

Karat

A Visual Framework for Constructing Neural Networks

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Georgia Tech Research Institute

Overview

- Motivation
- Design Choices
- Development Screenshots
- Roadmap





Motivation

“Any sufficiently advanced technology is indistinguishable from magic.”

~ Sir Arthur C. Clarke



Problems with Neural Networks in Application

- Distinguishing hype vs. reality
- Communication barrier between machine learning engineers and domain experts
 - Explainable AI¹ – Explain how models make decisions
 - Accessible AI – Make process of creating and managing models transparent
- Models lack trust and transparency
 - ML Technical Jargon
 - Domain Complexity
 - Security and IP Protection for Data



What aren't Neural Networks?

1. The only form of machine learning in existence.
 - Support Vector Machines
 - Decision Trees
 - Probabilistic Models
 - Clustering
2. Useful with limited quantity or quality of data.
 - GIGO (Garbage-in, Garbage-out)
 - Many diverse examples required to prevent overfitting.
3. Magic



What are Neural Networks?

1. Linear Algebra

$$\begin{bmatrix} a_{1,1} & a_{2,1} & \dots & a_{n,1} \\ a_{1,2} & a_{2,2} & \dots & a_{n,2} \\ \dots & \dots & \dots & \dots \\ a_{1,3} & a_{2,3} & \dots & a_{n,3} \end{bmatrix} * \begin{bmatrix} x_1 \\ x_2 \\ \dots \\ x_3 \end{bmatrix} + \begin{bmatrix} b_1 \\ b_2 \\ \dots \\ b_3 \end{bmatrix}$$

Image generated by Frazier N Baker using LaTeX

3. Optimization

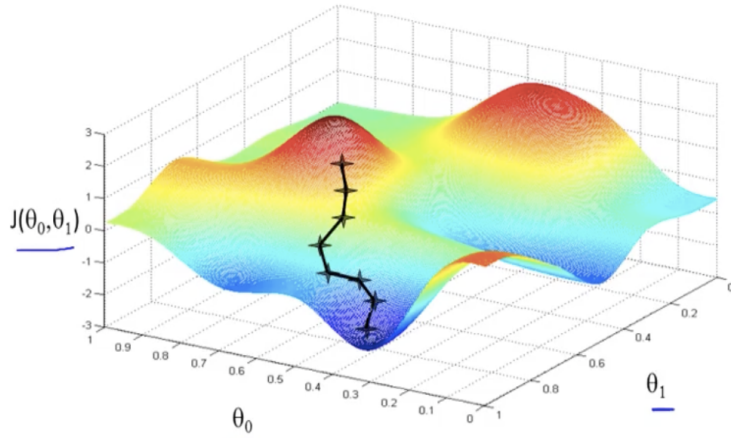


Image Credit:
"Machine Learning," Coursera. <https://www.coursera.org/learn/machine-learning> (accessed Oct. 22, 2020).

