One morning...

Source: manolith.com

Why!?

Practical Probabilistic Programming (With Cats)

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@noelwelsh

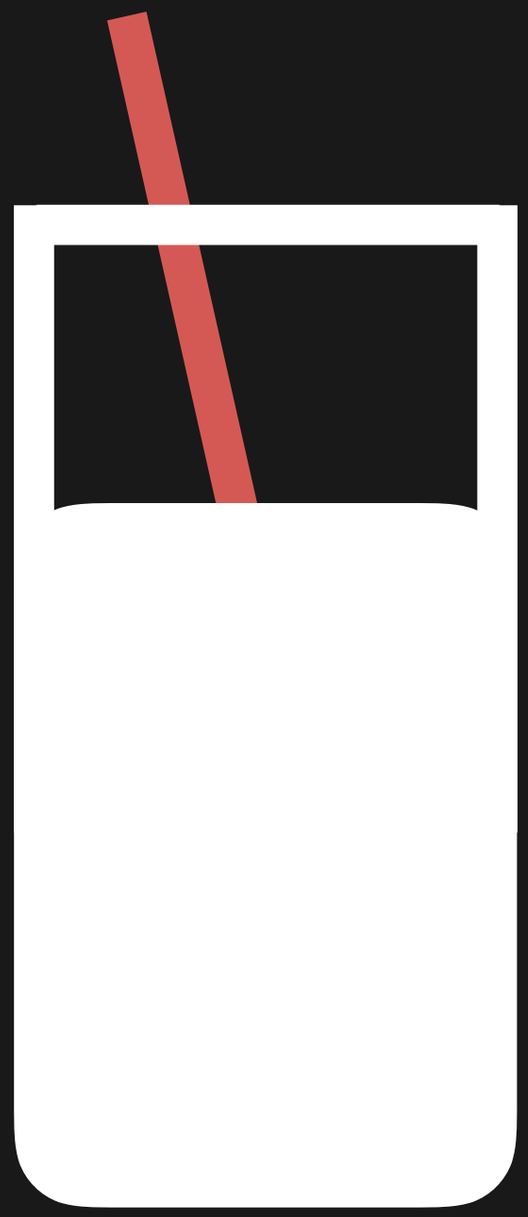
Explain what probabilistic programming is, for programmers

Show that all our favourite FP tricks apply

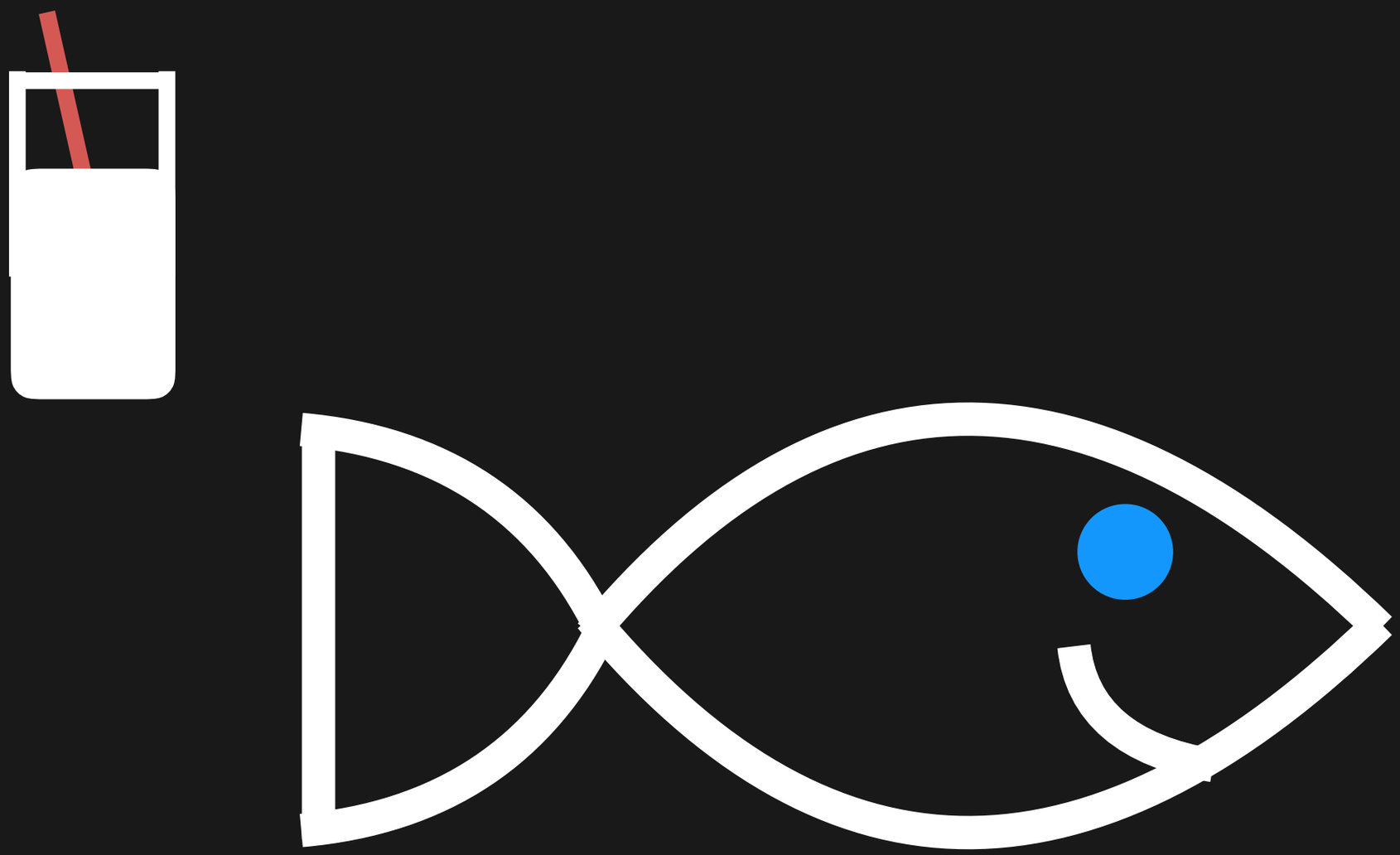
Work out what is bringing all the cats to the yard

