Harvard John A. Paulson
School of Engineering
and Applied Sciences

Visualizing Examples of Deep Neural Networks at Scale

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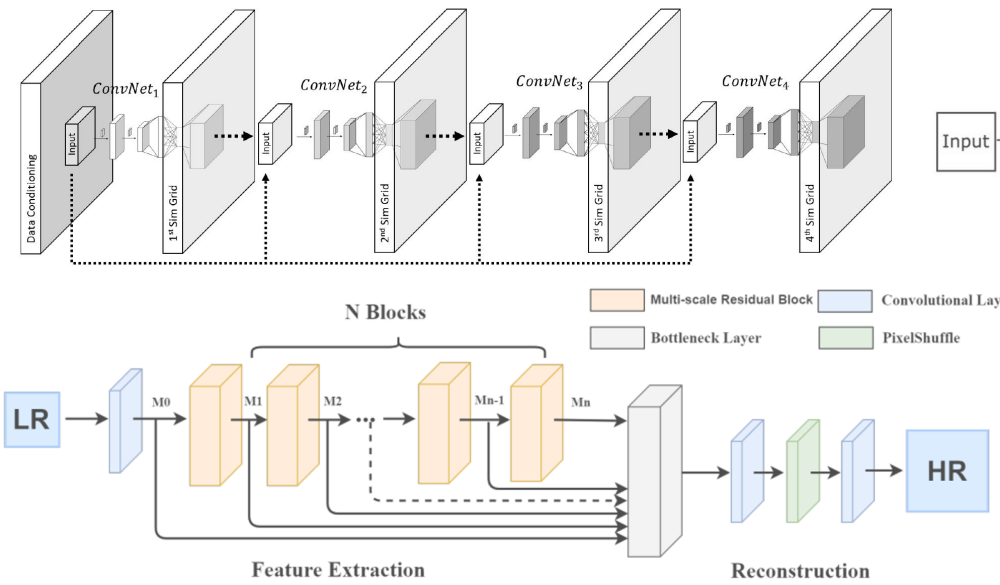
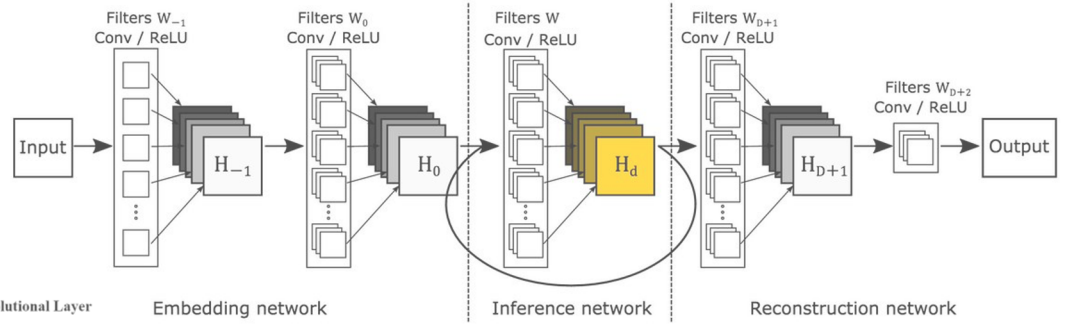
Harvard University

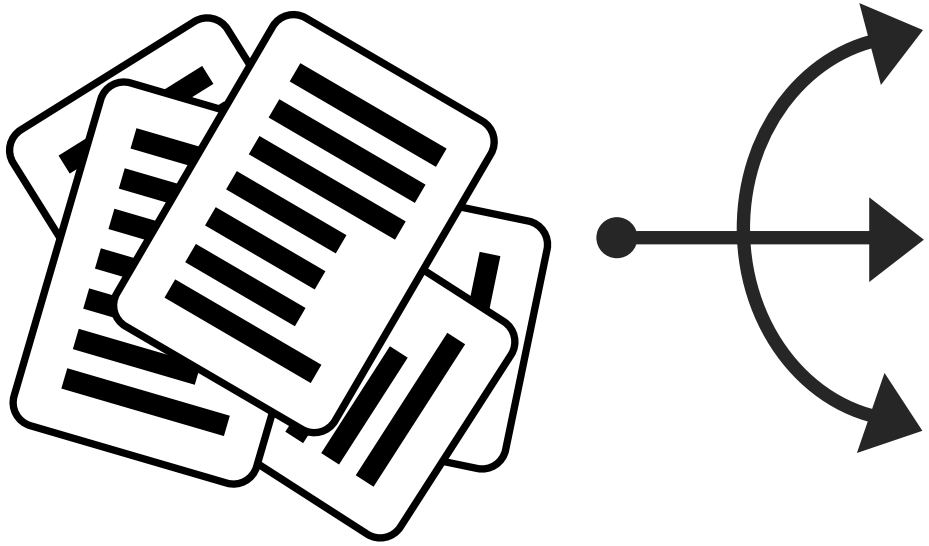
Introduction



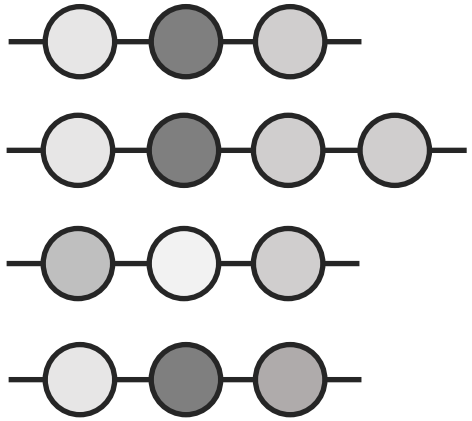


- Most of users use **online search** when they are designing a neural network
- It is **difficult** to choose appropriate **model structures** and **hyperparameter values**