2. Nonlinear Activation

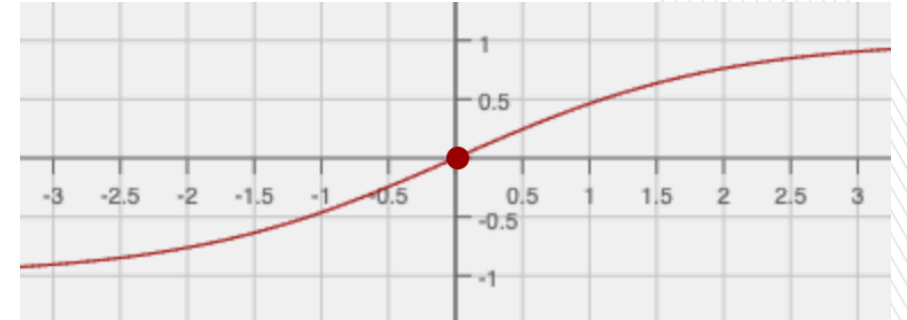


Image generated by Frazier N Baker using online graphing calculators

3. Data

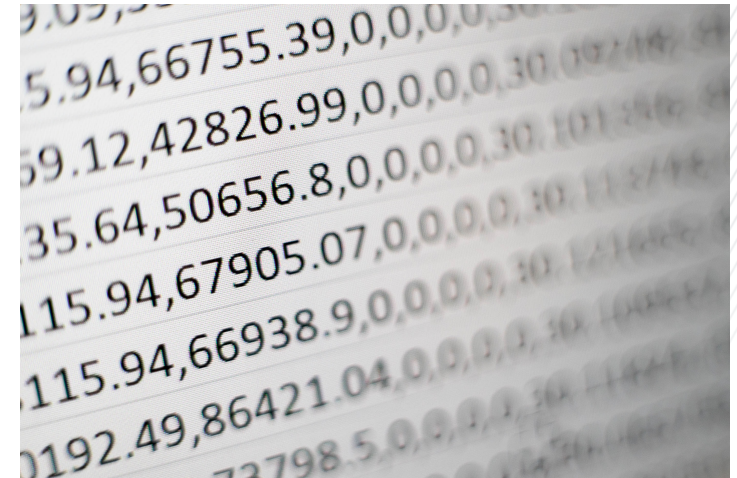


Photo by [Mika Baumeister](#) on [Unsplash](#)



Who are Neural Networks?



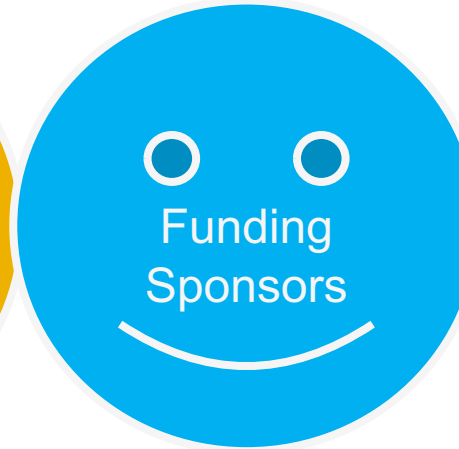


Who are Neural Networks?



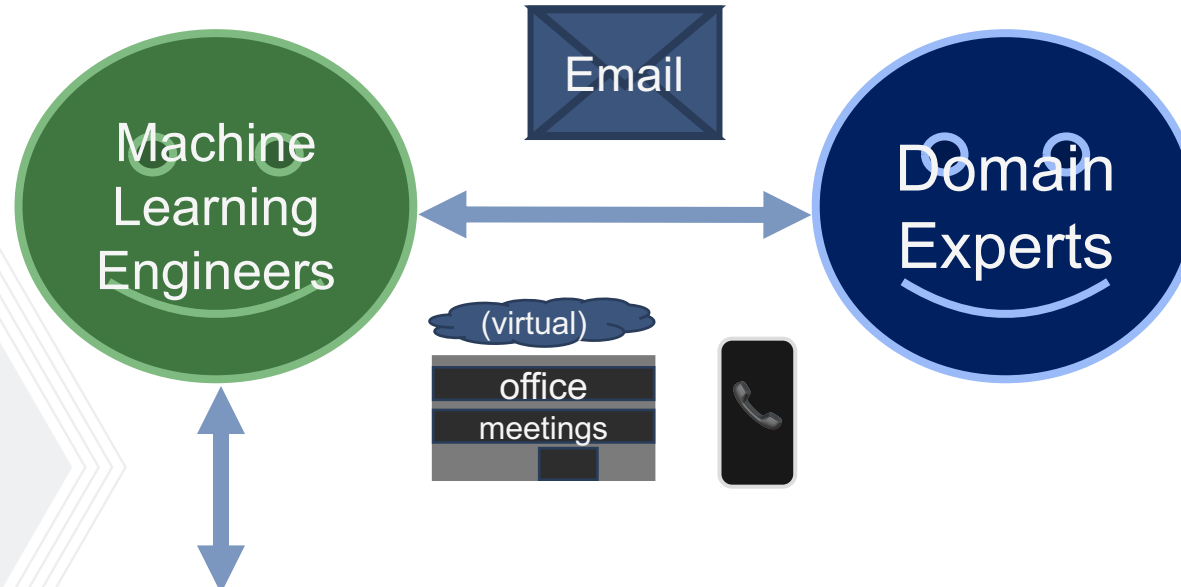
I don't know much about the application domain.

I don't know much about Neural Nets or programming.





