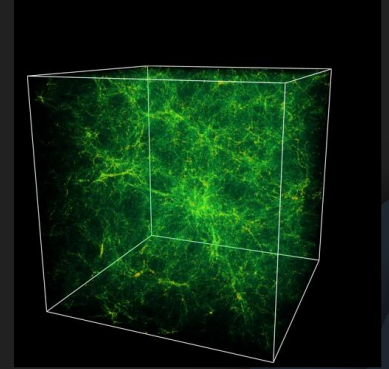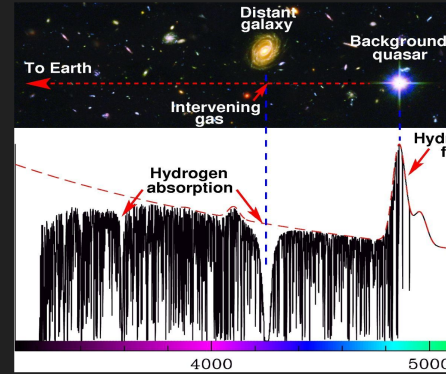# ANALYSING LYMAN ALPHA FOREST USING SIMULATIONS AND AI

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TALK OVERVIEW -

- ❖ **INTRODUCTION TO ARTIFICIAL INTELLIGENCE (AI)**
- ❖ **FITTING LYMAN ALPHA FOREST USING AI**
- ❖ **RESULTS**
- ❖ **LIMITATIONS OF NEURAL NETWORKS**

ARTIFICIAL INTELLIGENCE

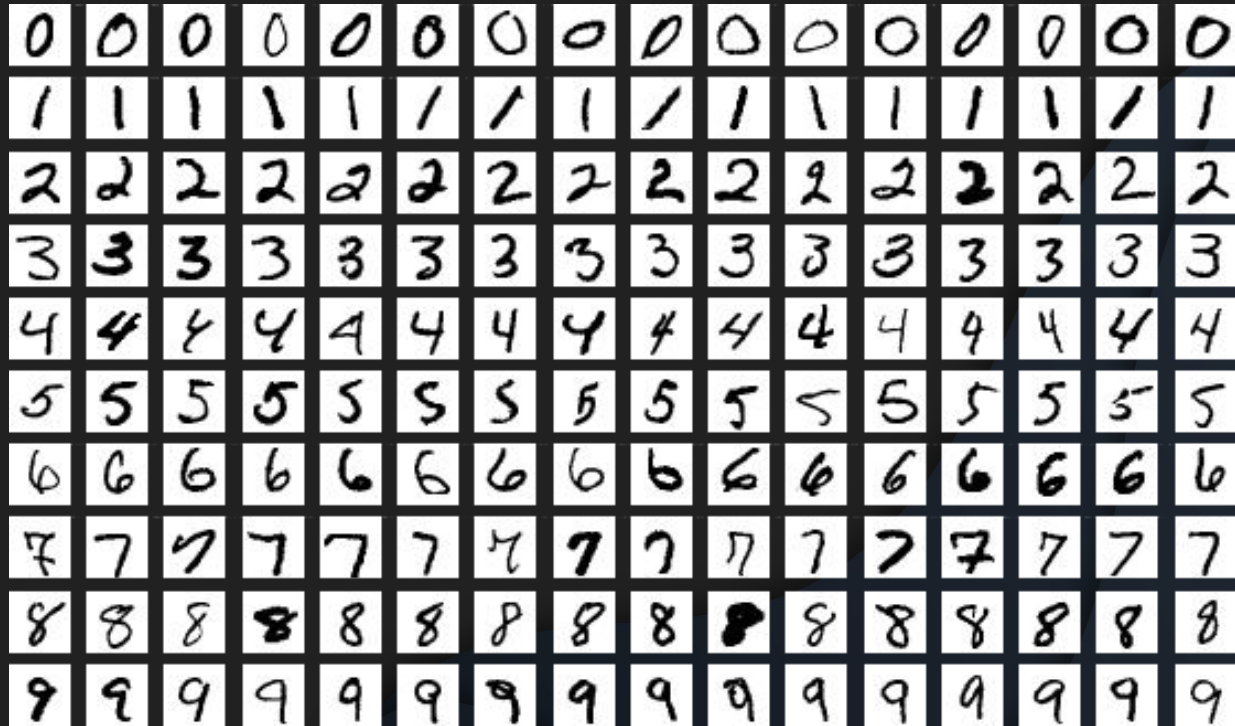EFFORT TO AUTOMATE INTELLECTUAL TASKS NORMALLY PERFORMED BY HUMANS
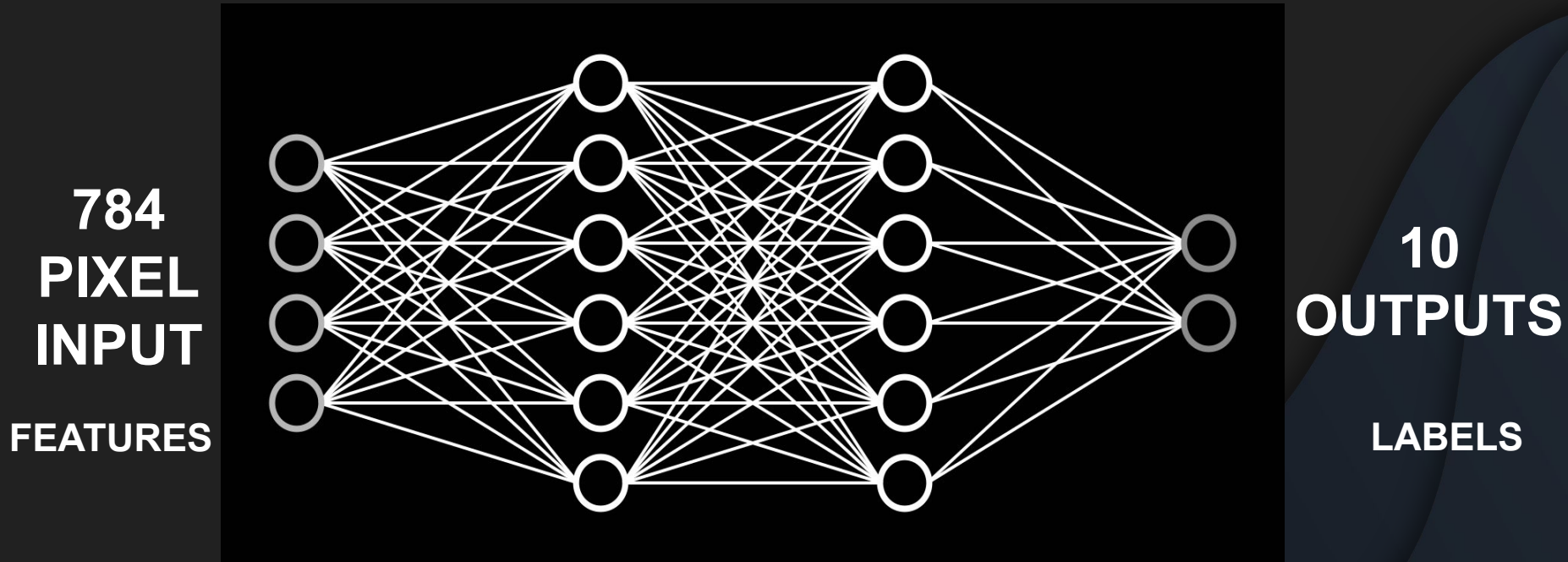
An Example - MNIST DATABASE