ExampleNet

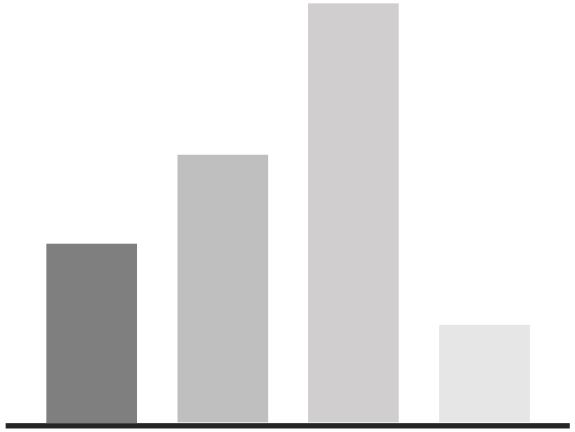


A Large Collection of Deep Learning Projects

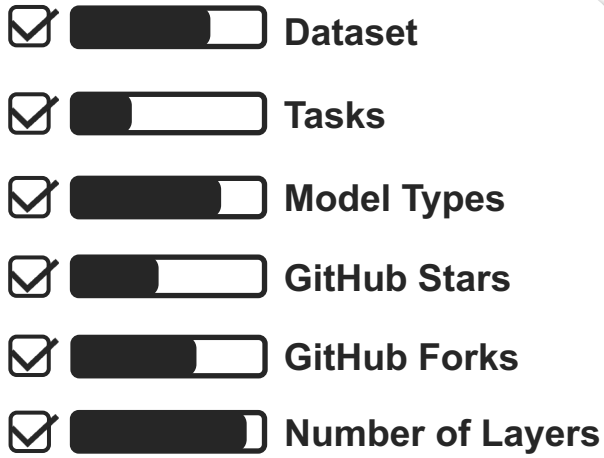


Network Structure

Distribution of Hyperparameters



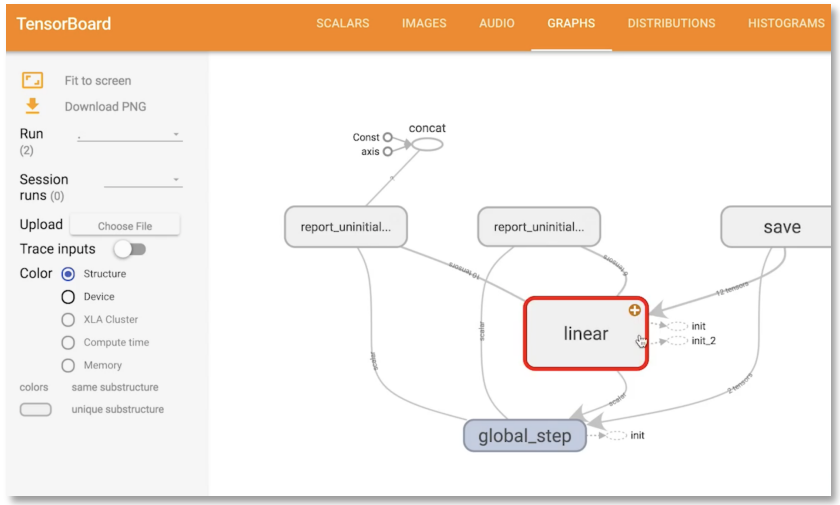
Distribution of Layer Types



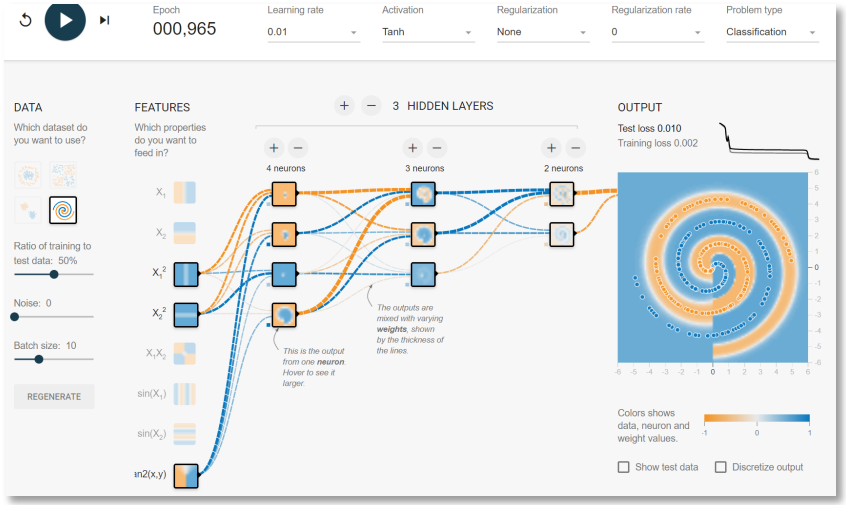
Other Meta-data

