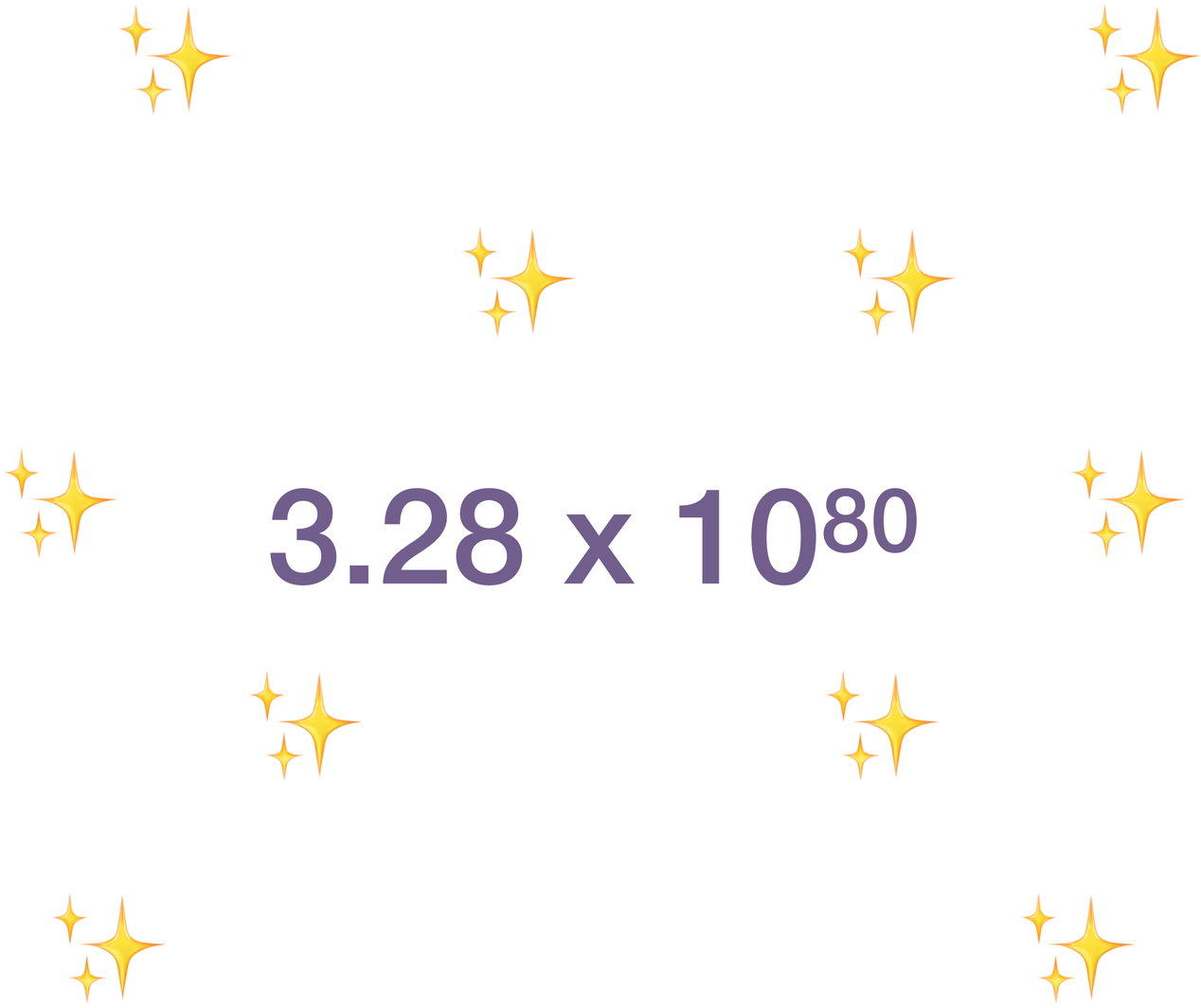
A trade off between *range* and *precision*

```
> 1.7e308
< 1.7e+308

> 1.8e308
< Infinity
```

```
> Number.MAX_VALUE
<- 1.7976931348623157e+308

> Number.MIN_VALUE
<- 5e-324
```



```
> Number.MAX_SAFE_INTEGER
<· 9007199254740991

> Number.MIN_SAFE_INTEGER
<· -9007199254740991
```