HOW DO YOU RECOGNIZE THESE NUMBERS?

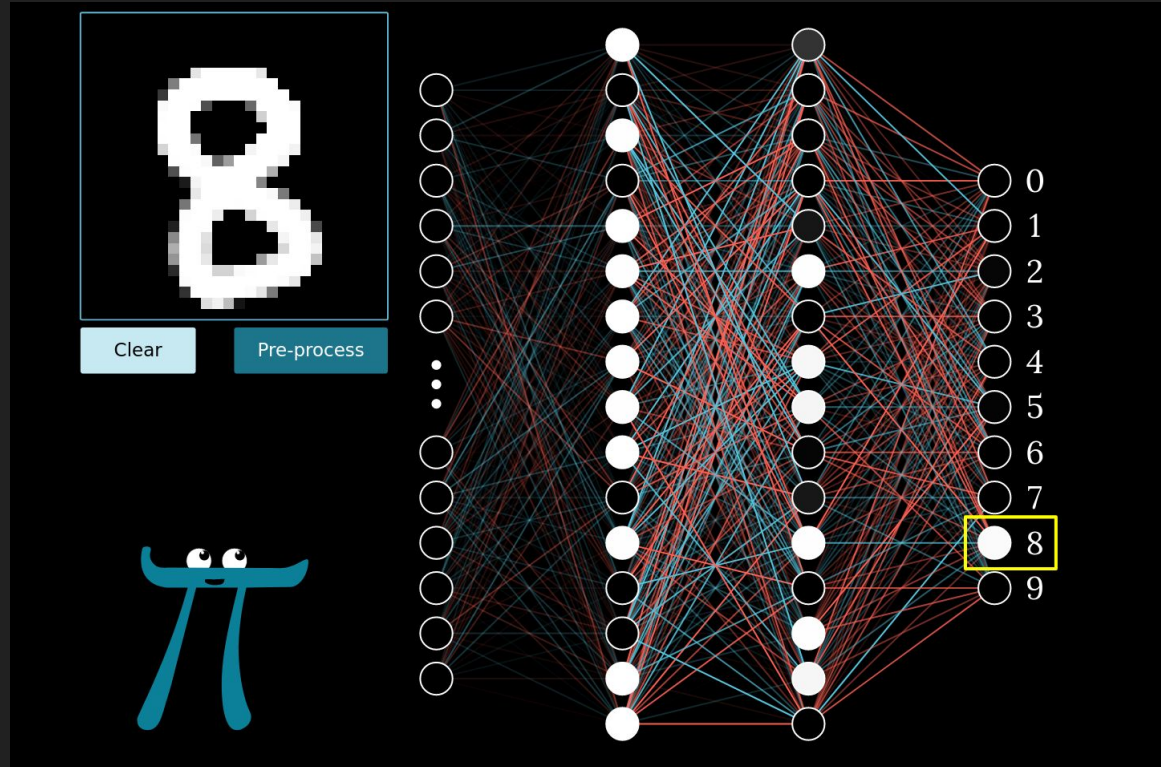**HOW CAN WE PERFORM THIS SAME TASK USING COMPUTERS?**