Comparison of Various Design Decisions

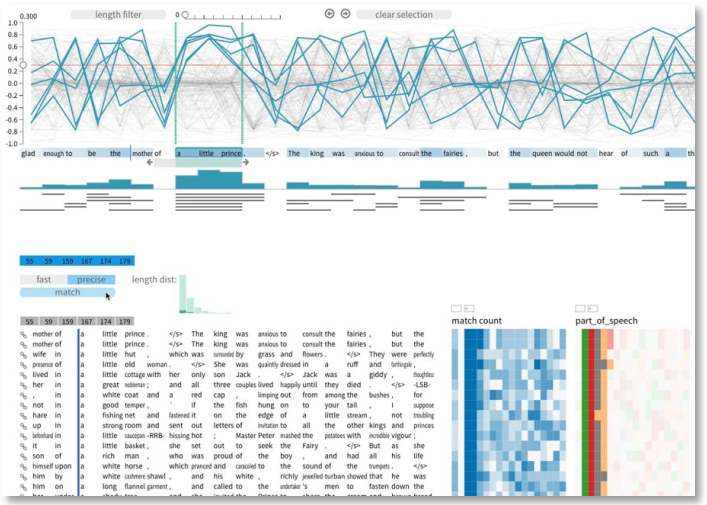
Differences from Previous Work



(a) TensorBoard

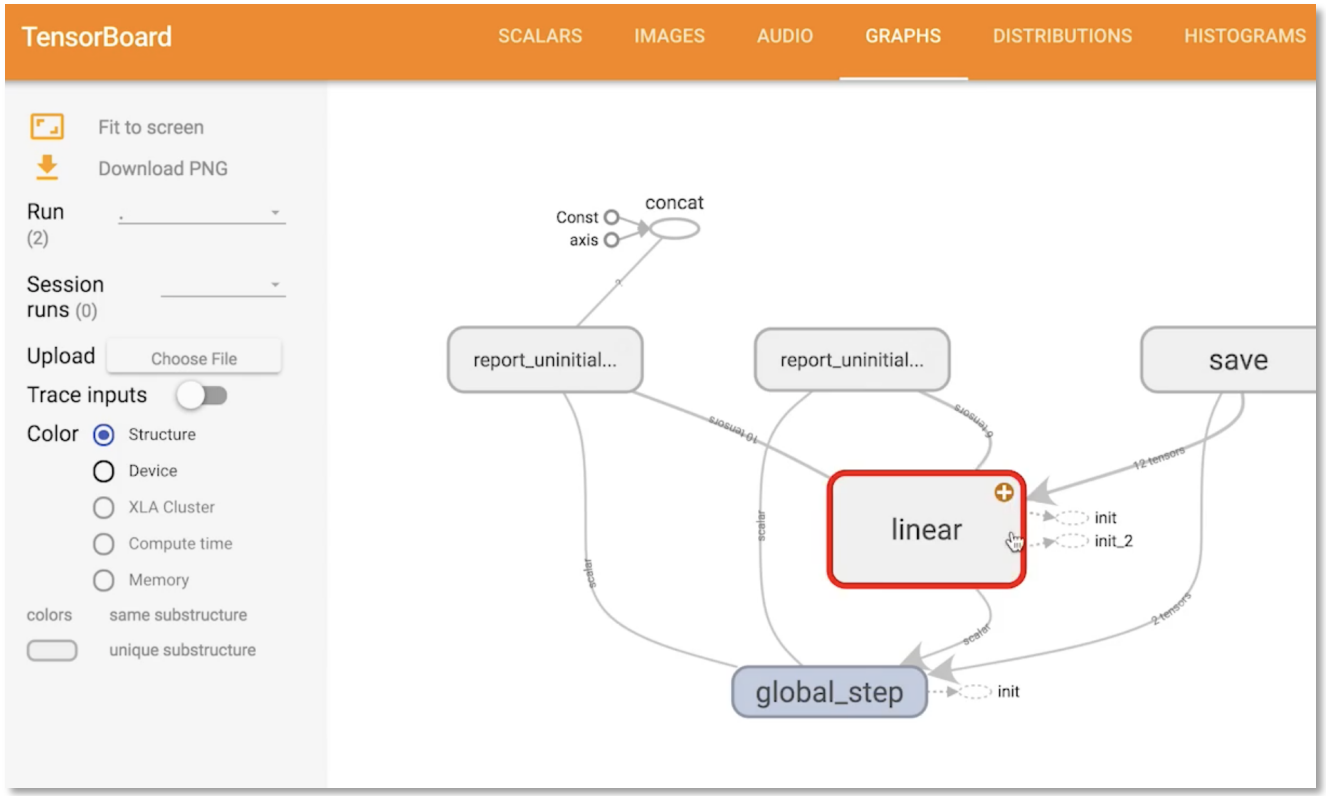


(b) TensorFlow Playground



(c) LSTMVis

Differences from Previous Work



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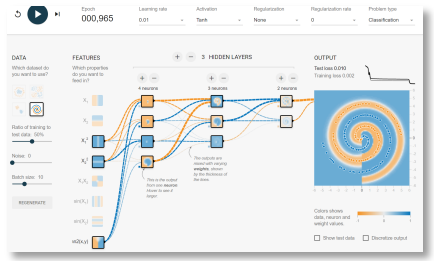

