

Modelhub: Plug & Predict Solutions for Reproducible AI Research



www.modelhub.ai

Ahmed Hosny & Michael Schmier



HARVARD
MEDICAL SCHOOL



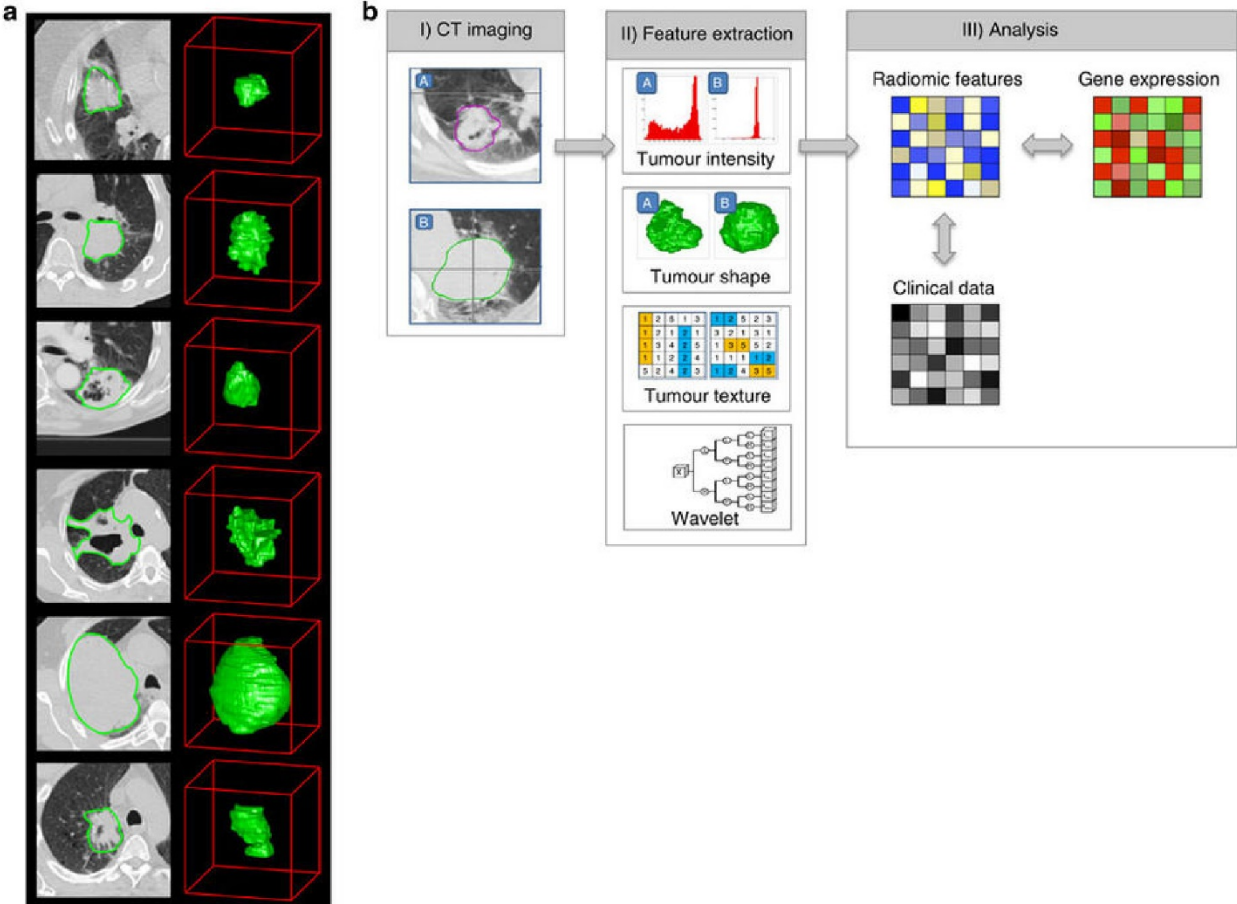
BRIGHAM AND
WOMEN'S HOSPITAL



DANA-FARBER
CANCER INSTITUTE

NCI Containers and Workflows Interest Group Seminar - July 2018

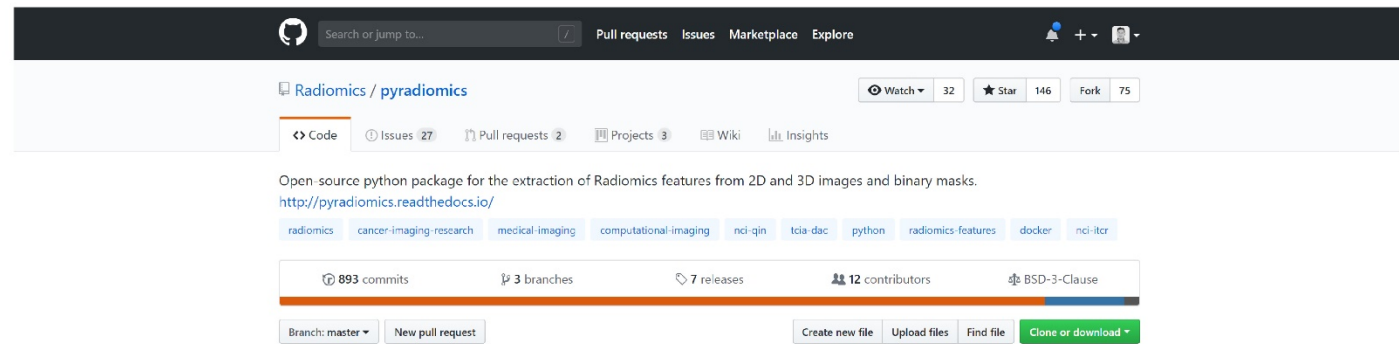
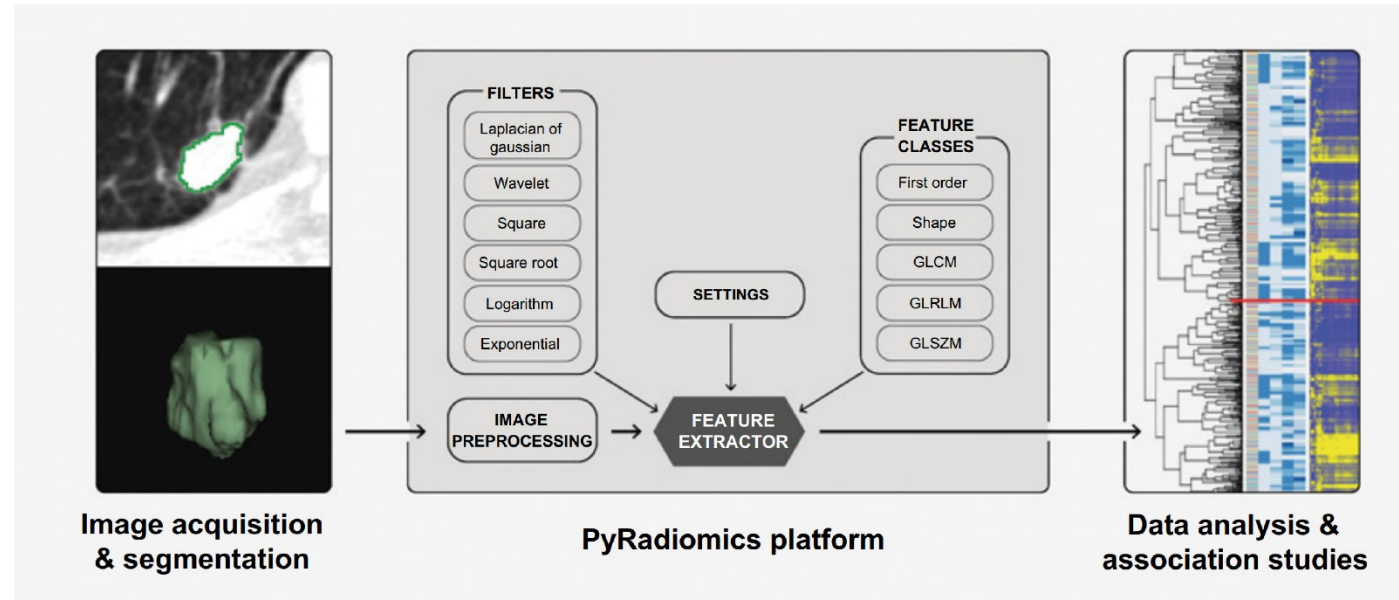
Tumor Phenotyping in 2014