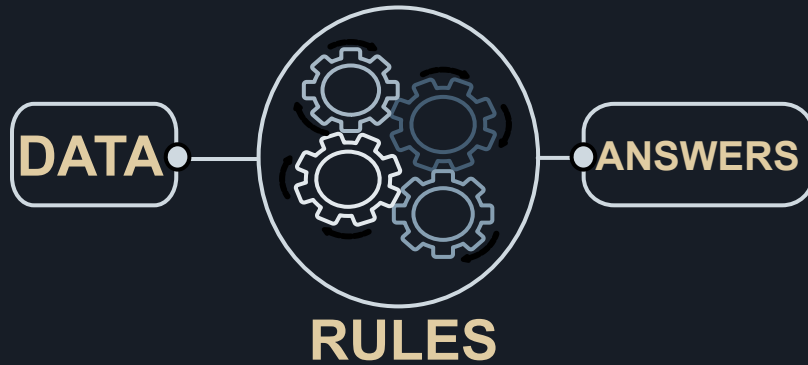**NEURAL NETWORKS**

A TYPICAL NEURAL NETWORK

784 PIXEL INPUT

FEATURES

10 OUTPUTS

LABELS

NUMBER DETECTION EXAMPLE

Credits -3b1b

THE STILWELL BRAIN

CLASSICAL PROGRAMMING
vs
MACHINE LEARNING

| DATA | → | **RULES** | → | ANSWERS |

RULES

CLASSICAL PROGRAMMING

| DATA | → | **ANSWERS** | → | RULES |

ANSWERS
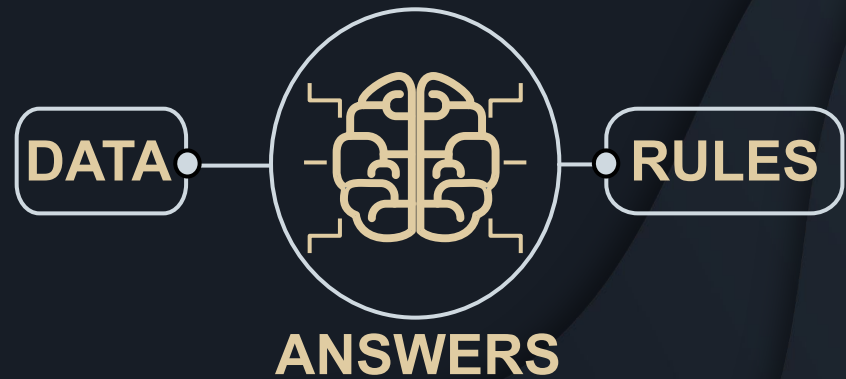
MACHINE LEARNING

Neural Networks are Universal Function Fitters
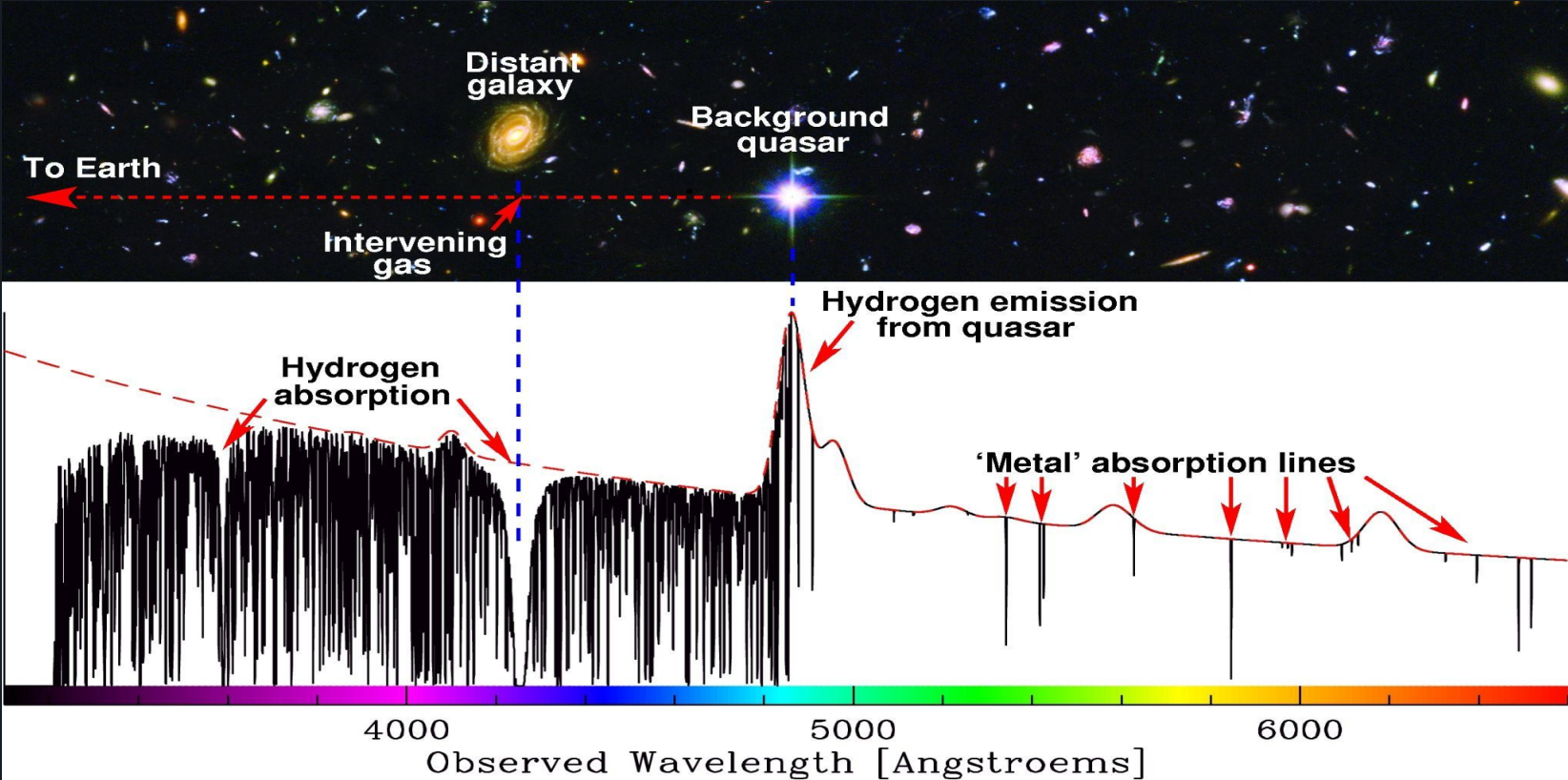