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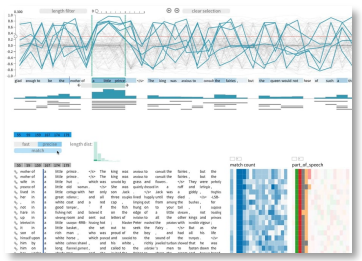

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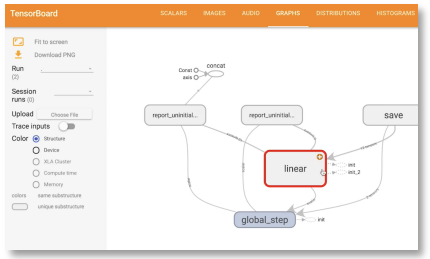

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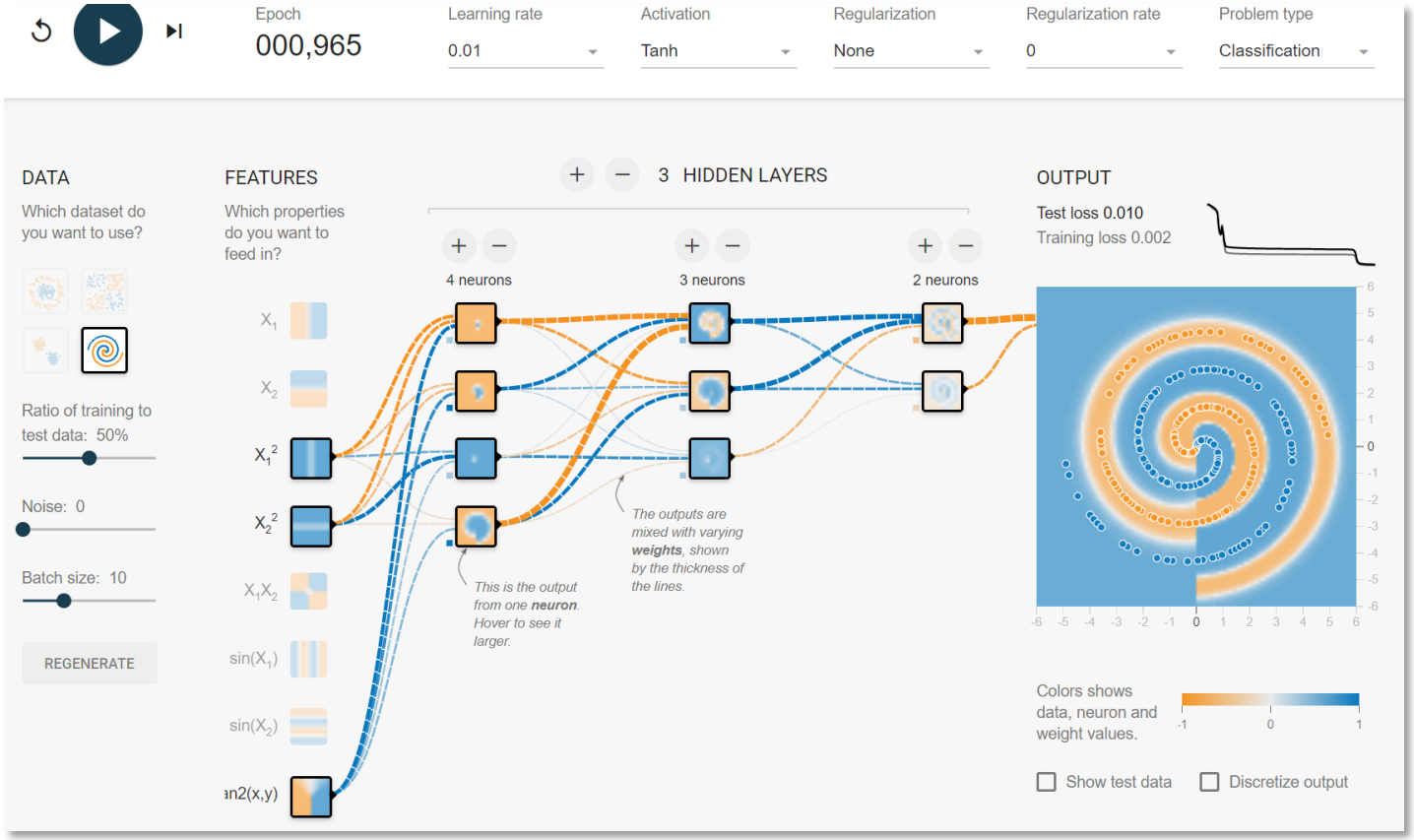

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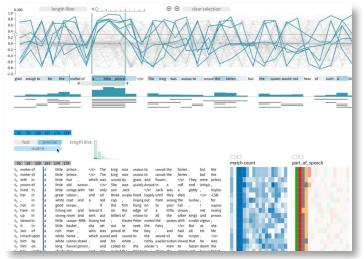