Hugo JWL Aerts, Emmanuel R Velazquez, Ralph TH Leijenaar, et al.

Decoding Tumour Phenotype by Noninvasive Imaging using a Quantitative Radiomics Approach
 Nature Communications - 2014

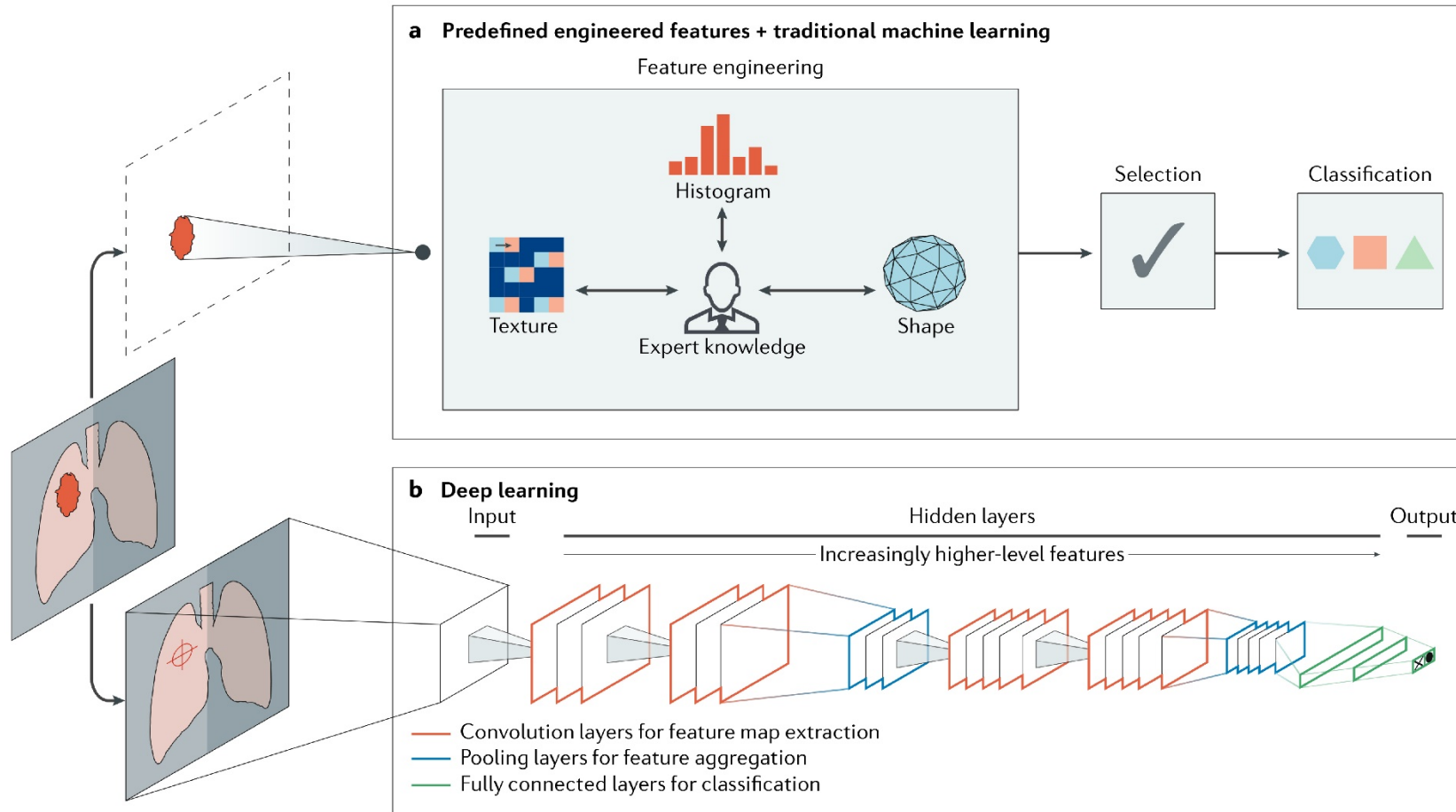
PyRadiomics



Joost JM van Griethuysen, Andriy Fedorov, Chintan Parmar, et al.

Computational Radiomics System to Decode the Radiographic Phenotype
Cancer Research - 2017