(or ~9 quadrillion)

```
> Number.MAX_SAFE_INTEGER
< 900719925474099 1

> Number.MAX_SAFE_INTEGER + 1
< 900719925474099 2

> Number.MAX_SAFE_INTEGER + 2
< 900719925474099 2

> Number.MAX_SAFE_INTEGER + 3
< 900719925474099 4

> Number.MAX_SAFE_INTEGER + 4
< 900719925474099 6

> Number.MAX_SAFE_INTEGER + 5
< 900719925474099 6

> Number.MAX_SAFE_INTEGER + 6
< 900719925474099 6
```

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Song

Drunk in Love

Song by Beyoncé

Our music credits mission

Listen

Overview | Releases | Lyrics

Credits

Main Artist

Main Artist	Beyoncé

Featured Artist

Featured Artist	Beyoncé

Songwriters

Composer	Andre Eric Proctor
	Beyoncé Knowles
	Brian Soko
	Jerome Harmon
	Noel Fisher
	Rasool Diaz
	Shawn Carter

Appears On

BEYONCÉ [Platinum Edition]
by Beyoncé
Album 2014

BEYONCÉ
by Beyoncé
Album 2014

Explore all releases

Lyrics

I've been drinking, I've been drinking
I get filthy when that liquor get into me
I've been thinking, I've been thinking
Why can't I keep my fingers off you, baby?

Info

Duration
05:23

Contributors
1 Main Artist
1 Featured Artist
8 Songwriters
6 Producers
1 Production Team
9 Engineers
5 Performers
1 Other Contributor

Appears On
2 Releases

Listen

Apple Music
Spotify

```
> parseInt(11016032301404167)
<· 11016032301404168
> parseInt(11016032301404168)
<· 11016032301404168
```

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New Tab


```
"creditRelationship": {
  "data": {
    "id": 110160323014041 67,
    "name": "Beyoncé 👸🏾",
    "type": "entityCreditRelationship"
  }
}
"creditRelationship": {
  "data": {
    "id": 110160323014041 68,
    "name": "Jay Z 🤴🏾",
    "type": "entityCreditRelationship",
  }
}
```


Dev Tools


```
▼ (2) [{…}, {…}] i
  ▼ 0:
    ▼ data:
        id: 110160323014041 68
        name: "Beyoncé 👸🏾"
        type: "entityCreditRelationship"
  ▼ 1:
    ▼ data:
        id: 110160323014041 68
        name: "Jay Z 🤴🏾"
        type: "entityCreditRelationship"
```

- Correct, unparsed integer in new tab
- Parsed integer in dev tools

- Parsed integer in new tab
- Parsed integer in dev tools

¯_(ツ)_/¯

Solution: use UUIDs

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Enter BigInt

- New numeric primitive (introduced in 2018)
- Available in Chrome, Firefox (68 beta), Edge
- We can represent numbers beyond the MAX_SAFE_INTEGER

```
> 100n
< 100n
> BigInt(100)
< 100n
```

```
> BigInt(100.5)
✕ ▶Uncaught RangeError: The number 100.5 is not a safe integer and thus cannot be converted to a BigInt    VM280384:1
    at BigInt (<anonymous>)
    at <anonymous>:1:1
```

