The Thinking Sidecar: Five Thoughts on Machine Learning, Medicine, and Future Physicians

Ruben R. Puentedura, Ph.D.

1. A Clockwork World

nature

THE INTERNATIONAL WEEKLY JOURNAL OF SCIENCE

LESIONS LEARNT

Artificial intelligence powers detection of skin cancer from images PAGES 36 & 115

NATURE.COM/NATURE

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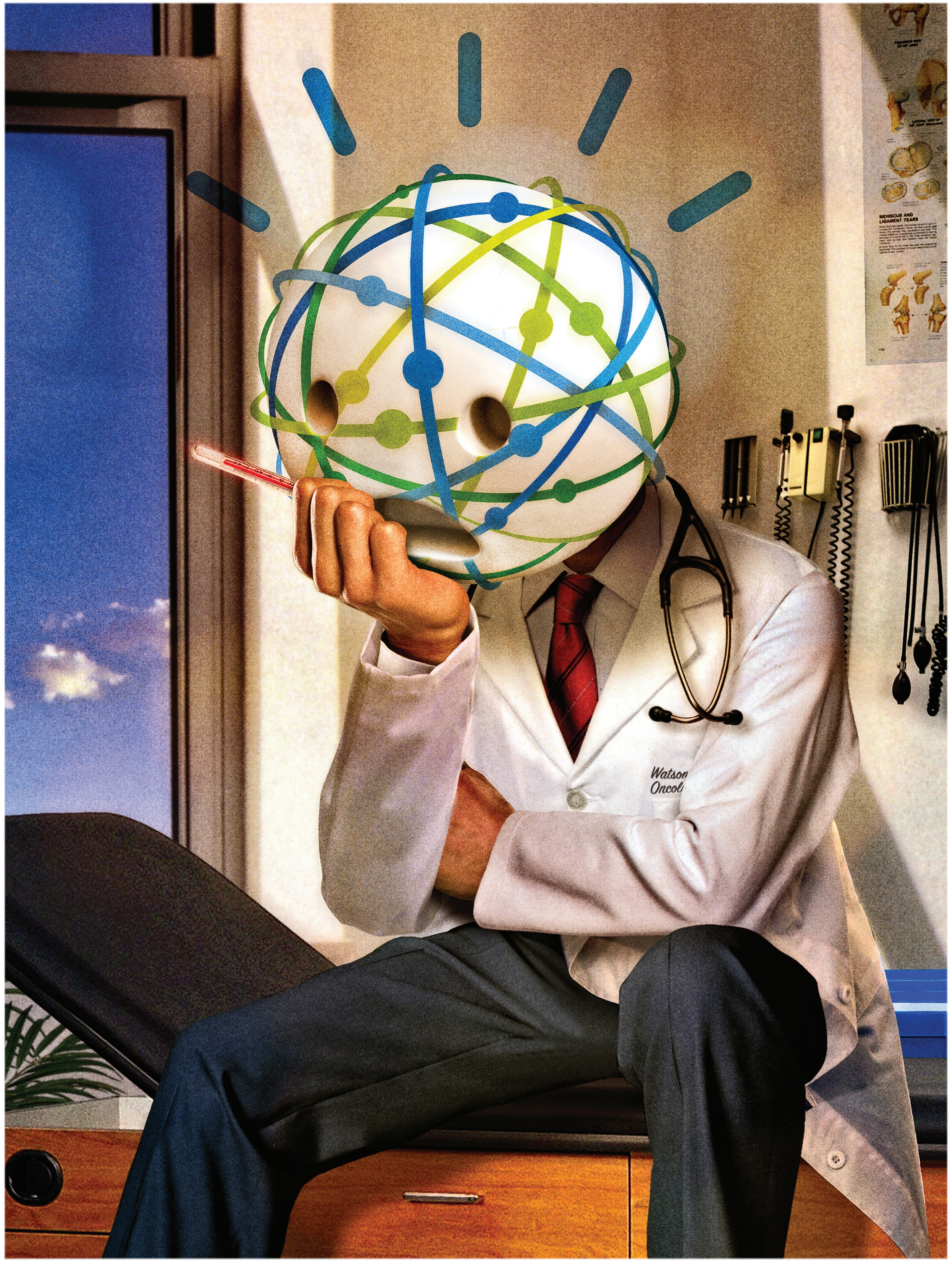
Vol. 542, No. 7639