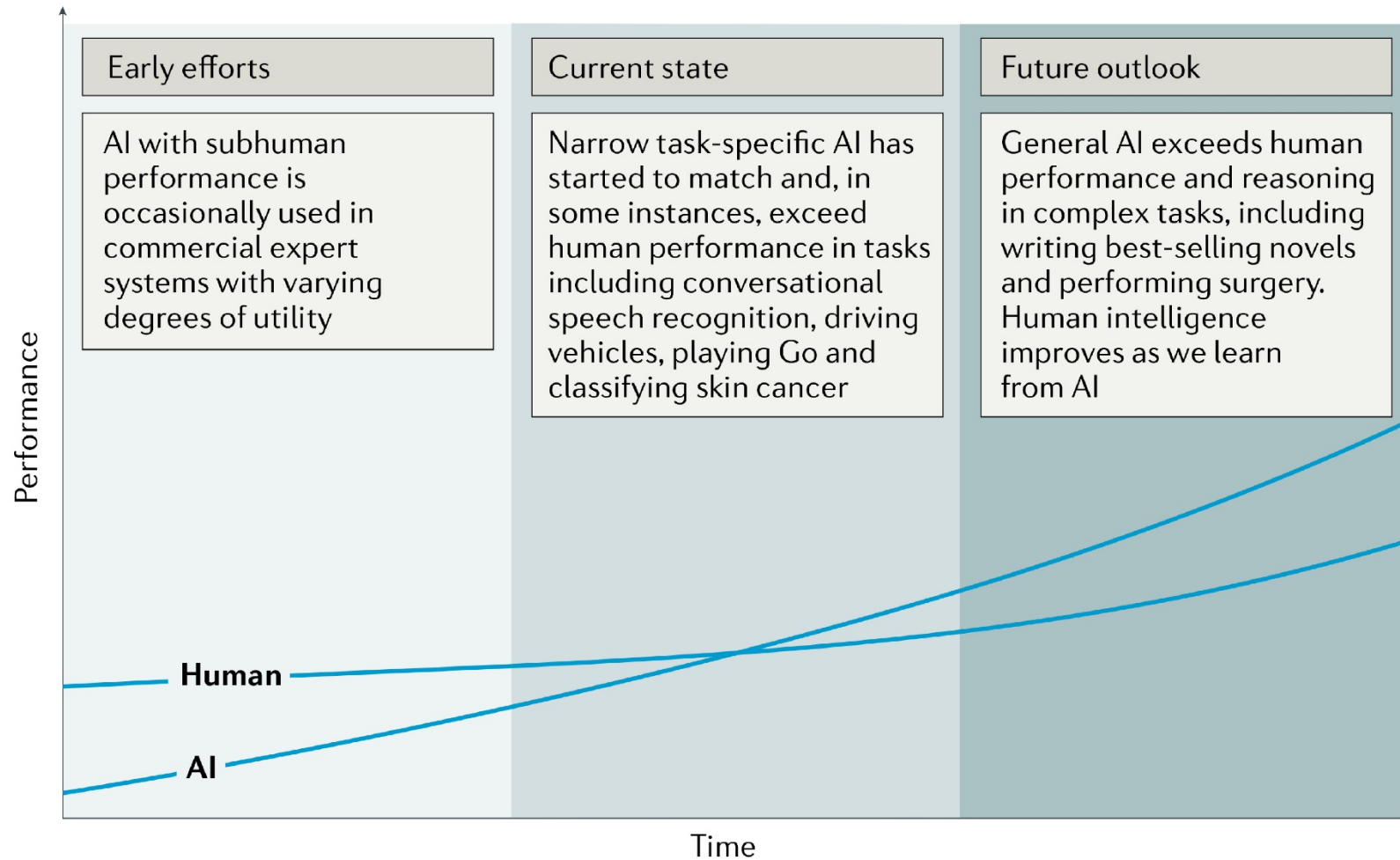
Deep Learning



Ahmed Hosny, Chintan Parmar, John Quackenbush, Lawrence H Schwartz and Hugo JWL Aerts

Artificial Intelligence in Radiology
Nature Reviews Cancer - 2018

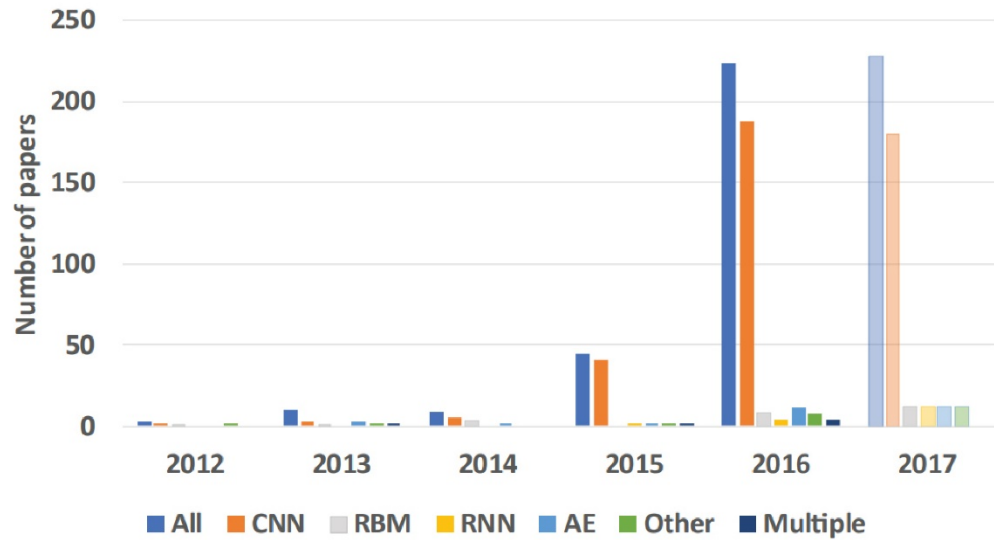
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Deep Learning



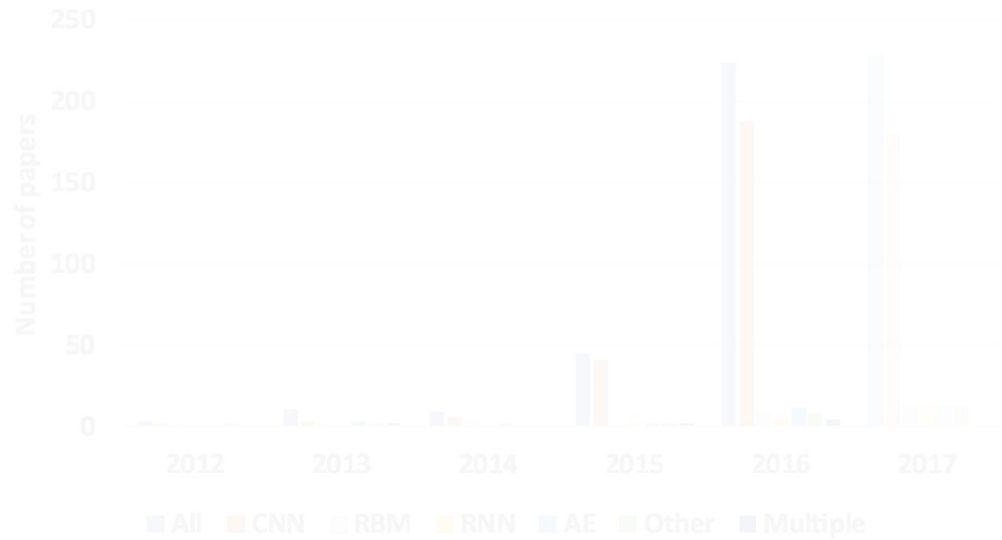
Geert Litjens, Thijs Kooi, Babak Ehteshami Bejnordi, et al.