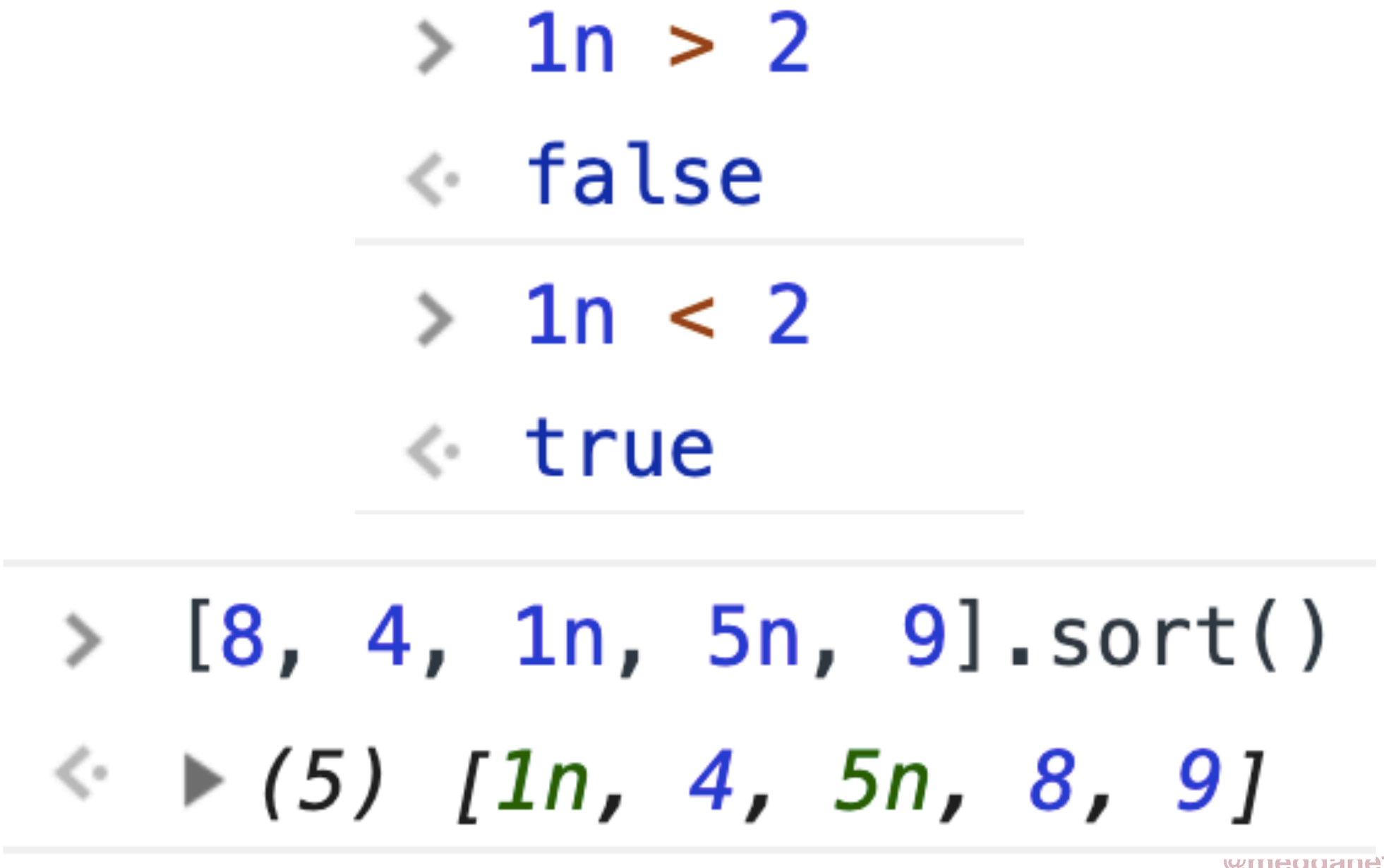
```
> 100n + 100n
<· 200n

> 10n - 5n
<· 5n

> 10n * 10n
<· 100n
```

```
> 10n / 3n
<· 3n

> 10n ** 2n
<· 100n

> 10n % 3n
<· 1n
```

⚠️ No mixed type operations ⚠️

```
> 100n + 100
✕ ▶Uncaught TypeError: Cannot mix BigInt and other types, use explicit conversions    VM867:1
    at <anonymous>:1:6
```

```
> 0n == 0
<· true

> 0n === 0
<· false
```



```
> Number.MAX_SAFE_INTEGER
< 900719925474099 1

> Number.MAX_SAFE_INTEGER + 1
< 900719925474099 2

> Number.MAX_SAFE_INTEGER + 2
< 900719925474099 2

> Number.MAX_SAFE_INTEGER + 3
< 900719925474099 4

> Number.MAX_SAFE_INTEGER + 4
< 900719925474099 6

> Number.MAX_SAFE_INTEGER + 5
< 900719925474099 6

> Number.MAX_SAFE_INTEGER + 6
< 900719925474099 6
```

```
> var bigNum =
  BigInt(Number.MAX_SAFE_INTEGER)

> bigNum + 1n
< 9007199254740992n

> bigNum + 2n
< 9007199254740993n

> bigNum + 3n
< 9007199254740994n
```

```
> bigNum + 4n
<· 9007199254740995n

> bigNum + 5n
<· 9007199254740996n

> bigNum + 6n
<· 9007199254740997n
```

