Simplification of symbolic expressions with constraints

Lab 4 TDA452

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Problem formulation

What we want to model:

$$x^4 + (y+1)z, \tag{1}$$
$$y = z - 1, \tag{2}$$
$$z = x^2. \tag{3}$$

Substituting (2), followed by (3), simplifies (1) to

$$2x^4. \tag{4}$$

Our model

```
newtype Variable = Variable String
    deriving Eq

data Expr =
    N Integer
    | V Variable
    | Add [Expr]
    | Mul [Expr]
    | Pow Expr Expr
```

Canonical form of expressions

```
toCanonical :: Expr -> Expr
```

- distributes multiplication over addition
- combines terms with the same factors
- removes multiplication by 1 and addition by 0
- etc

Simplification

```
newtype Rule = Rule (Variable, Expr)

findSimplest :: Expr -> [Rule] -> Expr
```

- builds a list of new expressions by applying a list of rules
- iterates
- prunes the expression list according to some heuristic

Example

Example from before:

$$x^4 + (y + 1)z, \tag{5}$$
$$y = z - 1, \tag{6}$$
$$z = x^2. \tag{7}$$

```
> findSimplest
    (Pow (V x) (N 4) .+ ((V y .+ N 1) .* V z))
    [Rule (y, V z .- N 1), Rule (z, Pow (V x) (N 2))]

2*x^4
```

LaTeX code from expressions

```
toLatex :: Expr -> String

> toLatex (Mul [N 2, Pow (V x) (N 4)])
    "2x^4"
```