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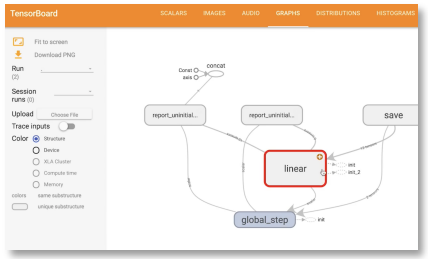

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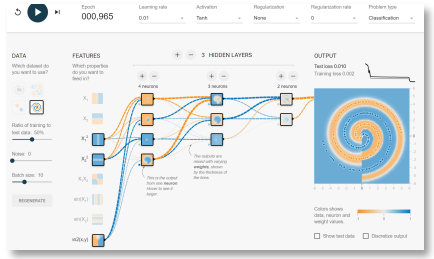
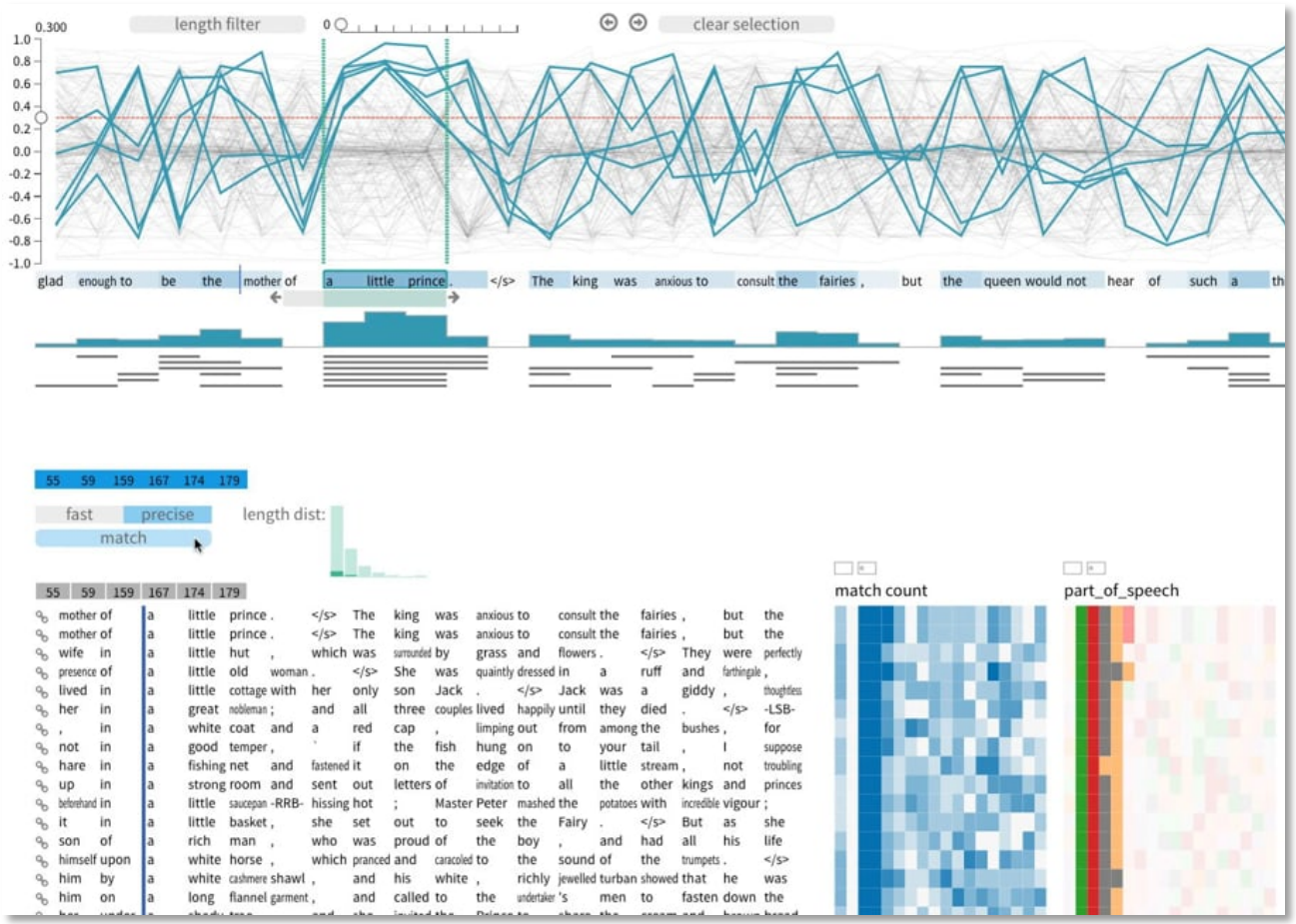


(b) TensorFlow Playground



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Differences from Previous Work

- Prior visualization tools only represent a **single model at a time.**
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  - Our tool represents **~100 models at a time.**

- Prior visualization tools mainly focus on **model debugging** or **training**.
  - Our tool supports **model design phrase**.

- In addition, our tool allows users to **compare and contrast multiple models** and **their design choices**.

Formative Study

10 Deep Learning Novices

Information Needs →

N1. What are different neural networks for similar tasks and datasets?

N2. I want to quickly find out the structure of a model in a project.