x

y

MAP FROM X TO Y

x
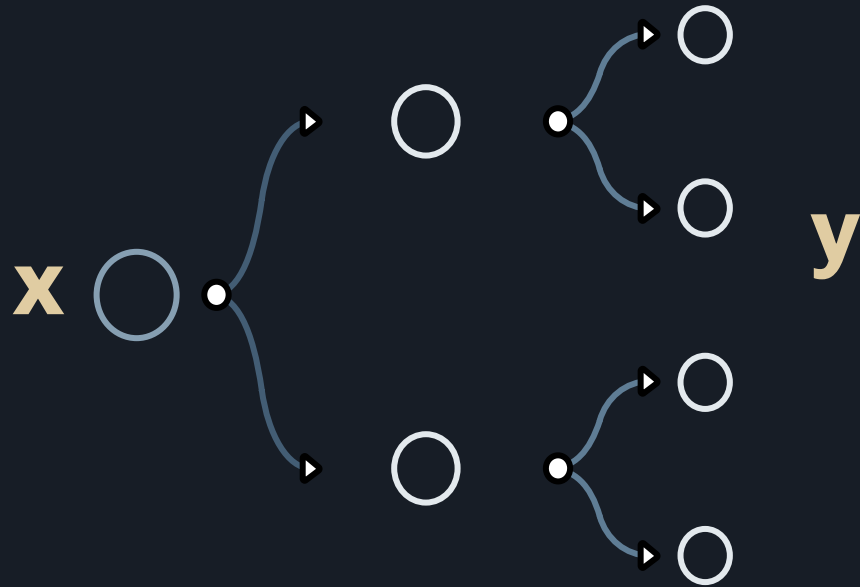
y
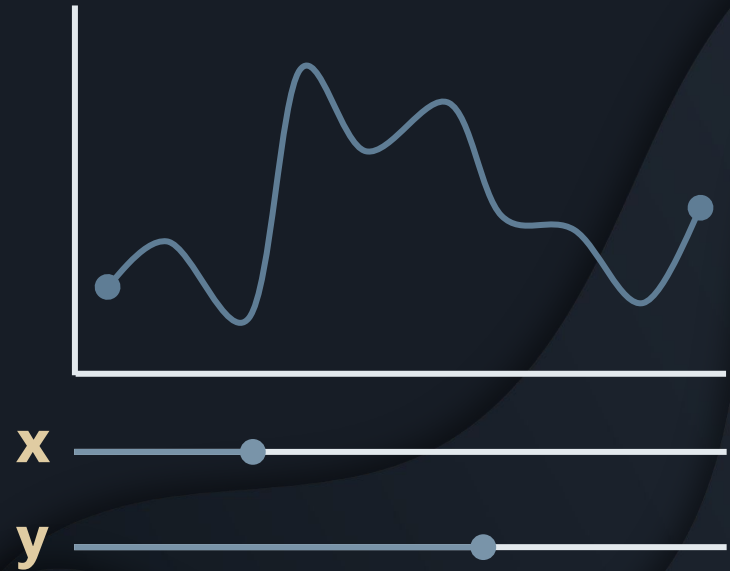
OUR GOAL-

USING
NEURAL NETWORKS
TO FIT
LYMAN ALPHA FOREST

LYMAN ALPHA FOREST

CHALLENGES WITH FITTING

- ❏ **TIME CONSUMING**
- ❏ **HIGH COMPUTATIONAL COST**
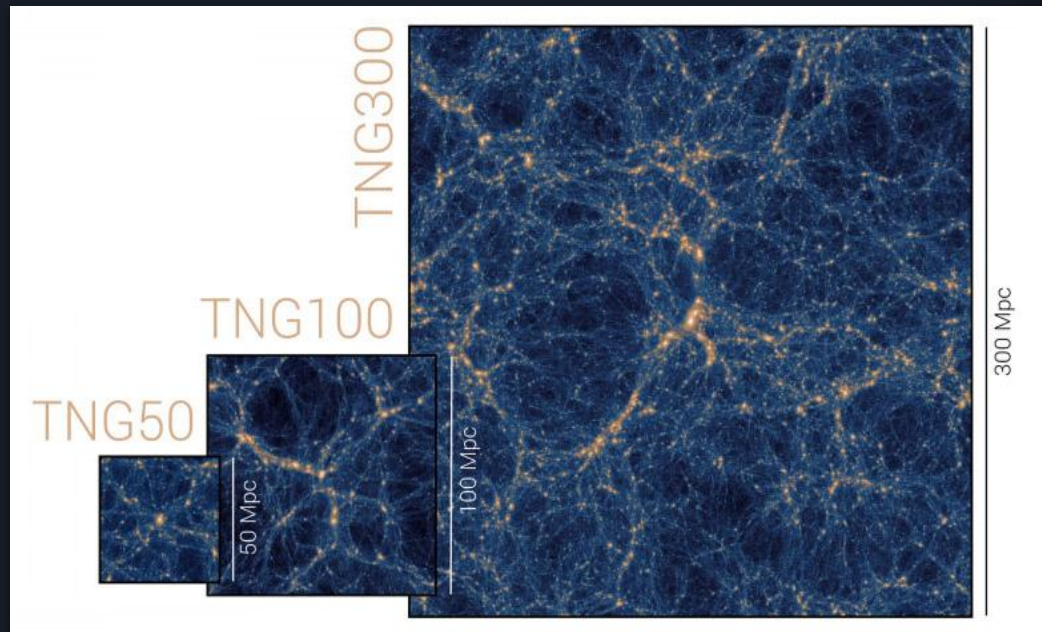- ❏ **SOME CODES REQUIRE HUMAN INTERVENTION**

