Numerical Evaluation

This lesson discusses numeric types and evaluation in SymPy.

WE'LL COVER THE FOLLOWING

Numeric types

While SymPy primarily focuses on symbols, it is impossible to have a completely symbolic system without the ability to numerically evaluate expressions. Many operations will directly use numerical evaluation, such as plotting a function or solving an equation numerically.

SymPy has 3 numeric types: rational, real, and integers. Since rational is the new one, let's discuss it here:

Rational

The rational class represents a rational number as a pair of two integers: the numerator and the denominator.

```
Rational(1, 4)
```

represents $\frac{1}{4}$

```
Rational(5, 3)
```

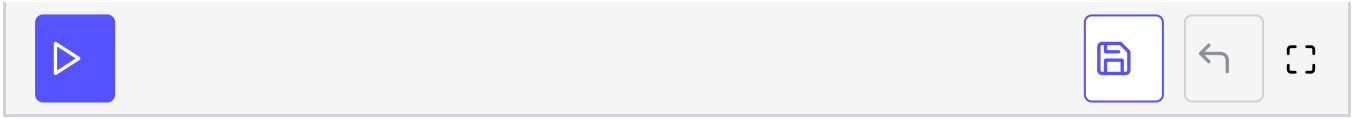
represents $\frac{5}{3}$

All the arithmetic operations can be performed on these rational numbers. Let's see an implementation of this below:

```
from sympy import *

x = Rational(4, 5)
y = Rational(4, 6)

print("Addition:", x + y)
print("Subtraction:", x - y)
print("Multiplication:", x * y)
print("Division:", x / y)
```



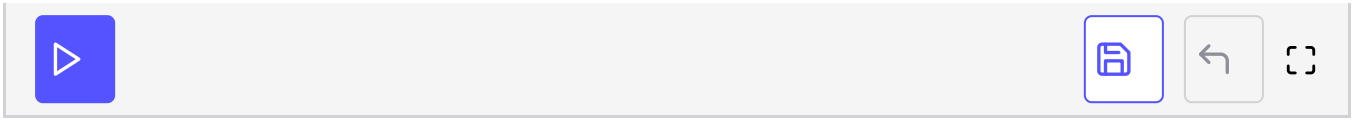
Conversion to float

The `evalf()` method converts a constant symbolic expression to a `Float` with the specified amount of precision. Let's convert the rational numbers in the code above to floating points:

```
from sympy import *

x = Rational(4, 5)
y = Rational(4, 6)

print("Addition:", (x + y).evalf(20))
print("Subtraction:", (x - y).evalf(10))
print("Multiplication:", (x * y).evalf(7))
print("Division:", (x / y).evalf(3))
```



Substituting values in an expression

To find the numerical values of expression, we use the `subs()` method. This method takes a dictionary as an input with the variables as the keys and its associated values as the substituting value:

```
expression.subs({'symbol_1': value_1, 'symbol_2': value_2 ....  })
```

Let's substitute the values of x and y into the following equation:

$$z = 2y^3 + 3x^2 + 2$$

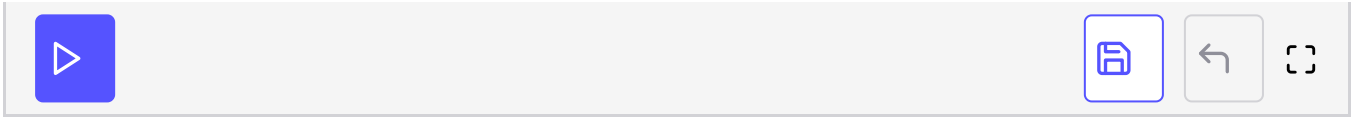
with $y = 2$ and $x = 3$

with $y = 2$ and $x = 3$.

```
from sympy import *

x, y, z = symbols('x, y, z')

z = (2 * y**3) + (3 * x**2) + 2
output = z.subs({'y': 2, 'x': 3})
print(output)
```



We will learn about the different techniques of algebraic manipulation in the next lesson.