#1 Science

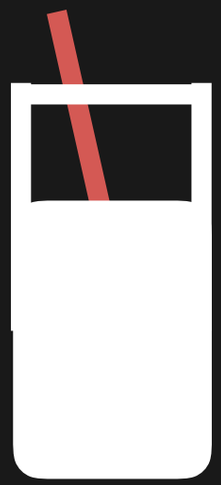
Build a model

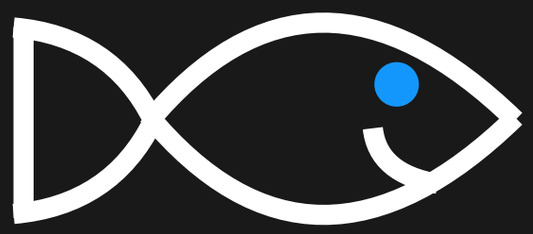


Milkshake



Fish





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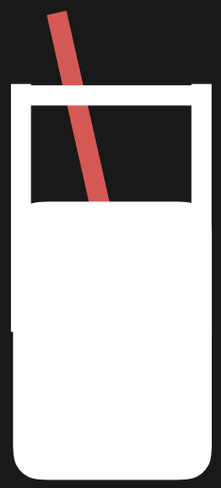

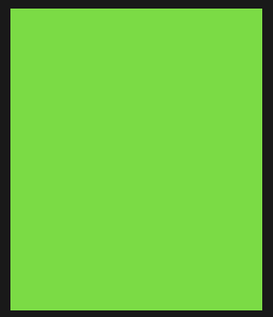

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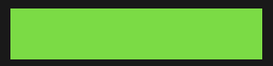

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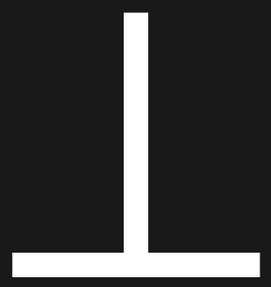

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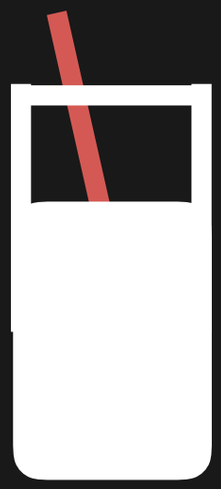
Probability distribution

Dist[Enticement]