IBM Watson, *Heal* Thyself

How IBM overpromised and underdelivered on AI health care

By **ELIZA STRICKLAND** ILLUSTRATIONS BY EDDIE GUY



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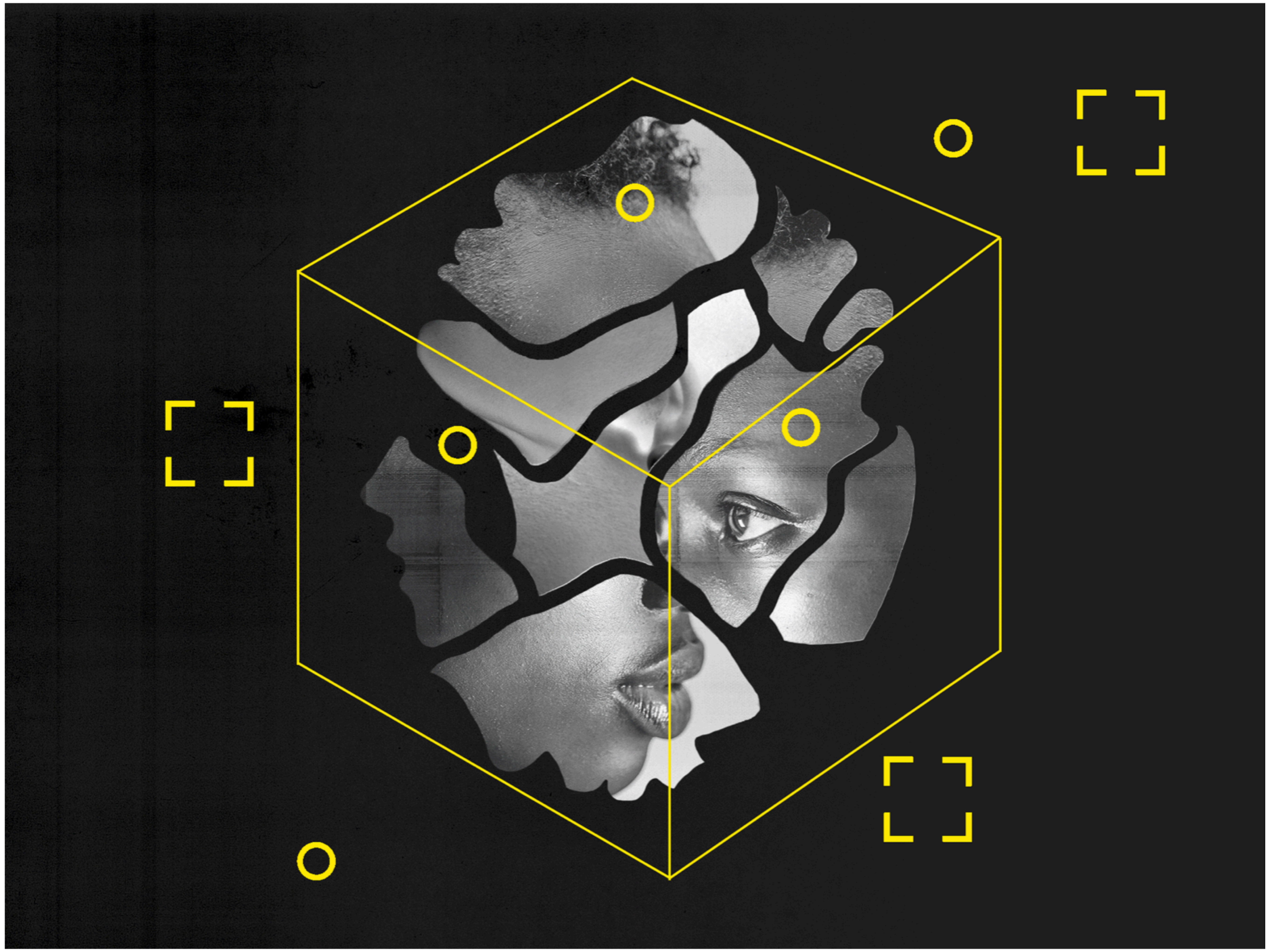
THE BEST ALGORITHMS STRUGGLE TO RECOGNIZE BLACK FACES EQUALLY



BETH HOLZER/GETTY IMAGES

2. Where Black Swans Sleep

Black Swan Events

- Cannot be predicted ahead of time
- Have a major effect
- Can be rationalized retrospectively

Taleb, Nassim Nicholas, *The Black Swan: The Impact of the Highly Improbable* (2007)

The New York Times.

"All the News That's Fit to Print."

NEW YORK, WEDNESDAY, OCTOBER 30, 1929.

STOCKS COLLAPSE IN 16,410,030-SHARE DAY, BUT RALLY AT CLOSE CHEERS BROKERS; BANKERS OPTIMISTIC, TO CONTINUE AID

GRUNDY FOR CURBING 'BACKWARD STATES' ON THE TARIFF BILL

KAHN REFUSES POST IN SENATE CAMPAIGN; CALLS CHOICE UNWISE

COALITION FIGHTING MOVE TO KILL TARIFF

MISSING AIRLINER BROUGHT IN SAFELY

LEADERS SEE FEAR WANING

CLOSING RALLY VIGOROUS

U. S. STEEL TO PAY $1 EXTRA DIVIDEND

RESERVE BOARD FINDS ACTION UNNECESSARY

"All the News That's Fit to Print"

The New York Times

Late Edition

NEW YORK, TUESDAY, OCTOBER 20, 1987

30 CENTS

STOCKS PLUNGE 508 POINTS, A DROP OF 22.6%; 604 MILLION VOLUME NEARLY DOUBLES RECORD

U.S. Ships Shell Iran Installation In Gulf Reprisal

Offshore Target Termed a Base for Gunboats

A Huge Blow to the Five-Year Bull Market

Dow's Record Fall

WORLDWIDE IMPACT

Frenzied Trading Raises Fears of Recession — Tape 2 Hours Late

Does 1987 Equal 1929?