A Survey on Deep Learning in Medical Image Analysis
Medical Image Analysis - 2017

Misc.

Open-Source Deep Learning Tools
github.com

Deep Learning



 Keras

 DL4J

 Caffe2

 PYTORCH

 torch

 Caffe

 Microsoft
CNTK

 TensorFlow

 theano

 mxnet

Geert Litjens, Thijs Kooi, Babak Ehteshami Bejnordi, et al.

A Survey on Deep Learning in Medical Image Analysis
Medical Image Analysis - 2017

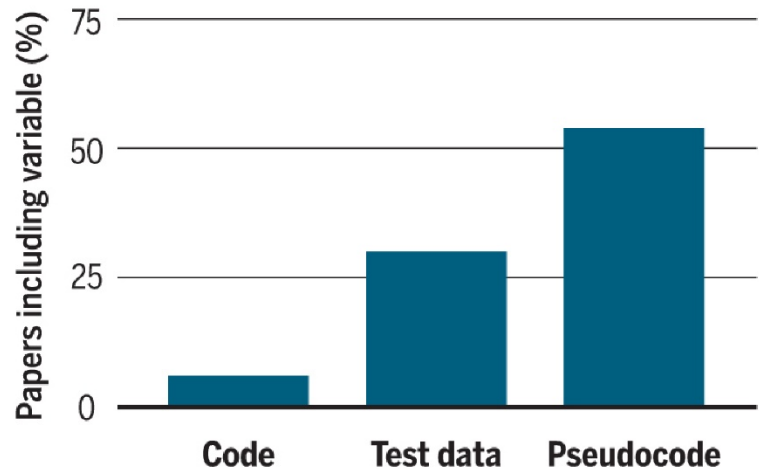
Misc.

Open-Source Deep Learning Tools
github.com

Reproducibility

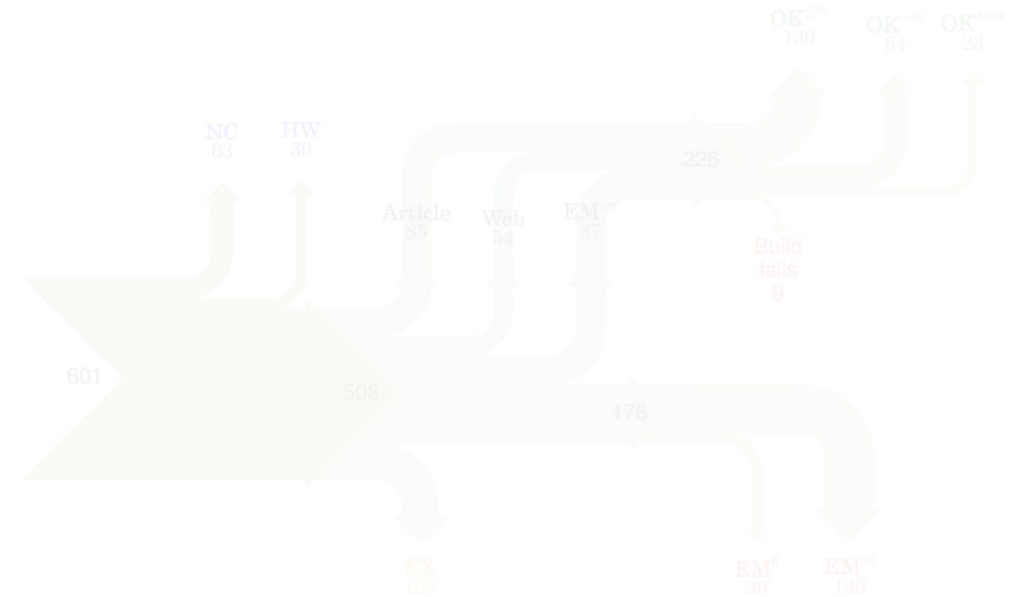
Code break

In a survey of 400 artificial intelligence papers presented at major conferences, just 6% included code for the papers' algorithms. Some 30% included test data, whereas 54% included pseudocode, a limited summary of an algorithm.



Matthew Hutson

Artificial Intelligence Faces Reproducibility Crisis
Science - 2018



Christian Collberg and Todd A Proebsting

Repeatability in Computer Systems Research
Communications of the ACM - 2016

Reproducibility

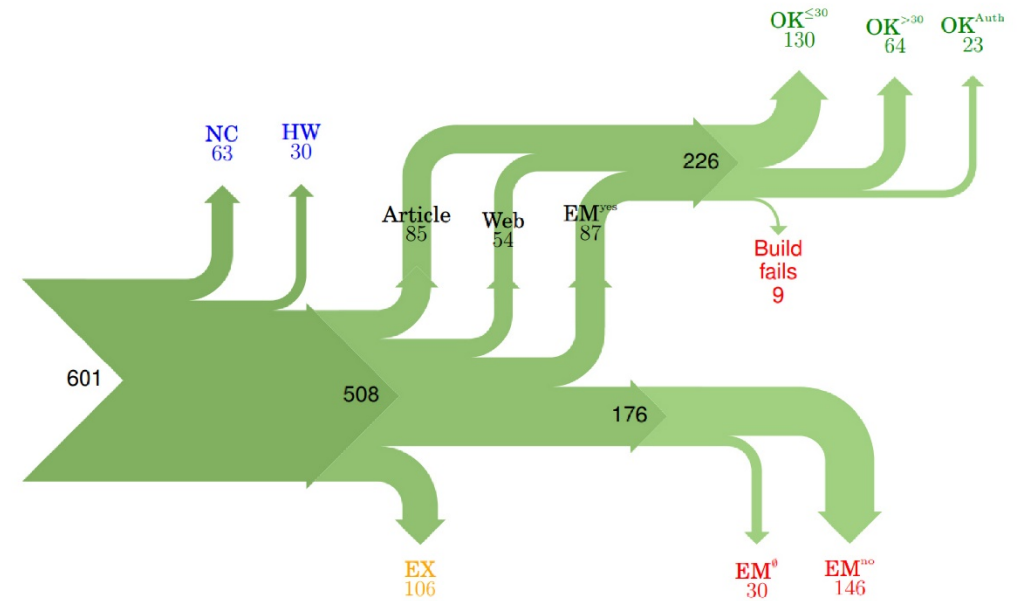
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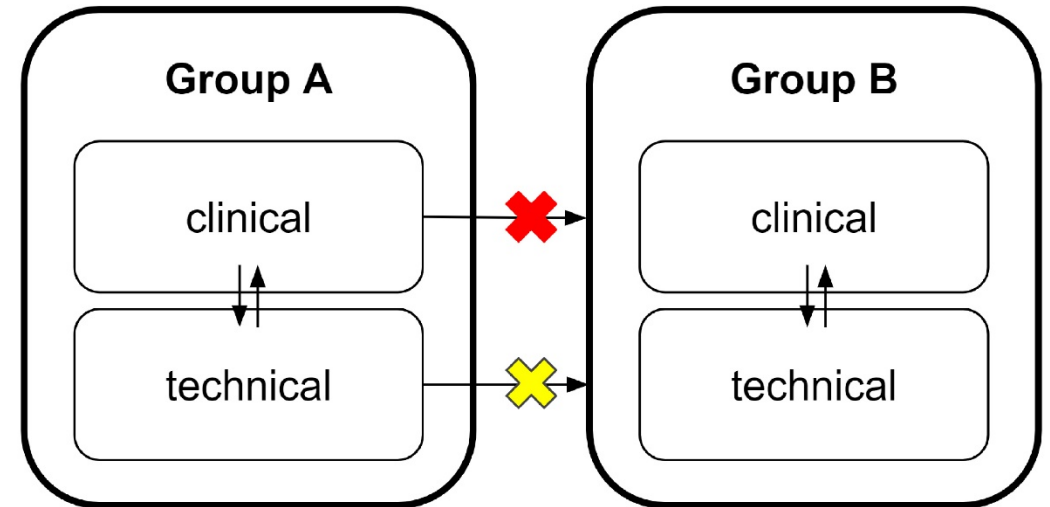
Christian Collberg and Todd A Proebsting