N3. What kinds of “tricks” (e.g., attention, dropout) have other programmers used?

N4. Is my hyperparameter setting similar to those in popular projects?

N5. What kinds of models are often used for specific datasets and tasks?

N6. What are the common hyperparameters set by others?

N7. Do these projects use similar datasets and perform similar tasks as mine?

N8. Is this model runnable? How easy? What is the running environment?

N9. What is the accuracy of the model? How long does it take to train?

N10. How do others pre-process their data before feeding to a model?

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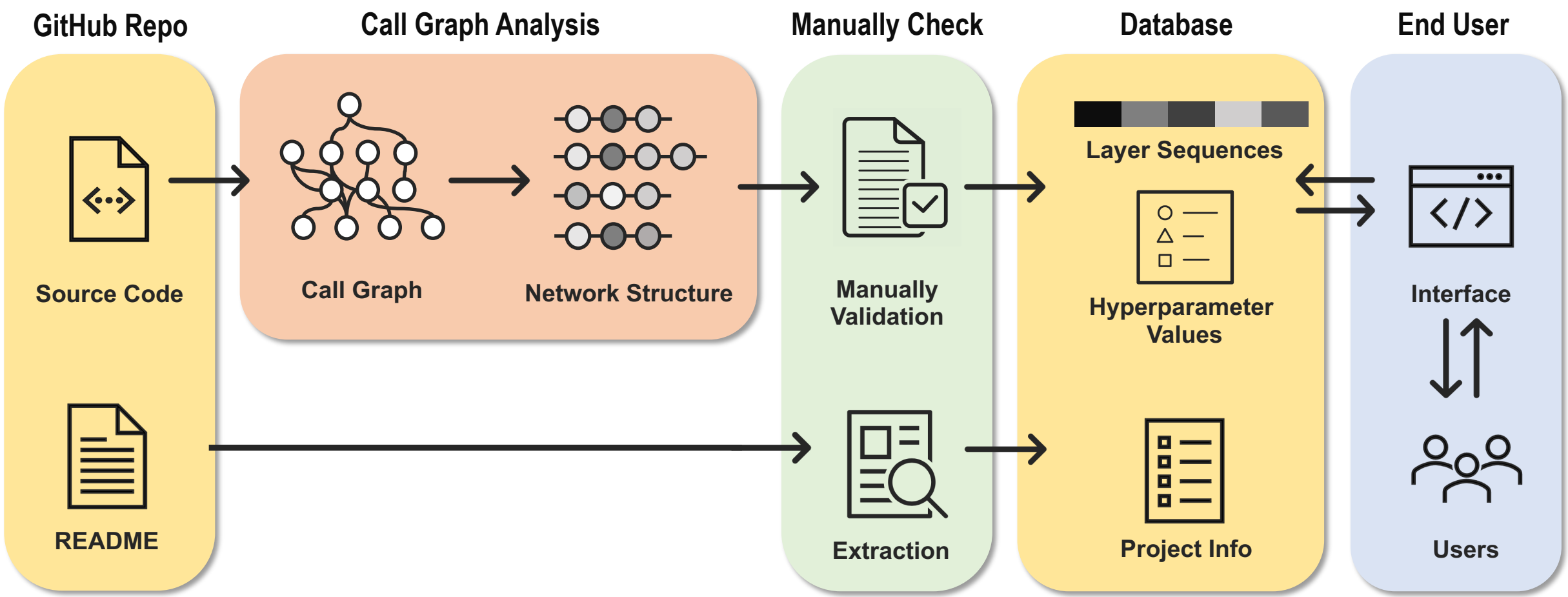
D2. Help users distill **high-level design decisions**.

D3. Help users understand the **commonalities** and **variations** of design choices.