REQUIREMENTS FOR TRAINING -

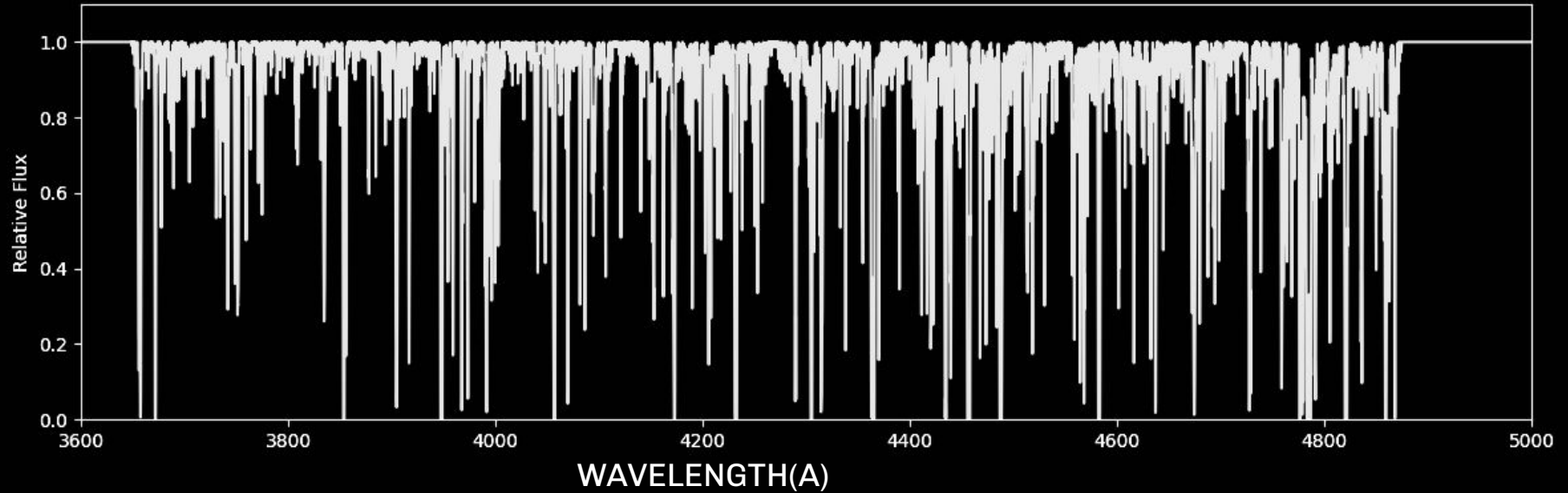- ## LYMAN ALPHA FOREST SPECTRA (FEATURES)

- ## THEIR LINE CATALOGS (LABELS)

TNG SIMULATION

A cosmological magnetohydrodynamic simulations of galaxy formation

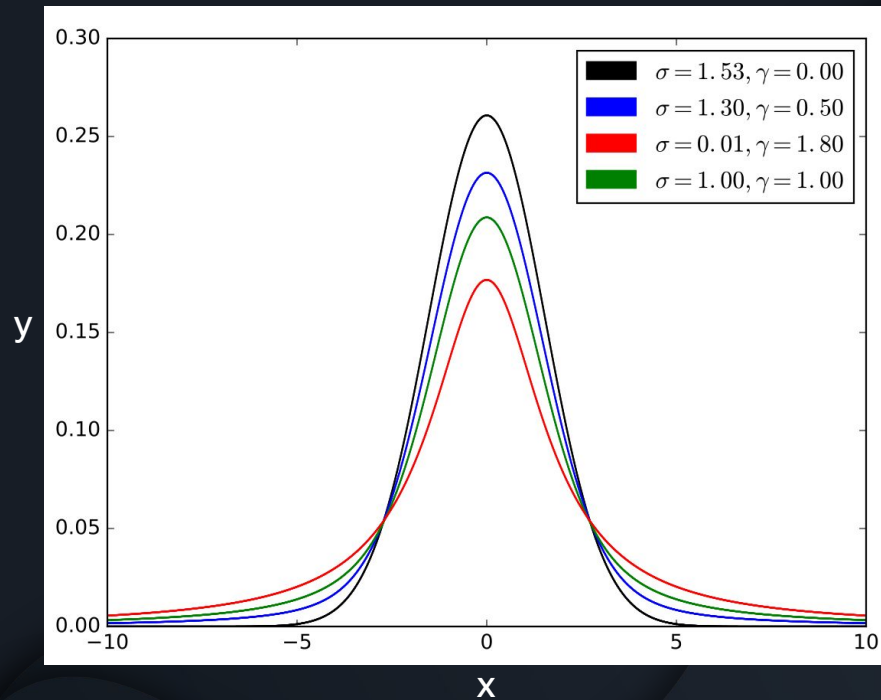**Shoot a sightline and obtain a spectrum**