"All the News That's Fit to Print"

The New York Times

Late Edition

NEW YORK, TUESDAY, SEPTEMBER 30, 2008

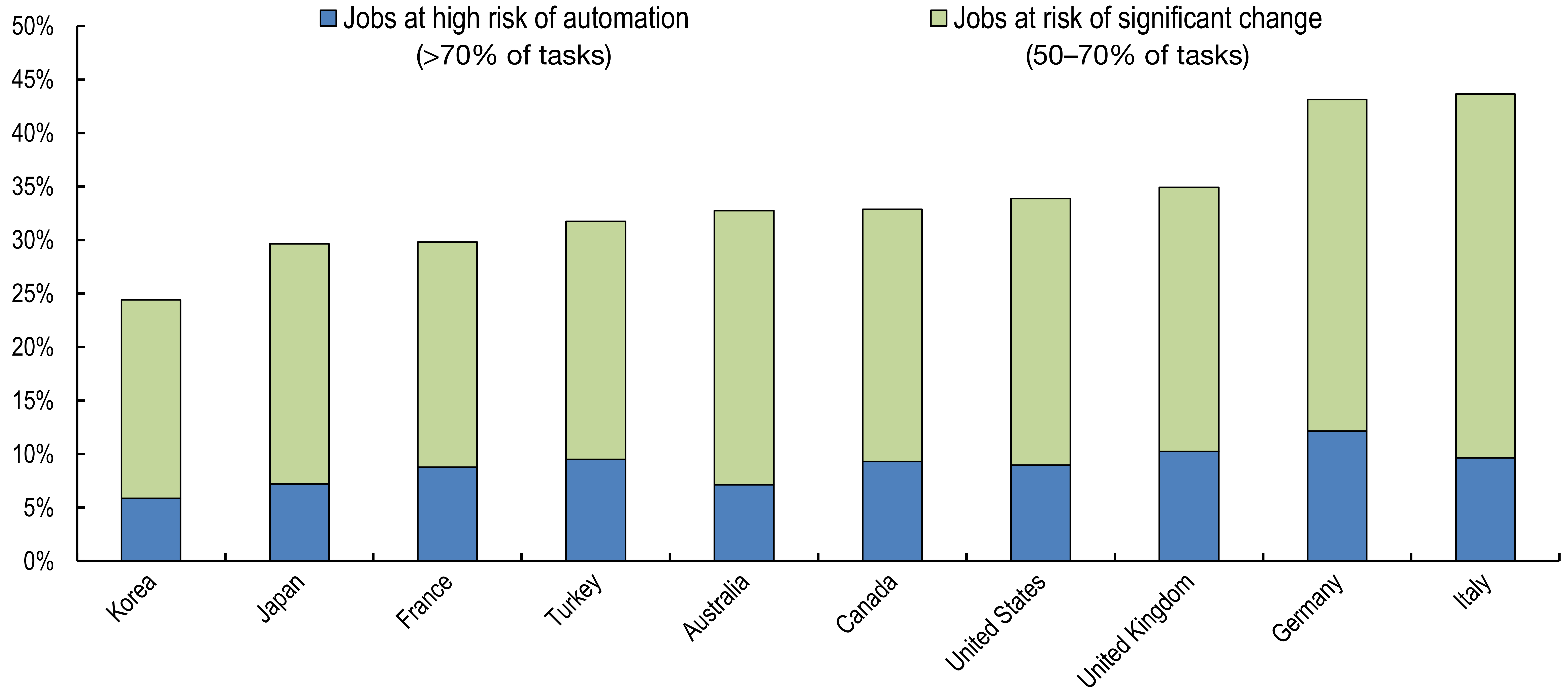
DEFIANT HOUSE REJECTS HUGE BAILOUT; STOCKS PLUNGE; NEXT STEP IS UNCERTAIN

7% DROP IN DOW

Central Banks Try to Aid Credit Markets — Global Worry

Leaders Rebuffed in 228-205 Vote — Broad Public Anger Is Cited

Advanced G20 Countries: Jobs at High Risk of Automation

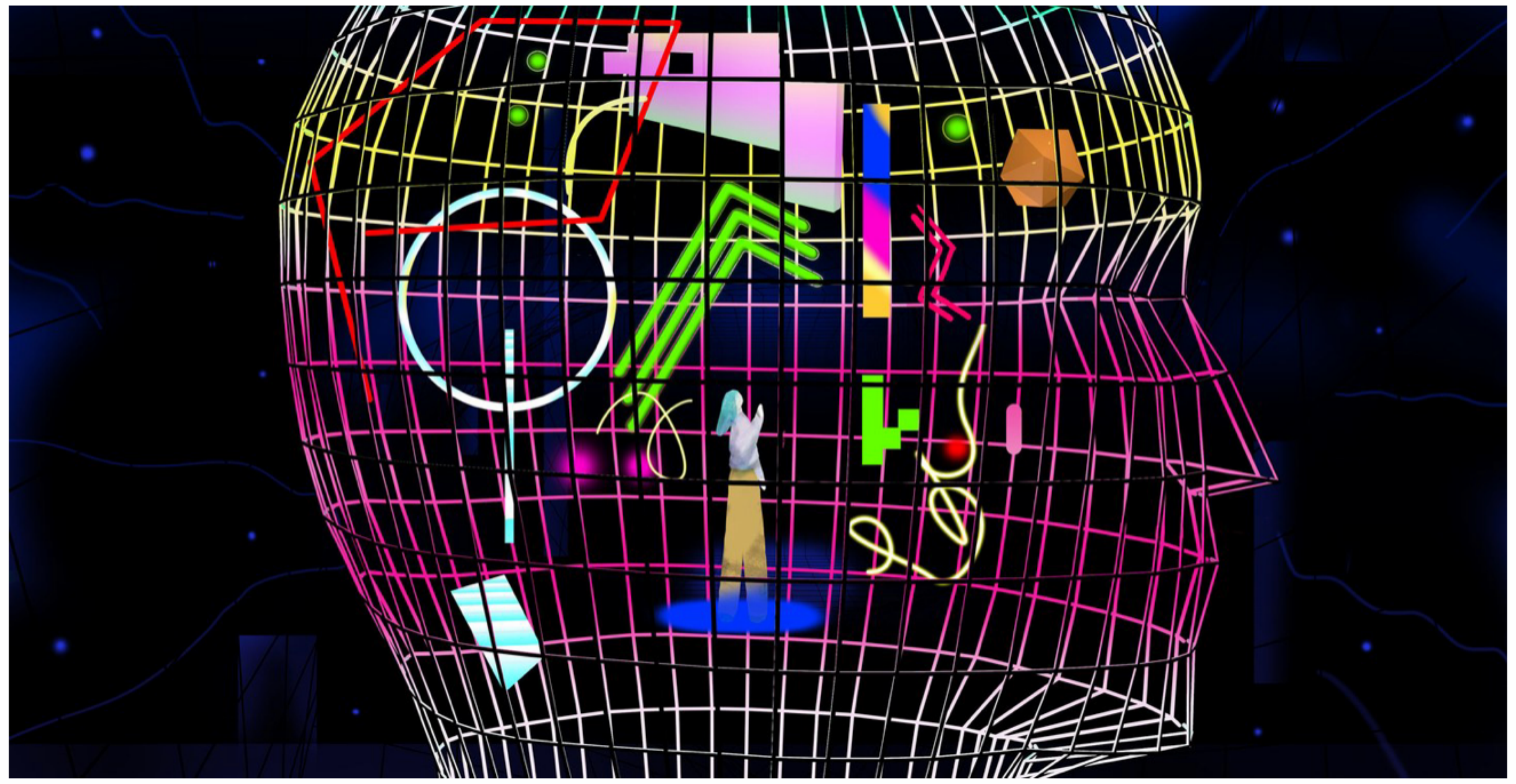


Organisation for Economic Co-operation and Development (OECD), *Future of Work and Skills*. Paper presented at the 2nd Meeting of the G20 Employment Working Group, Hamburg, Germany. (2017)

ANNALS OF TECHNOLOGY

THE HIDDEN COSTS OF AUTOMATED THINKING

By Jonathan Zittrain July 23, 2019



Overreliance on artificial intelligence may put us in intellectual debt. Illustration by Jon Han

Like many medications, the wakefulness drug modafinil, which is marketed under the trade name Provigil, comes with a small, tightly folded paper pamphlet. For the most part, its contents—lists of instructions and precautions, a diagram of the drug's molecular structure—make for anodyne reading. The subsection called "Mechanism of Action," however, contains a sentence that might induce sleeplessness by itself: "The mechanism(s) through which modafinil promotes wakefulness is unknown."

Provigil isn't uniquely mysterious. Many drugs receive regulatory approval, and are widely prescribed, even though no one knows exactly how they work. This mystery is built into the process of drug discovery, which often proceeds by trial and error. Each year, any number of new substances are tested in cultured cells or animals; the best and safest of those are tried out in people.

3. Faber

Live View 〉 ImageClassifierPG.playground (Live View)