Data Curation Pipeline



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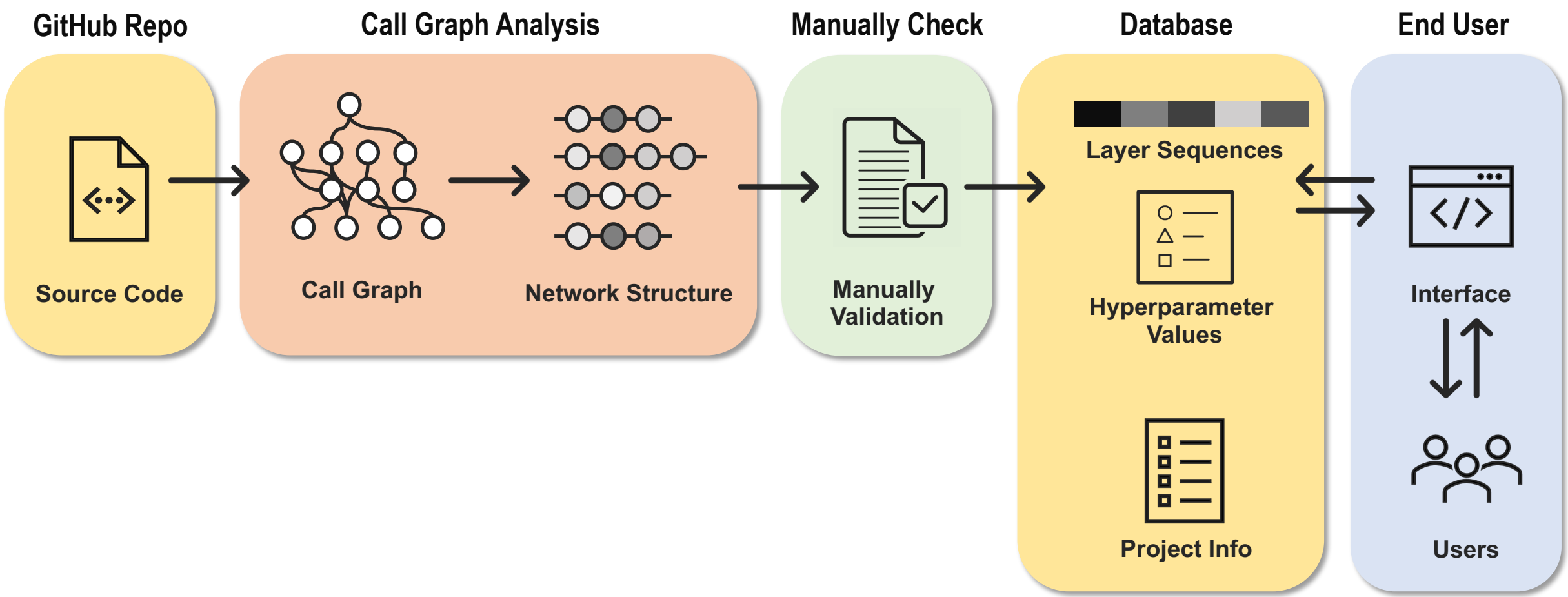

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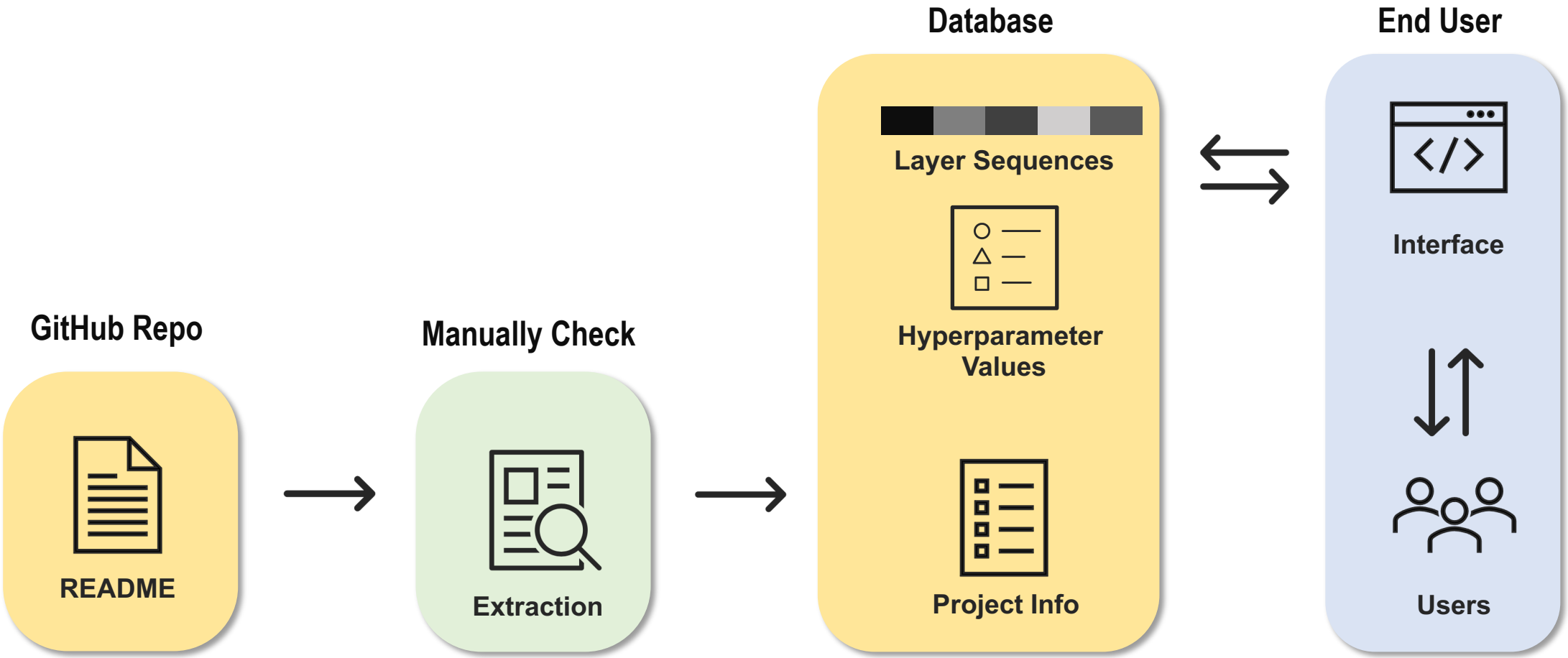
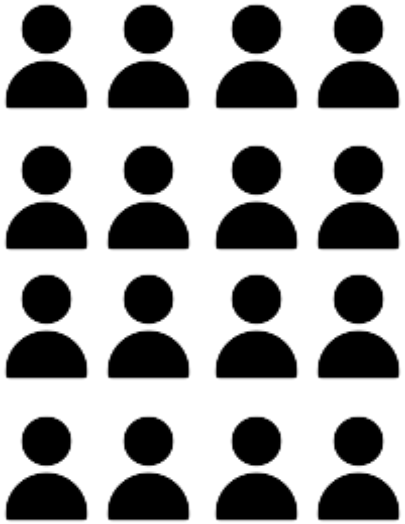