Repeatability in Computer Systems Research
Communications of the ACM - 2016

Reproducibility in Multidisciplinary Teams

DL applications developed by medical imaging engineers in isolation from other clinical researchers

High barrier to entry for novice programmers without means to exploring work done by others



Leo A Celi, Sharukh Lokhandwala, Robert Montgomery, et al.

Datathons and Software to Promote Reproducible Research
Journal of Medical Internet Research - 2016

Existing Solutions

houseroad Rename ZFNet to ZFNet-512 (#36)		Latest commit 3be4824 11 hours ago
📁 bvlc_alexnet	Update bvlc_alexnet model	4 months ago
📁 bvlc_googlenet	Add the value_info.json for the remaining of the models except style ...	3 months ago
📁 bvlc_reference_caffenet	Add the value_info.json for the remaining of the models except style ...	3 months ago
📁 bvlc_reference_rcnn_ilsvrc13	Add the value_info.json for the remaining of the models except style ...	3 months ago
📁 densenet121	Add DenseNet-121 model	4 months ago
📁 detectron	Add Detectron e2e_faster_rcnn_R-50-C4_2x model	3 months ago
📁 inception_v1	Add Inception models	4 months ago
📁 inception_v2	Add Inception models	4 months ago
📁 resnet50	Add ResNet-50 model	4 months ago
📁 scripts	Add Detectron e2e_faster_rcnn_R-50-C4_2x model	3 months ago
📁 squeezeNet	Correct SqueezeNet value_info to 227x227	3 months ago
📁 style_transfer	Add other style transfer models	4 months ago
📁 vgg19	Add VGG models	4 months ago
📁 zfn512	Rename ZFNet to ZFNet-512 (#36)	11 hours ago
📄 .gitattributes	Remove squeezeNet-specific lines from .gitattributes.	4 months ago
📄 LICENSE	Add Apache 2.0 license	4 months ago
📄 README.md	Update README to describe subdirectory access	3 months ago

Yangqing Jia, Evan Shelhamer, Jeff Donahue, et al.

Caffe: Convolutional Architecture for Fast Feature Embedding
arxiv.org/abs/1408.5093



Samim and Graphific

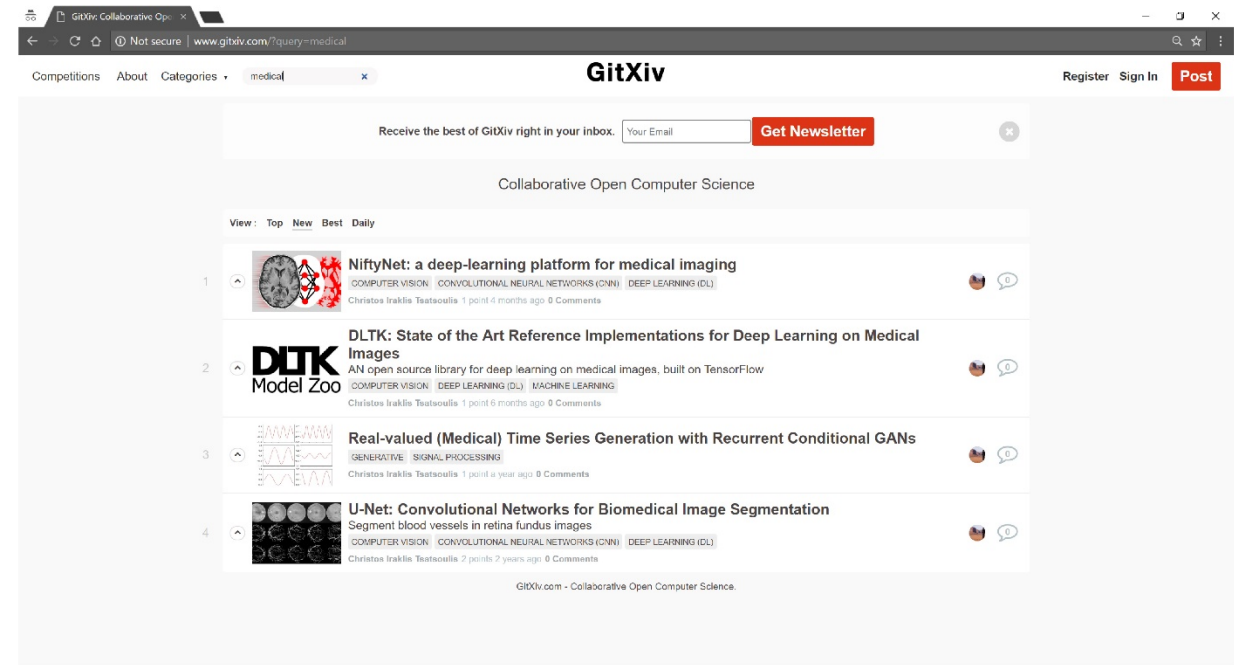
GitXiv—Collaborative Open Computer Science
gitxiv.com

Existing Solutions

housearoad Rename ZFNet to ZFNet-512 (#36)	Latest commit 35e4824 11 hours ago	
bvlc_alexnet	Update bvlc_alexnet model	4 months ago
bvlc_googlenet	Add the value_info.json for the remaining of the models except style ...	3 months ago
bvlc_reference_caffenet	Add the value_info.json for the remaining of the models except style ...	3 months ago
bvlc_reference_rcnn_ilsvrc13	Add the value_info.json for the remaining of the models except style ...	3 months ago
densenet121	Add DenseNet-121 model	4 months ago
detectron	Add Detectron e2e_faster_rcnn_R-50-C4_2x model	3 months ago
inception_v1	Add Inception models	4 months ago
inception_v2	Add Inception models	4 months ago
resnet50	Add ResNet-50 model	4 months ago
scripts	Add Detectron e2e_faster_rcnn_R-50-C4_2x model	3 months ago
squeezenet	Correct SqueezeNet value_info to 227x227	3 months ago
style_transfer	Add other style transfer models	4 months ago
vgg19	Add VGG models	4 months ago
zfn512	Rename ZFNet to ZFNet-512 (#36)	11 hours ago
.gitattributes	Remove squeezenet-specific lines from .gitattributes	4 months ago
LICENSE	Add Apache 2.0 license	4 months ago
README.md	Update README to describe subdirectory access	3 months ago

Yangqing Jia, Evan Shelhamer, Jeff Donahue, et al.