ImageClassifier

Model accuracy

83%	79%	79%
Training	Validation	Evaluation

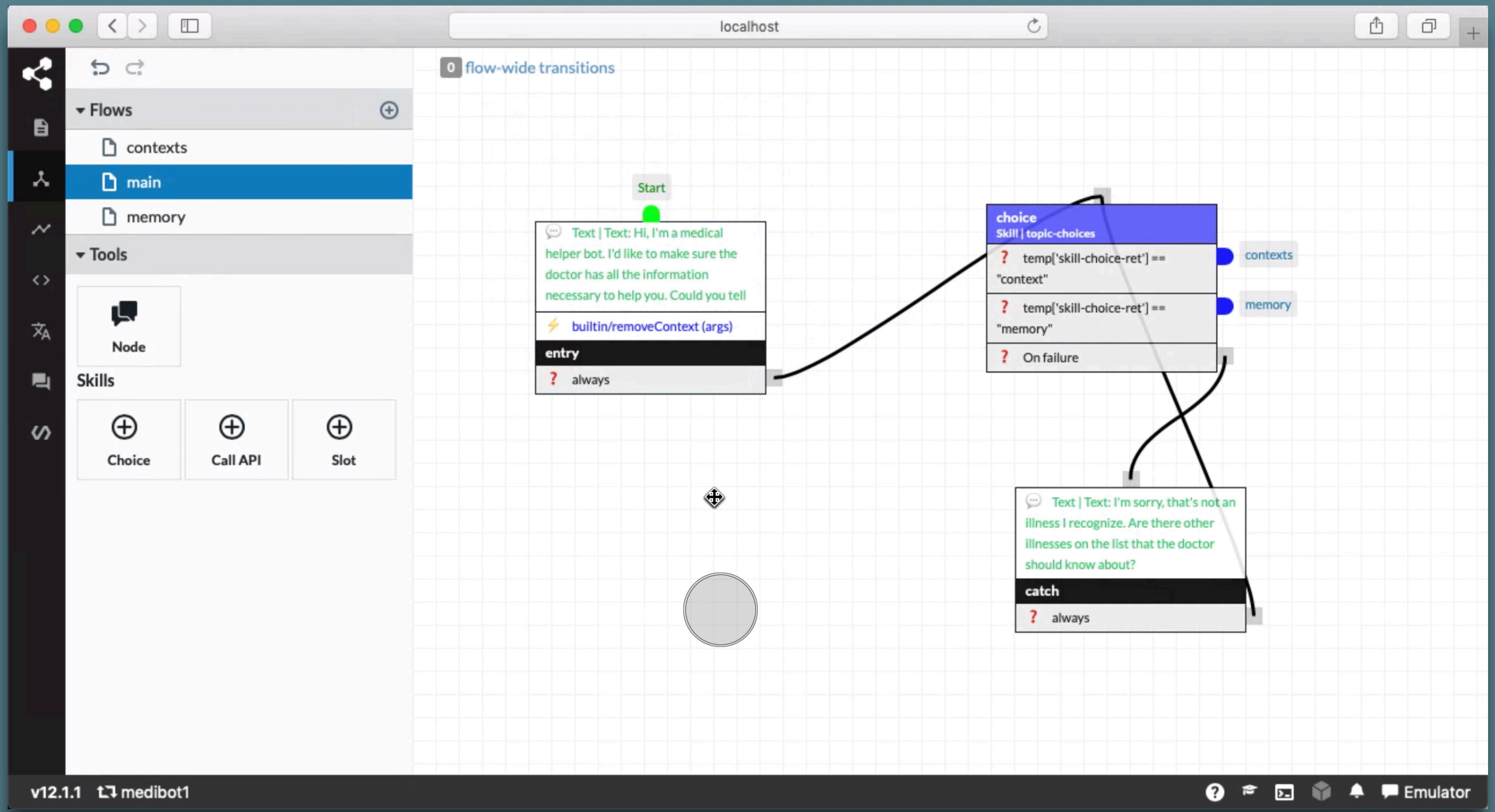
Predicted	True
Positive	Positive

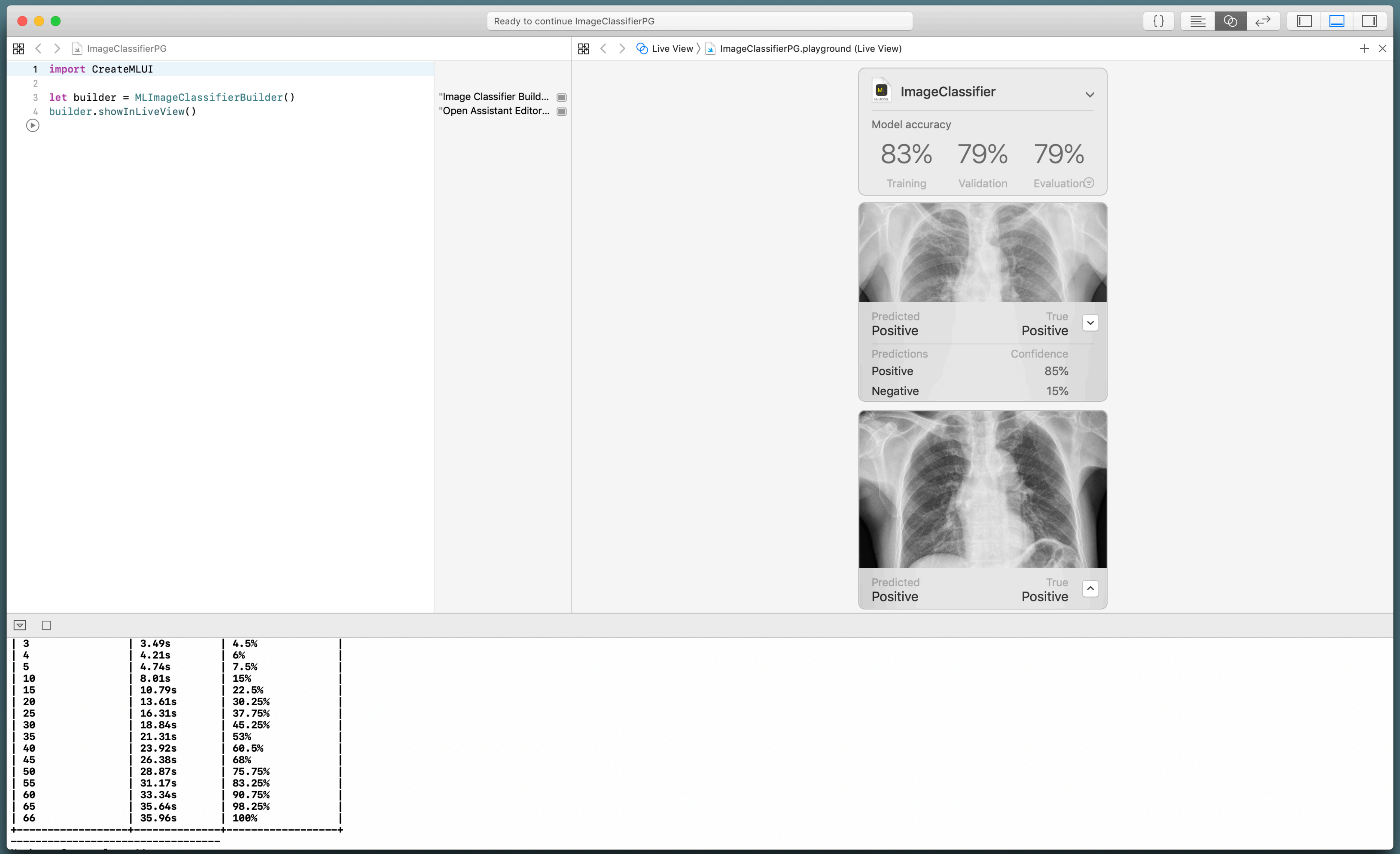
Predictions	Confidence
Positive	85%
Negative	15%