How is it done today?



jupyter ML Notebook Last Checkpoint: 6 minutes ago (unsaved changes) Logout

File Edit View Insert Cell Kernel Widgets Help Trusted Python 3

```
In [17]: import tensorflow as tf
import pandas as pd
from matplotlib import pyplot as plt
```

Load Data
Here is a description of the data for us to talk about how it is.

```
In [9]: data = pd.read_csv("data.csv")
```

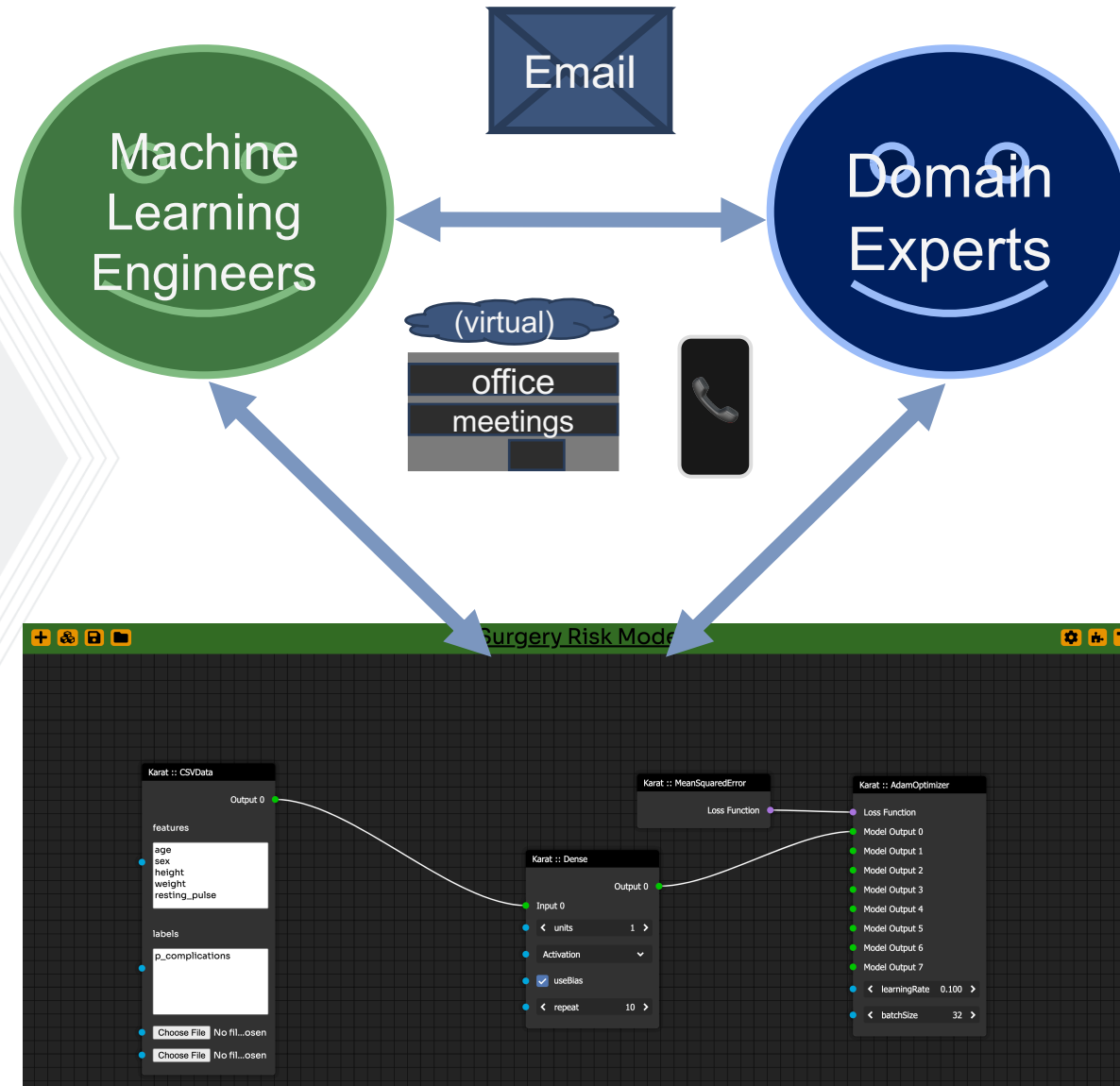
Build Model
Here is the code to build our model and a discussion of the choices we made.

```
In [10]: model = tf.keras.Sequential()
In [11]: model.add(tf.keras.layers.Dense(32))
In [12]: model.add(tf.keras.layers.Dense(1))
In [13]: model.compile(tf.keras.optimizers.Adam(0.1))
In [15]: model.fit(data)
```

Testing and Results



How could it be done better?





Design Choices

“Plurality must never be posited without necessity.”

~ Brother William of Ockham



Facilitate Communication through Graphical Representation

Better models will result from better understanding of the data.