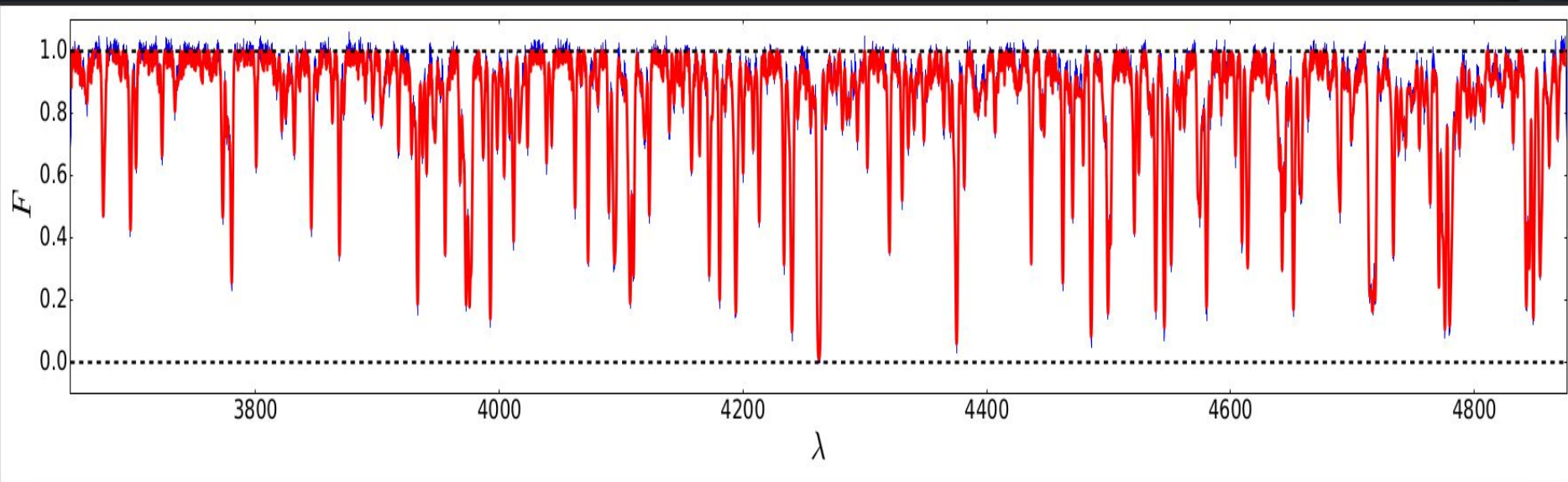# A NORMALIZED SIMULATED LYMAN ALPHA FOREST

VIPER

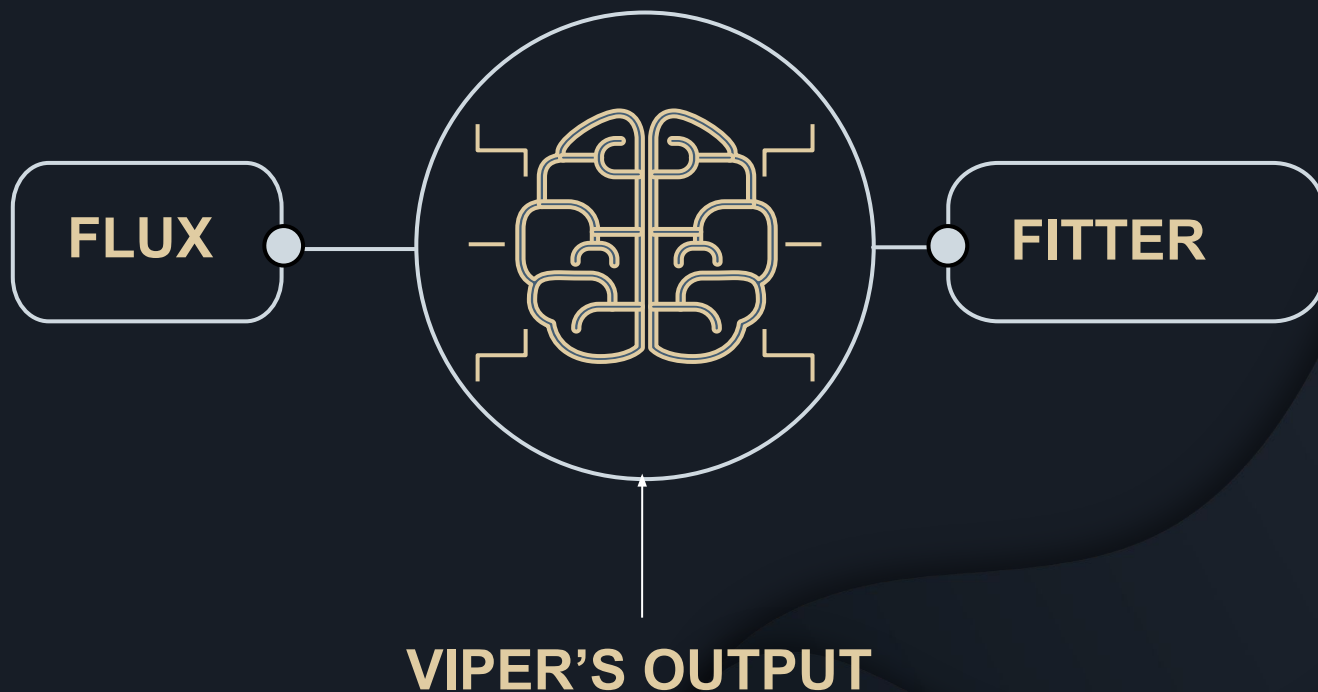**Viper is an