- Not ready for production apps (yet)
- Not available in all browsers
- Not a lot of documentation available

Dan Abramov
@dan_abramov

Replying to @rachelnabors @eyekwasi and @drosenwasser

I think the original tweet is a satirical take on how people sometimes like to poke at JavaScript even when JavaScript behavior is totally reasonable (e.g. quirks of floating point math).

9:57 AM · Jun 15, 2019 · Twitter Web App

- 64 bit floating points
- Precision errors
- Round!

- Max Safe Integer
- BigInt

Less

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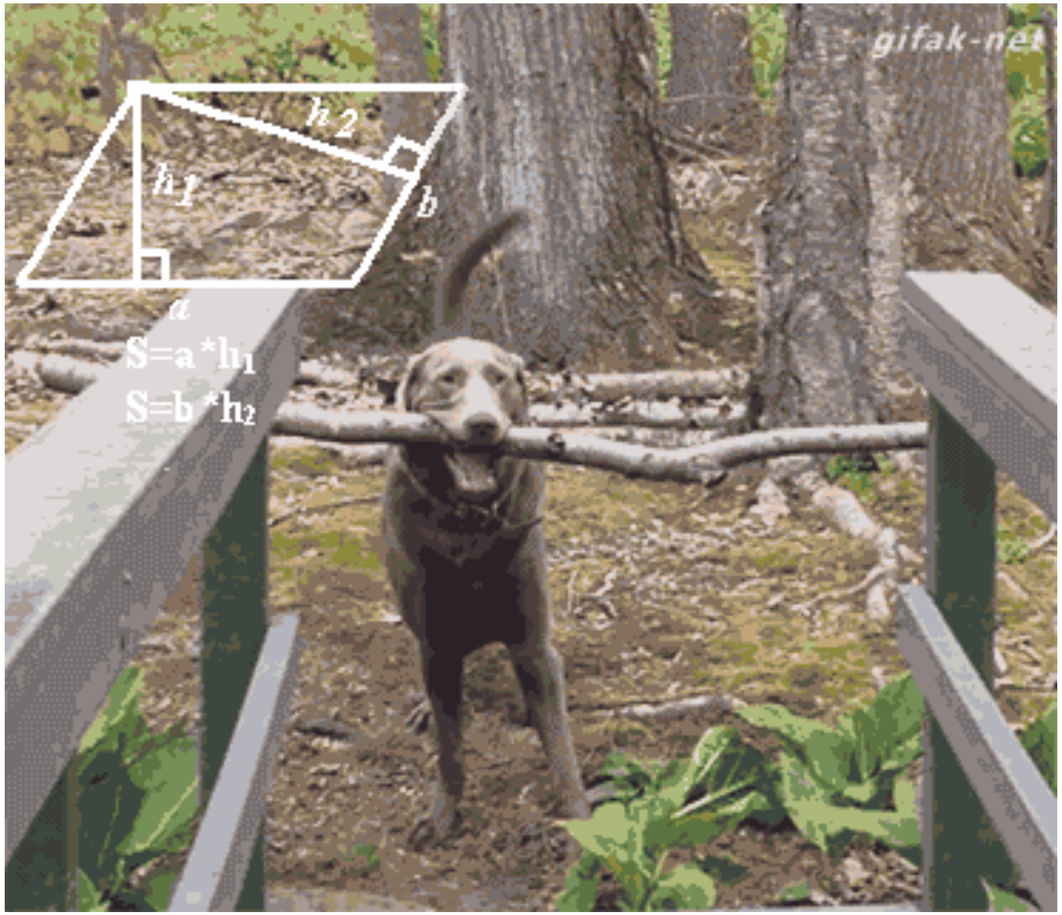
More



Less

More