Predicted	True
Positive	Positive

AI in Medical Education -Basic Exercises

- Bots
- Recommendation Systems
- Regression and Clustering
- Image Classification
- Object Detection
- Sequence Classification





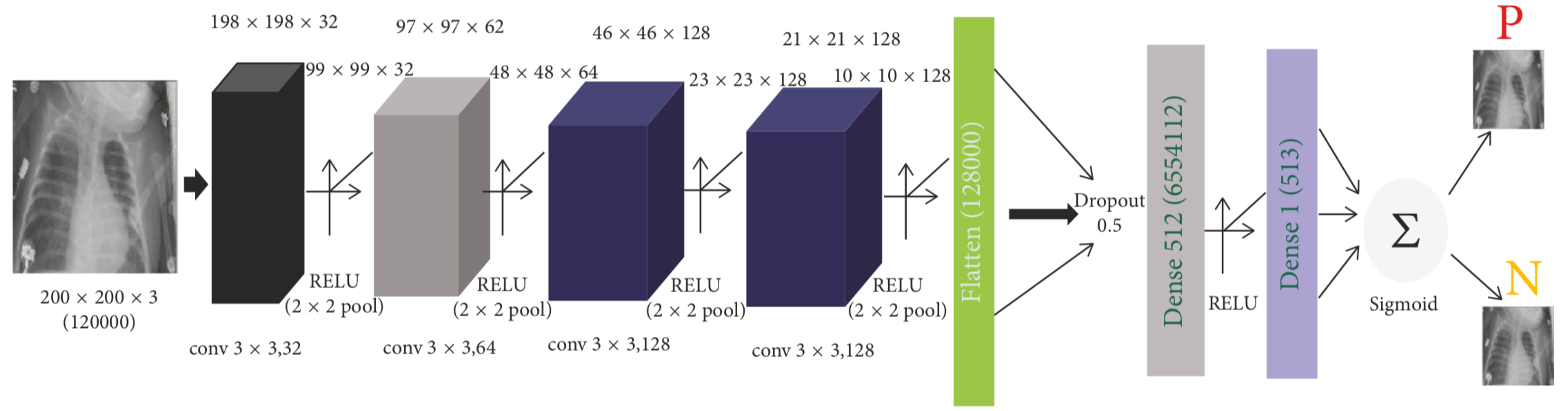
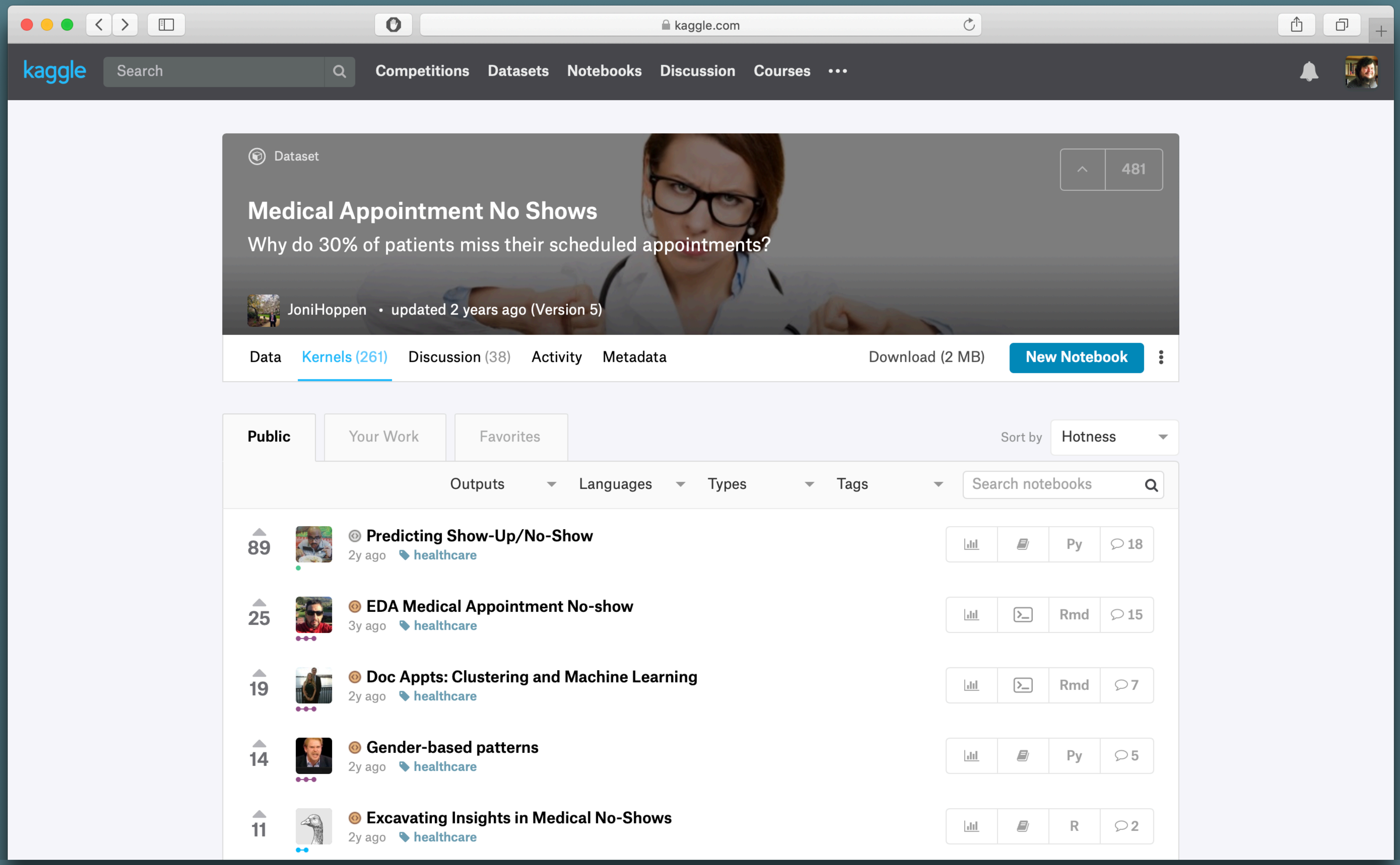