Domain experts have a better understanding of the data.



Make models accessible to domain experts.

People trust things they can understand and inspect.



People can understand inspect simple flowcharts.



Representing models as simple flowcharts to improve transparency.

Neural network technology will continue to advance.



Machine learning engineers can understand and implement new neural network technology.



Provide extensibility through a plugin interface for ML engineers.



Government-Purpose Software

Open Source

Free, inspectable, maintainable.

Web UI

Familiar, simple, sandboxed. Uses VueJS¹ and BaklavaJS².

Container Backend

Reproducible, portable, secure. Uses Docker³.

Extendable

Capable of supporting simulation engines and data sources for practical DoD applications.

Warfighter Oriented

Leveraging years of technological innovation supporting the warfighter at GTRI⁴.



Development Screenshots

“AI lives on getting software right.”
~ Dr. Will Roper



Untitled Model





Untitled Model

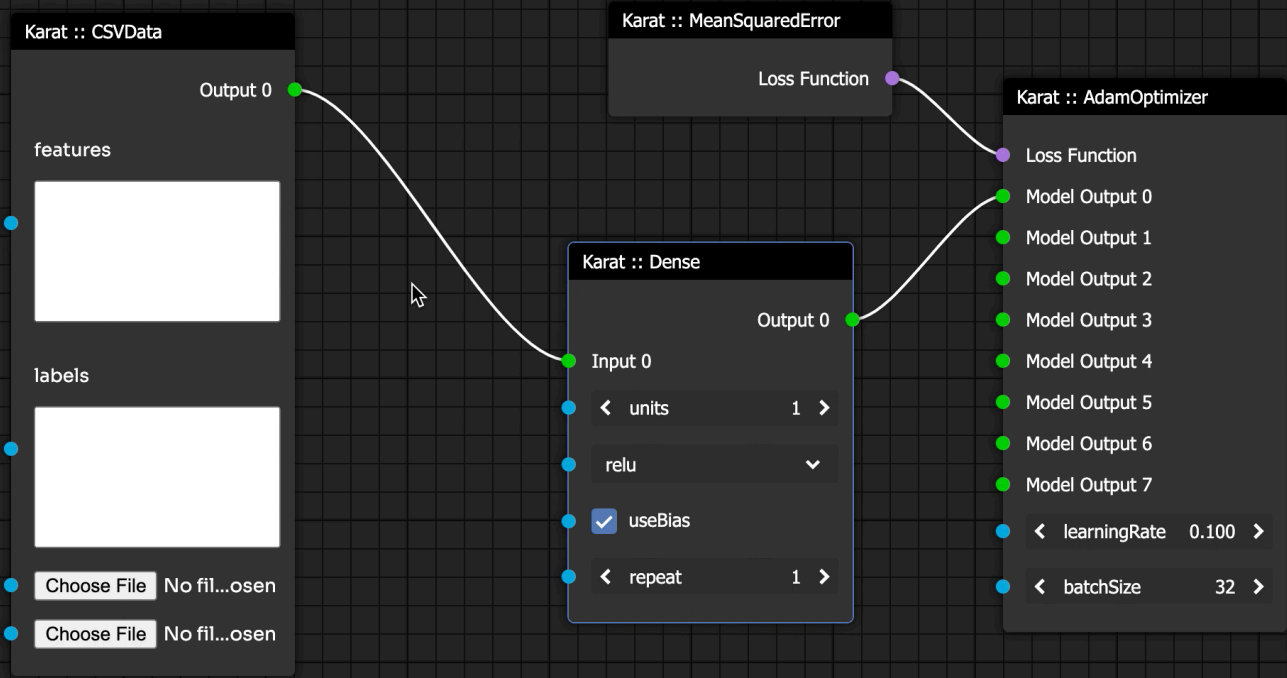


Add Node	<input type="checkbox"/>	Data	<input type="checkbox"/>
Copy Nodes		Layer	<input type="checkbox"/>
Paste Nodes		Optimizer	<input type="checkbox"/>
		Loss	<input type="checkbox"/>

Karat :: AdamOptimizer



Untitled Model



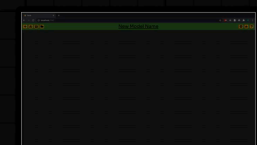
New Model Name



Plugins

- + Load New Plugin
- karat

Confirm Plugin Selection





localhost:7147 says

Warning!
Removing the karat plugin may result in changes to your neural network architecture.
Click OK only if you are sure you wish continue.