automatic voigt profile fitting code for fitting of H-I absorption lines**
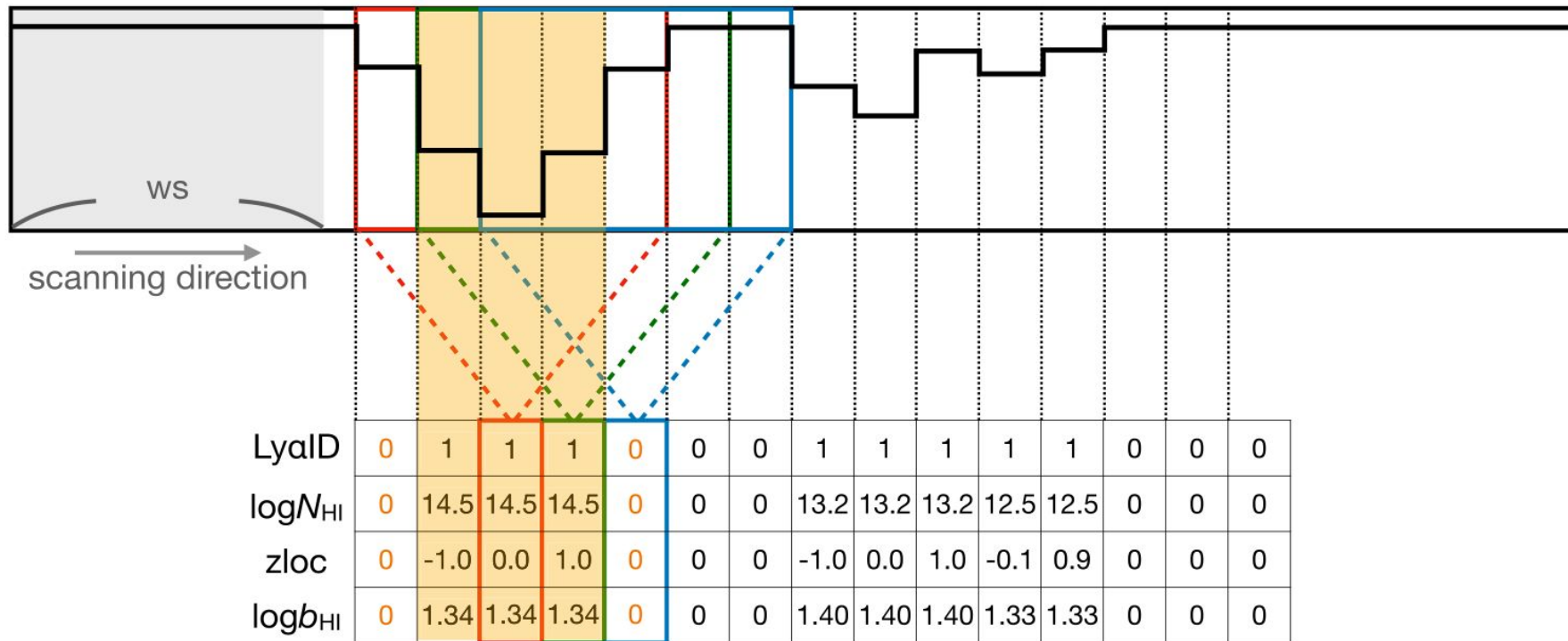
A FITTED SPECTRUM USING VIPER