A Within-subjects User Study



16 Computer Science Students

Tasks

- Image Classification
- Text Classification

Conditions

- ExampleNet
- Search manually on the Internet for tutorials, examples, etc

User Study Results

When using ExampleNet:

- **Participants inspected 3X more examples**

User Study Results

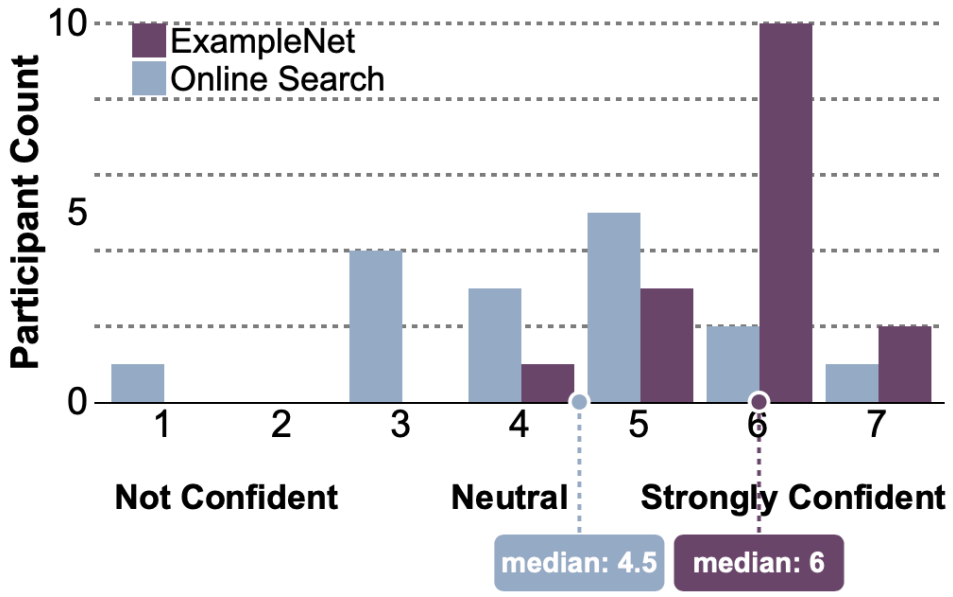
When using ExampleNet:

- **Participants inspected 3X more examples**
- **Participants made more diverse design choices**
  - layer types (7 vs. 5)
  - layer numbers (13 vs. 9.5)
  - hyperparameter types (5 vs. 4.5)

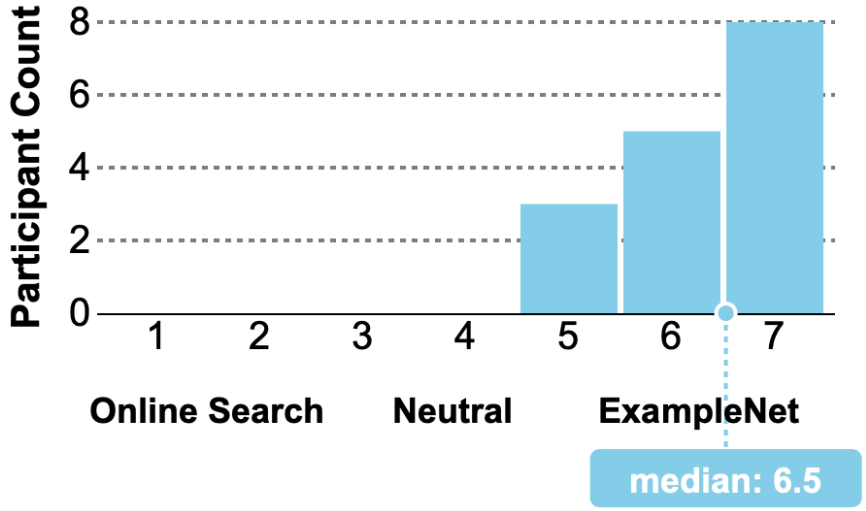
Participants made less design mistakes when using ExampleNet.

The Mistakes Participants Made	Online Search	ExampleNet
Missing Activation Function	P4, P6, P8, P9, P10, P11, P12, P14	None
Huge Epochs	P3, P4, P5, P7, P8, P15	P3, P5
Missing Loss Function	P1, P2, P3, P8, P10	None
Missing Dropout Rate	P1, P4, P8, P9	None
Missing Dense Layer	P13, P14	P3
Huge Learning Rate	P3	None
Incorrect Layer Sequence Order	P12	None

Participants felt more confident and rated ExampleNet as more helpful.



(a) User Confidence



(b) Helpfulness

Main Contributions

C1. A formative study that identifies real needs of DL learners.

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C3. A user study that demonstrates the usefulness of ExampleNet.