Disco
A Functional Programming Language for Discrete Mathematics

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Disco

- Functional teaching language
- Designed for use in a Discrete Mathematics course
- Birthplace: TFPIE 2016, Maryland, USA!
- Have used it in a Discrete Math class once, in Spring 2022.
- Plan to use it again starting next week.
Disco goals

- Teach early CS students basic FP concepts
- Help students connect math and computation
- Enhance learning with an interactive platform
- Minimize notational & conceptual friction
Friction?

\[ f : \mathbb{N} \rightarrow \mathbb{Q} \]

\[ f(2n) = 0 \]

\[ f(2n + 1) = \begin{cases} 
  n/2 & \text{if } n > 5, \\
  3n + 7 & \text{otherwise}
\end{cases} \]
Friction?

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\[
\begin{align*}
  f &:: \text{Int} \rightarrow \text{Rational} \\
  f \ x &\mid \text{even } x \quad = \ 0 \\
  &\mid \ n > 5 \quad = \ \text{fromIntegral } n / 2 \\
  &\mid \ \text{otherwise} \quad = \ 3*n + 7
\end{align*}
\]

where

\[ n = x \ `\text{div}` \ 2 \]
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\end{cases} \]
Demo!

https://replit.com/@BrentYorgey/Disco#README.md
Numeric types in Disco

\[
\begin{array}{c}
\mathbb{N} \xrightarrow{x/y} \mathbb{F} \\
\mathbb{Z} \xrightarrow{x-y} \mathbb{Q} \\
\mathbb{Q} \xrightarrow{|-|} \mathbb{Z} \\
\mathbb{F} \xrightarrow{|-|} \mathbb{N}
\end{array}
\]
Issues / Future work

- Error messages!
- Showing multiple type instantiations
- Types vs sets
Showing multiple type instantiations

What is the most general type of \( \lambda x . x - 2 \)?
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We do this instead, but it’s confusing:

```
Disco> :type \x. x - 2
\x. x - 2 : \mathbb{Z} \rightarrow \mathbb{Z}
Disco> (\x. x - 2) (5/2)
1/2
```
Showing multiple type instantiations

What about something like this instead?

\texttt{Disco> :type \lambda x. x - 2}
\texttt{\lambda x. x - 2}
\texttt{: \mathbb{Z} \rightarrow \mathbb{Z}}
\texttt{: \mathbb{Q} \rightarrow \mathbb{Q}}
Types vs sets

- \{2, 4, 7\} is an example of a _________________
Types vs sets

- \{2, 4, 7\} is an example of a ____________________________
- \(\mathbb{N}\) is an example of a ____________________________
Types vs sets

- \{2, 4, 7\} is an example of a _set_.
- \(\mathbb{N}\) is an example of a _set_.
- In a math class, \(\mathbb{N} - \{2, 4, 7\}\) is a perfectly well-defined, countably infinite set.

Why the difference, and how do we explain/frame it for students?
Types vs sets

- \{2, 4, 7\} is an example of a __________________________
- \(\mathbb{N}\) is an example of a __________________________
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- In Disco, \(\mathbb{N} - \{2, 4, 7\}\) is a syntax error!
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https://github.com/disco-lang/disco