Figure 3: The proposed architecture.

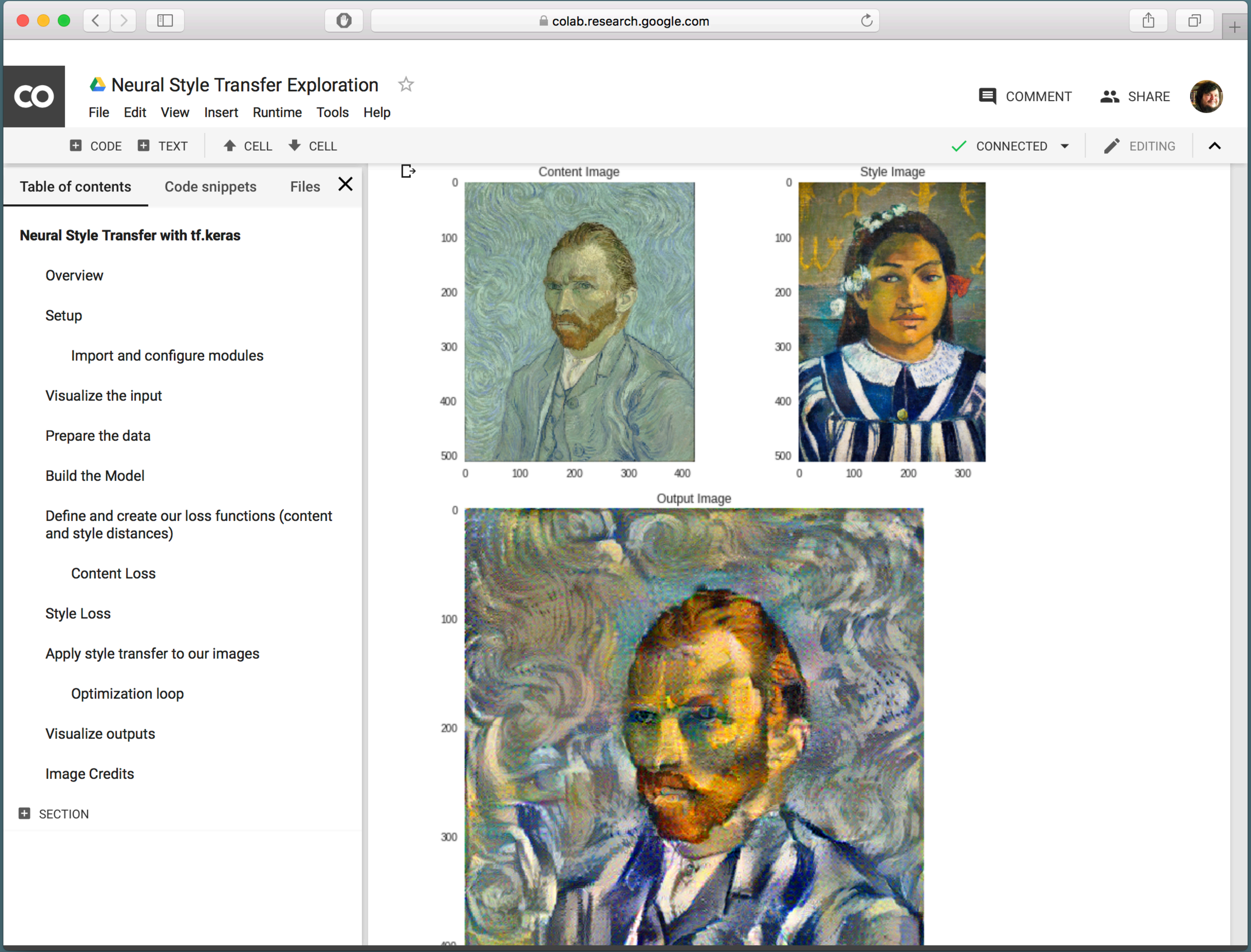
Table 2: The output of the proposed network architecture.