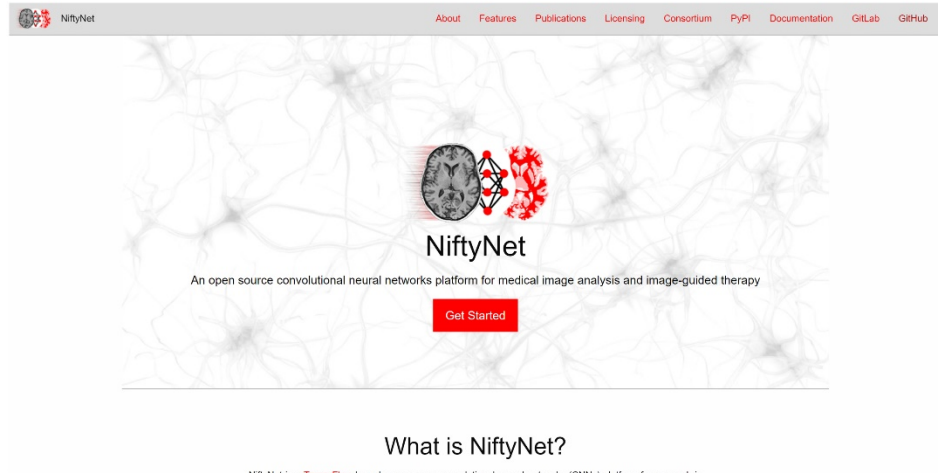
Caffe: Convolutional Architecture for Fast Feature Embedding
arxiv.org/abs/1408.5093



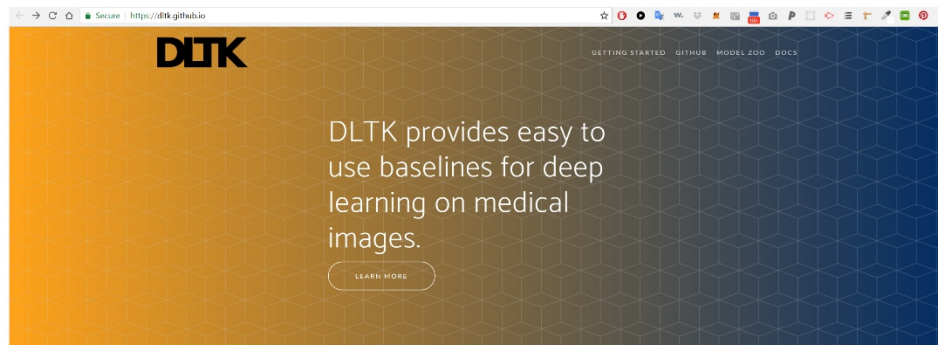
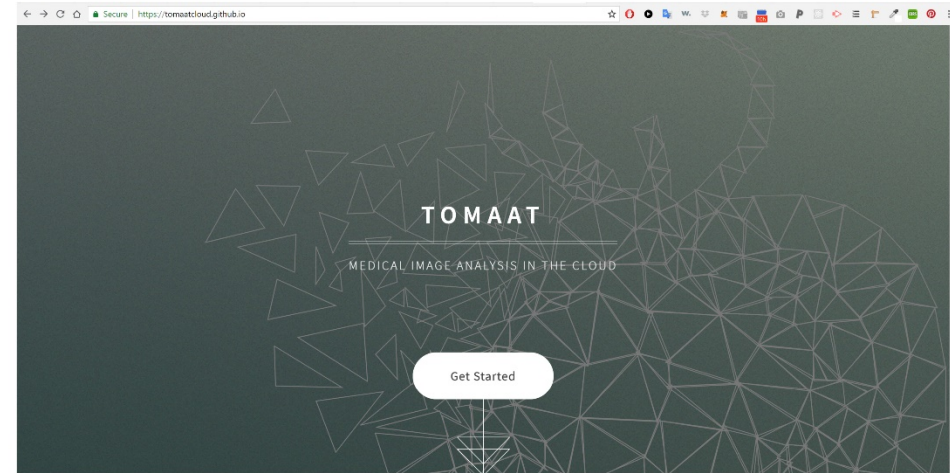
Samim and Graphific

GitXiv—Collaborative Open Computer Science
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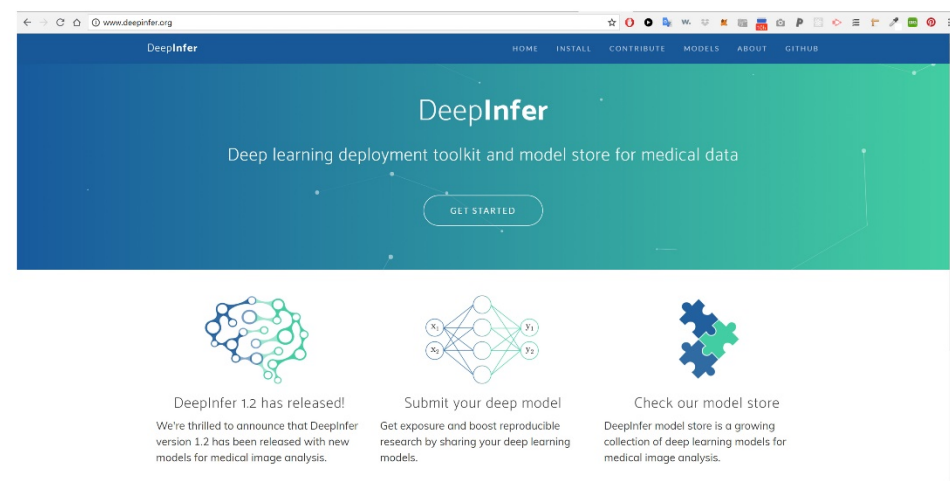
Existing Medical Imaging Solutions



What is NiftyNet?



Getting Started.