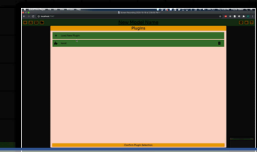
Cancel OK

+ Load New Plugin

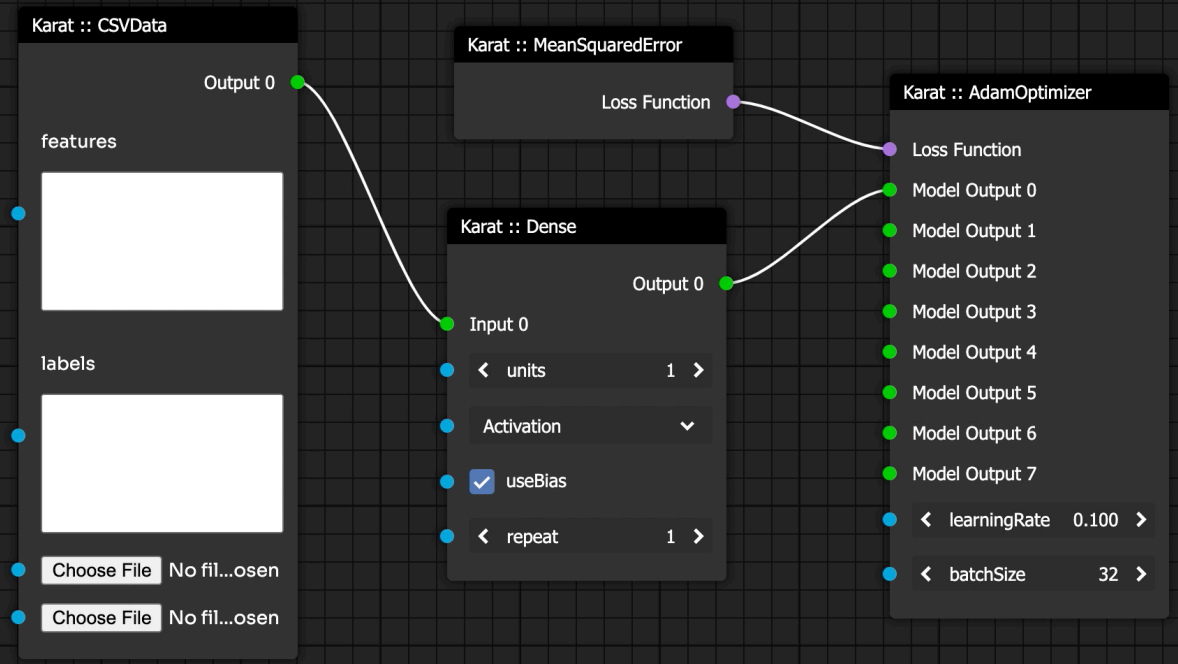
🧩 karat



Confirm Plugin Selection



New Model Name





Roadmap

“Plans are worthless, but planning is everything.”

~ President Dwight D. Eisenhower



2020 Roadmap

- **More Layers** from the Keras⁵ Neural Network Library
 - November 2020
- **Training Container** to run the Python⁶ scripts generated by the frontend
 - November 2020
- **Plugin Development Documentation** to support extension
 - December 2020



2021 Roadmap

- **Automatic Hyperparameter Tuning** using Optuna⁷ with graphical configuration of hyperparameters
 - March 2021
- **Tutorial Generation** for users who are new to neural networks and machine learning
 - April 2021
- **Integration and Testing** with teams of potential users pursuing ML projects at GTRI
 - June 2021



Website

<https://karat.gtri.gatech.edu>

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References

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- [3] F. Wagner, *newcat/baklavajs*. 2020.
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- [5] Georgia Tech Research Institute, "About Us," *GTRI*. <https://gtri.gatech.edu/about> (accessed Oct. 20, 2020).
- [6] F. Chollet, *Keras*. 2015.
- [7] G. Van Rossum and F. L. Drake, *Python 3 Reference Manual*. Scotts Valley, CA: CreateSpace, 2009.
- [8] T. Akiba, S. Sano, T. Yanase, T. Ohta, and M. Koyama, "Optuna: A Next-generation Hyperparameter Optimization Framework," in *Proceedings of the 25th ACM SIGKDD International Conference on Knowledge Discovery & Data Mining*, New York, NY, USA, Jul. 2019, pp. 2623–2631, doi: 10.1145/3292500.3330701.