TAKES 20-30 MINS TO FIT

TRAINING NEURAL NETWORK TO FIT A SPECTRUM

FLUX

FITTER
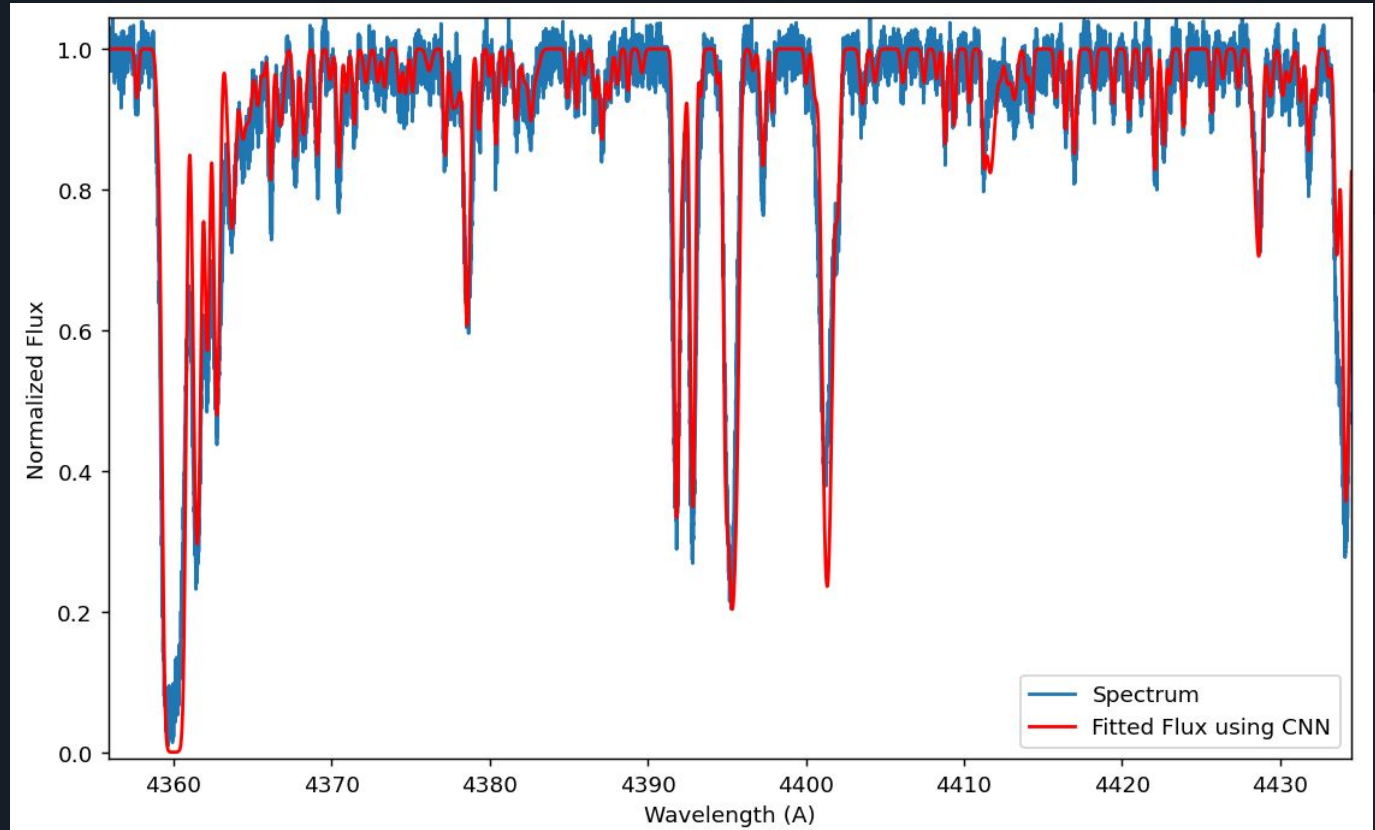
VIPER'S OUTPUT
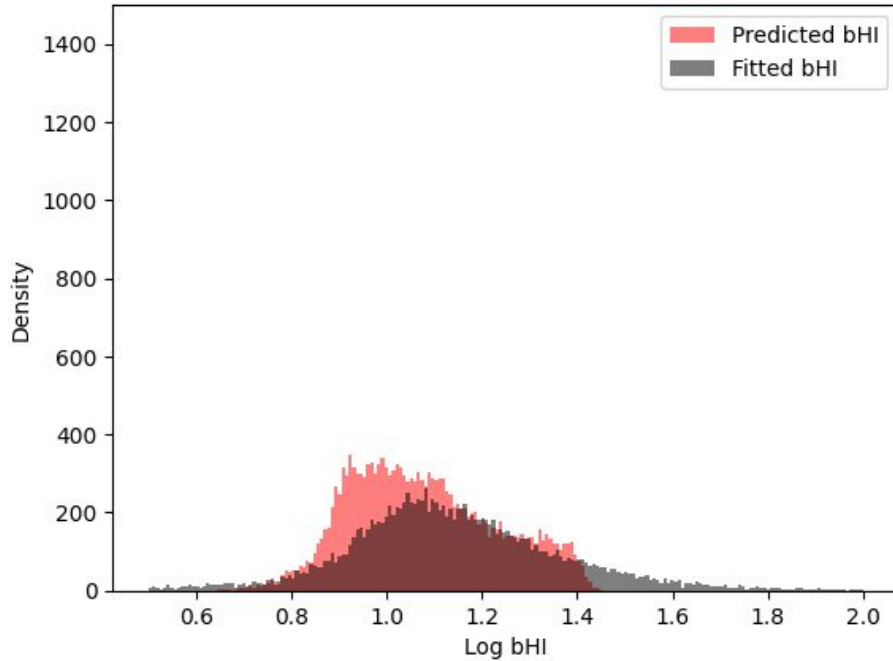
TRAINING METHOD

Cheng et. al. 2022

A FITTED SPECTRUM WITH A NEURAL NETWORK
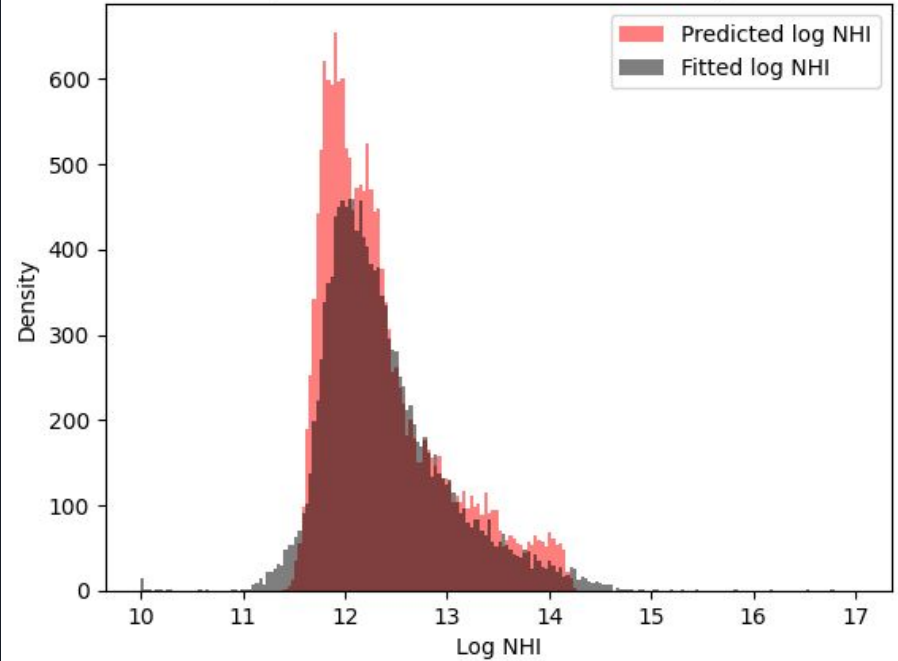
FITTING TOOK LESS THAN 5 SECONDS!

TRAINING RESULTS TILL NOW...

Comparison of Predicted and Fitted bHI

Comparison of Predicted and Fitted log NHI

PROBLEMS WITH NEURAL NETWORKS

- **BLACK BOX FUNCTIONS**

- **ONLY GIVE PREDICTIONS**

- **NEED TRAINING DATASET(SUPERVISED MACHINE LEARNING)**

- **HYPER PARAMETER TUNING**

THANK YOU !

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