Layer (type)	Output shape	Turtles
conv2d_9 (conv2D)	(None, 198, 198, 32)	896
max_Pooling2d_9 (MaxPooling2)	(None, 99, 99, 32)	0
conv2d_10 (conv2D)	(None, 97, 97, 64)	18496
max_Pooling2d_10 (MaxPooling2)	(None, 48, 48, 64)	0
conv2d_11 (conv2D)	(None, 46, 46, 128)	73856
max_Pooling2d_11 (MaxPooling2)	(None, 23, 23, 128)	0
conv2d_12 (conv2D)	(None, 21, 21, 128)	147584
max_Pooling2d_12 (MaxPooling2)	(None, 10, 10, 128)	0
flatten_3 (Flatten)	(None, 12800)	0
dropout_3 (Dropout)	(None, 12800)	0
dense_5 (Dense)	(None, 512)	6554112
dense_6 (Dense)	(None, 1)	513

Stephen, Okeke, et al. "An Efficient Deep Learning Approach to Pneumonia Classification in Healthcare." *Journal of healthcare engineering* (2019).



4. Ludens


colab.research.google.com
CO
Neural Style Transfer Exploration
File Edit View Insert Runtime Tools Help
COMMENT
SHARE
CODE
TEXT
CELL
CELL
CONNECTED
EDITING
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Code snippets
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Import and configure modules
Visualize the input
Prepare the data
Build the Model
Define and create our loss functions (content and style distances)
Content Loss
Style Loss
Apply style transfer to our images
Optimization loop
Visualize outputs
Image Credits
SECTION
Content Image
Style Image
Output Image

5. The Thinking Sidecar

EDITORIAL

Chess, a *Drosophila* of reasoning

The recent world chess championship saw Magnus Carlsen defend his title against Fabiano Caruana. But it was not a contest between the two strongest chess players on the planet, only the strongest humans. Soon after I lost my rematch against IBM's Deep Blue in 1997, the short window of human-machine chess competition slammed shut forever. Unlike humans, machines keep getting faster, and today a smartphone chess app can be stronger than Deep Blue. But as we see with the AlphaZero system (see pages 1118 and 1140), machine dominance has not ended the historical role of chess as a laboratory of cognition.

"...machine dominance has not ended the historical role of chess as a laboratory of cognition."

Much as the *Drosophila melanogaster* fruit fly became a model organism for geneticists, chess became a *Drosophila* of reasoning. In the late 19th century, Alfred Binet hoped that understanding why certain people excelled at chess would unlock secrets of human thought. Sixty years later, Alan Turing wondered if a chess-playing machine might illuminate, in the words of Norbert Wiener, "whether this sort of ability represents an essential difference between the potentialities of the machine and the mind."

Much as airplanes don't flap their wings like birds, machines don't generate chess moves like humans do. Early programs that attempted it were weak. Success came with the "minimax" algorithm and Moore's law, not with the ineffable human combination of pattern recognition and visualization. This prosaic formula dismayed the artificial intelligence (AI) crowd, who realized that profound computational insights were not required to produce a machine capable of defeating the world champion.

But now the chess fruit fly is back under the microscope. Based on a generic game-playing algorithm, AlphaZero incorporates deep learning and other AI techniques like Monte Carlo tree search to play against itself to generate its own chess knowledge. Unlike top traditional programs like Stockfish and Fritz, which employ many preset evaluation functions as well as massive libraries of opening and endgame moves, AlphaZero starts out knowing only the rules of chess, with no embedded human strategies. In just a few hours, it plays more games against itself than have been recorded in human chess history. It teaches itself the best way to play, reevaluating such fundamental concepts as the relative values of the pieces. It quickly becomes strong enough to defeat the best chess-playing entities in the world, winning 28, drawing 72, and losing none in a victory over Stockfish.

I admit that I was pleased to see that AlphaZero had a dynamic, open style like my own. The conventional wisdom was that machines would approach perfection with endless dry maneuvering, usually leading to drawn games. But in my observation, AlphaZero prioritizes piece activity over material, preferring positions that to my eye looked risky and aggressive. Programs usually reflect priorities and prejudices of programmers, but because AlphaZero programs itself, I would say that its style reflects the truth. This superior understanding allowed it to outclass the world's top traditional program despite calculating far fewer positions per second. It's the embodiment of the cliché, "work smarter, not harder."

AlphaZero shows us that machines can be the experts, not merely expert tools. Explainability is still an issue—it's not going to put chess coaches out of business just yet. But the knowledge it generates is information we can all learn from. AlphaZero is surpassing us in a profound and useful way, a model that may be duplicated on any other task or field where virtual knowledge can be generated.

Machine learning systems aren't perfect, even at a closed system like chess. There will be cases where an AI will fail to detect exceptions to their rules. Therefore, we must work together, to combine our strengths. I know better than most people what it's like to compete against a machine. Instead of raging against them, it's better if we're all on the same side.

–**Garry Kasparov**

Garry Kasparov *is the former world chess champion and the author of* Deep Thinking: Where Machine Intelligence Ends and Human Creativity Begins. *He is chairman of the Human Rights Foundation, New York, NY, USA.* *kasparov@hrf.org*

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