Existing Commercial Solutions

The screenshot shows the Google Cloud Vision API landing page. At the top, there's a navigation bar with 'Products', 'Solutions', 'Launcher', 'Pricing', 'Security', 'Customers', 'Documentation', 'Support', and 'Partners'. A search bar and 'CONSOLE' link are also present. Below the navigation, the main heading is 'CLOUD VISION API' with the subtext 'Derive insight from images with our powerful Cloud Vision API'. A 'TRY IT FREE' button is prominently displayed. The section 'Powerful Image Analysis' follows, explaining that the API uses machine learning models to understand image content, classify images, detect objects and faces, and read text. An illustration shows a sailboat image being analyzed into categories like 'SUN' and 'SAILBOAT'.

Google Cloud

Why Google **Products** Solutions Launcher Pricing Security Customers Documentation Support Partners [TRY IT FREE](#) [CONTACT SALES](#)

CLOUD VISION API

Derive insight from images with our powerful Cloud Vision API

[TRY IT FREE](#)

Powerful Image Analysis

Google Cloud Vision API enables developers to **understand the content of an image** by encapsulating **powerful machine learning models** in an easy to use REST API. It quickly **classifies images** into thousands of categories (e.g., "sailboat", "lion", "Eiffel Tower"), **detects individual objects and faces within images**, and finds and reads printed words contained within images. You can build metadata on your image catalog, moderate offensive content, or enable new marketing scenarios through image sentiment analysis. **Analyze images uploaded in the request** or integrate with your image storage on Google Cloud Storage.

The screenshot shows the Clarifai website. The navigation bar includes 'PRODUCTS', 'SOLUTIONS', 'DEVELOPERS', 'COMPANY', 'DEMO', 'PRICING', and 'LOG IN'. The main heading is 'THE LEADING AI SOLUTION FOR REAL-WORLD BUSINESS PROBLEMS'. Below this, a paragraph states: 'The problems that your business encounters don't change very often. The way you can solve those problems just has, with Clarifai.' A 'CONTACT SALES' button is visible. The background features a 3D rendering of a computer monitor displaying a grid of images, with a person's face visible on the right side.

clarifai

PRODUCTS SOLUTIONS DEVELOPERS COMPANY DEMO PRICING [LOG IN](#)

THE LEADING AI SOLUTION FOR REAL-WORLD BUSINESS PROBLEMS

The problems that your business encounters don't change very often. The way you can solve those problems just has, with Clarifai.

[CONTACT SALES](#)

UNDERSTAND EVERYTHING

The screenshot shows the Kairos website. The navigation bar includes 'Use cases', 'Developers', 'Token Sale **LIVE**', 'About us', 'News', and 'TALK TO SALES'. The main heading is 'We Serve Businesses with Face Recognition'. Below this, a sub-heading reads 'Create safer, more accessible customer experiences'. A 'TALK TO SALES' button is present. The background features a dark image of a smiling woman's face with a white bounding box around it and a green checkmark below, indicating successful face recognition.

KAIROS

Use cases Developers Token Sale **LIVE** About us News [TALK TO SALES](#)

We Serve Businesses with Face Recognition

Create safer, more accessible customer experiences

[TALK TO SALES](#)

The screenshot shows the Envoy AI website. The navigation bar includes 'ABOUT', 'PLATFORM', 'PARTNERS', 'EXCHANGE', 'CONTACT', and 'BLOG'. The main heading is 'EnvoyAI adds best of breed clinical tools to PAC'. Below this, a sub-heading reads 'We Make AI Work For Radiology.' Two buttons, 'LEARN MORE' and 'GET STARTED', are visible. The background features a dark, textured pattern of hexagons.

ENVOY AI

ABOUT PLATFORM PARTNERS EXCHANGE CONTACT BLOG

EnvoyAI adds best of breed clinical tools to PAC

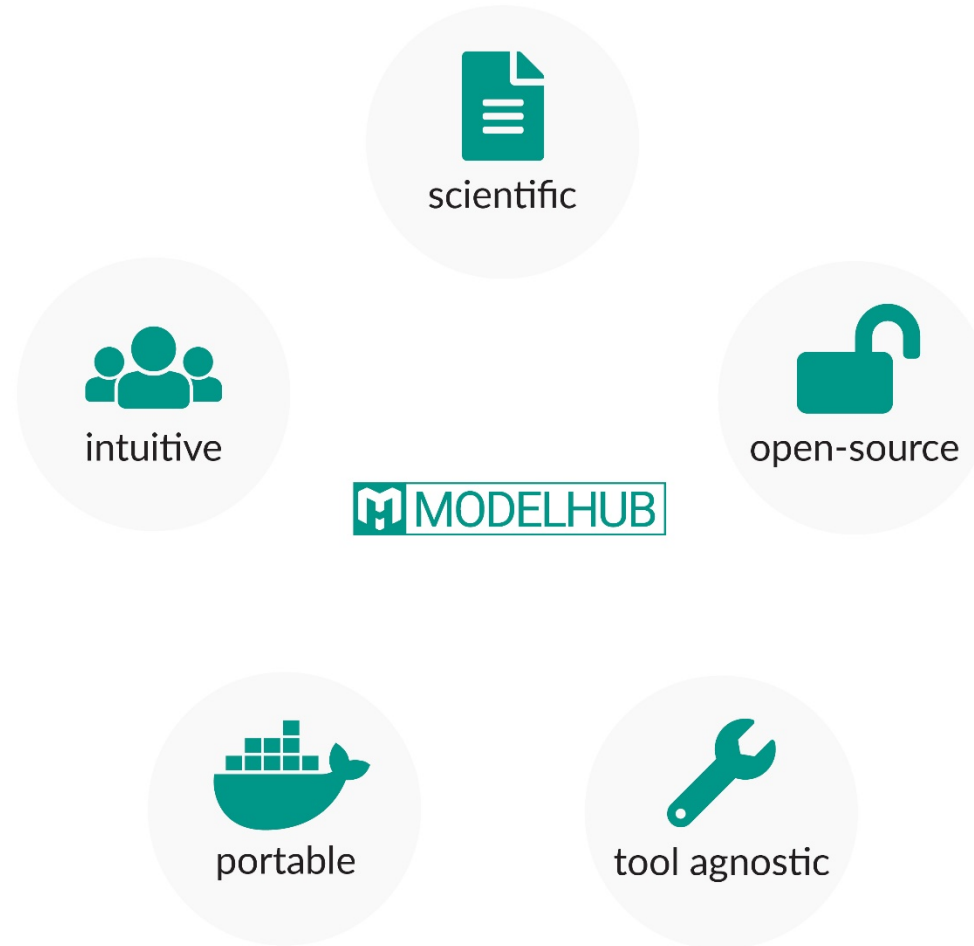
We Make AI Work For Radiology.