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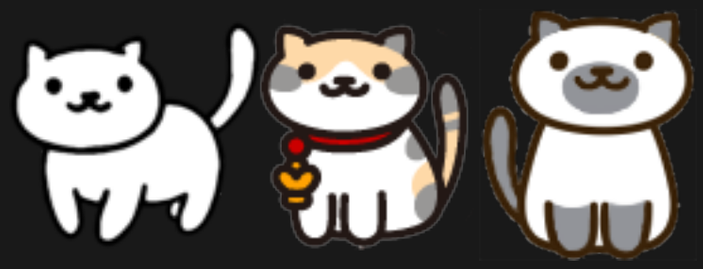

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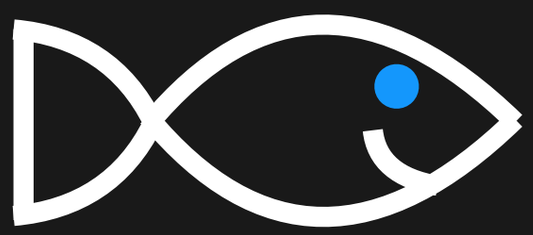

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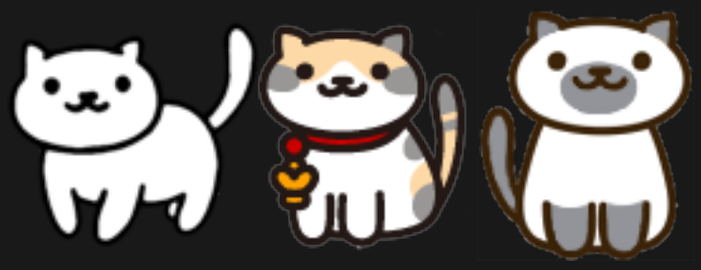

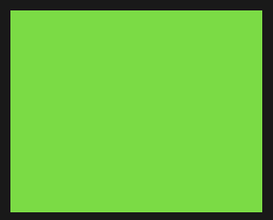

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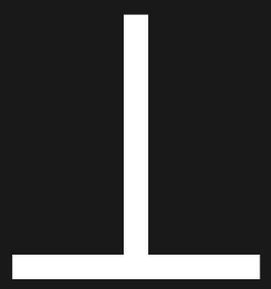

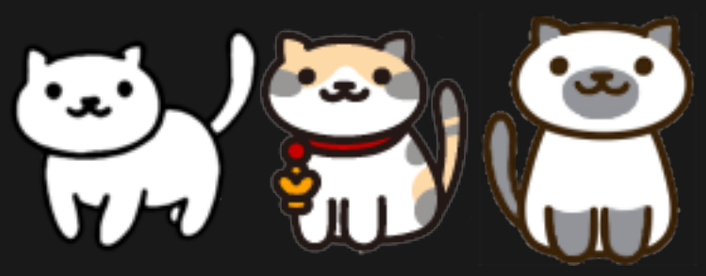

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Conditional probability distribution

Enticement =>

Dist[Cats]

Dist[E] ??? E => Dist[Cats] =

Dist[Cats]

Dist[E] flatMap E => Dist[Cats] =

Dist[Cats]

There is a monad for probability

Challenge question: if the monad represents conditional probability, what does the applicative represent?

#2 Engineering

Implement the model and answer queries

Given there are 3 cats in the yard, what is the probability there is milkshake?

$$P(enticement = milkshake | cats = 3)$$

Dist[(Enticement, Cats)]

Small discrete problems can be solved exactly

The general case requires approximate solutions

Sampling is a general method for calculating approximate solutions

Separate description of model from sampling process

User can interactively choose number of samples

Sampling method can be tailored to problem

Separate description of model from sampling process

Separate abstract syntax tree from interpreter

Reify monad as abstract syntax tree

The free monad!

Sampling is an interpreter for the free monad in the usual way.

#2 Extensions #3

Condition distribution on observations

Bayesian inference

Composition of inference algorithms

Distributing computation over a cluster

Probabilisitic programming is an open area of research

#4 Conclusions

There is a monad for probability

This is the basis for probabilistic programming

Reducing the cost of probabilistic inference has many benefits

Identify objects in deep space

Analysis of gene sequencing experiments

Better targeting of online ads

Functional programming is extremely relevant for probabilistic programming

Code: github.com/
noelwelsh/pfennig

Thank You

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https://github.com/noelwelsh/pfennig