[LEARN MORE](#) [GET STARTED](#)



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Components

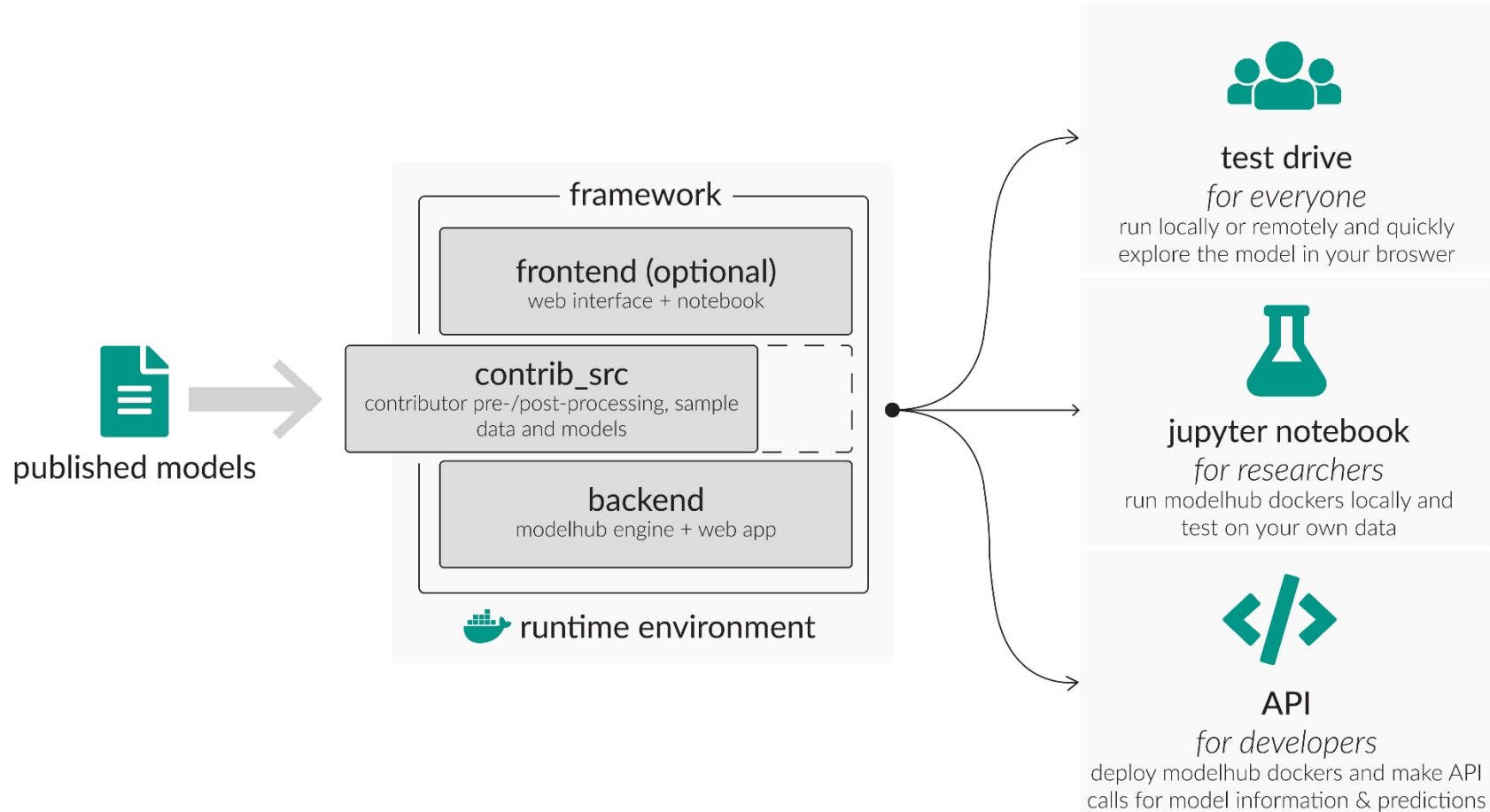


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How it Works



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For Users



test drive
for everyone



jupyter notebook
for researchers



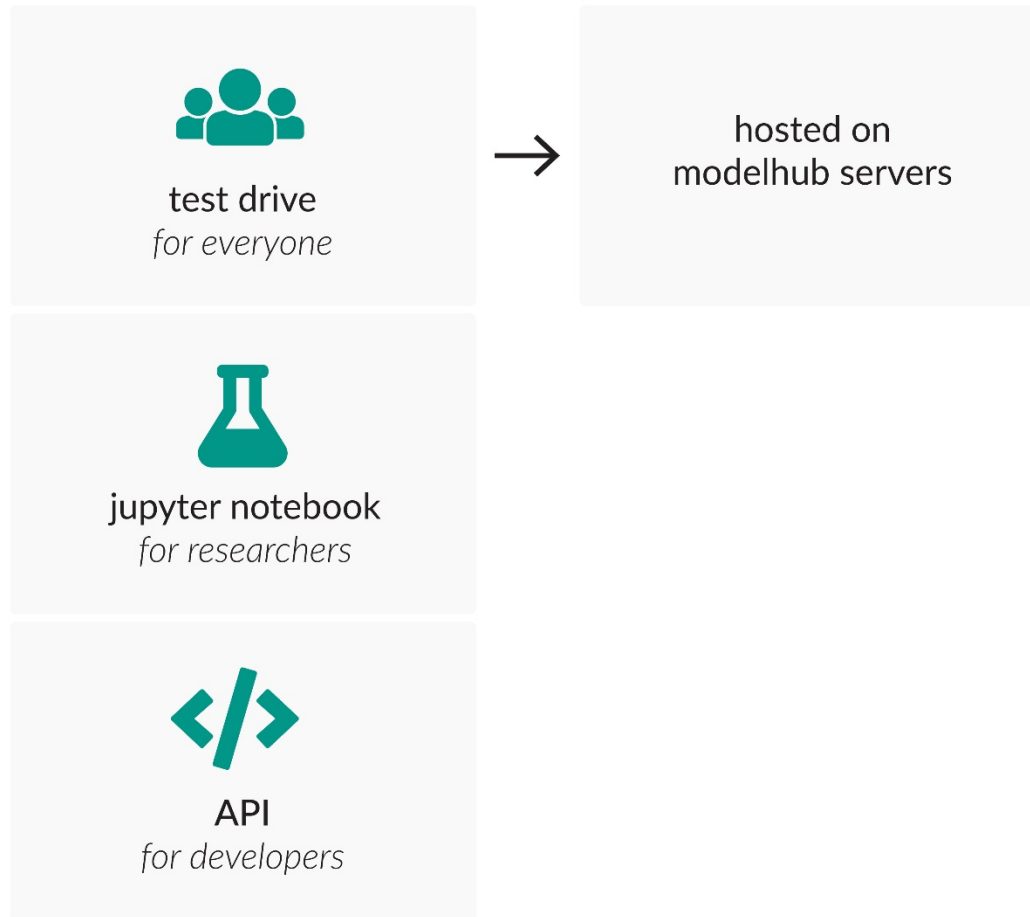
API
for developers

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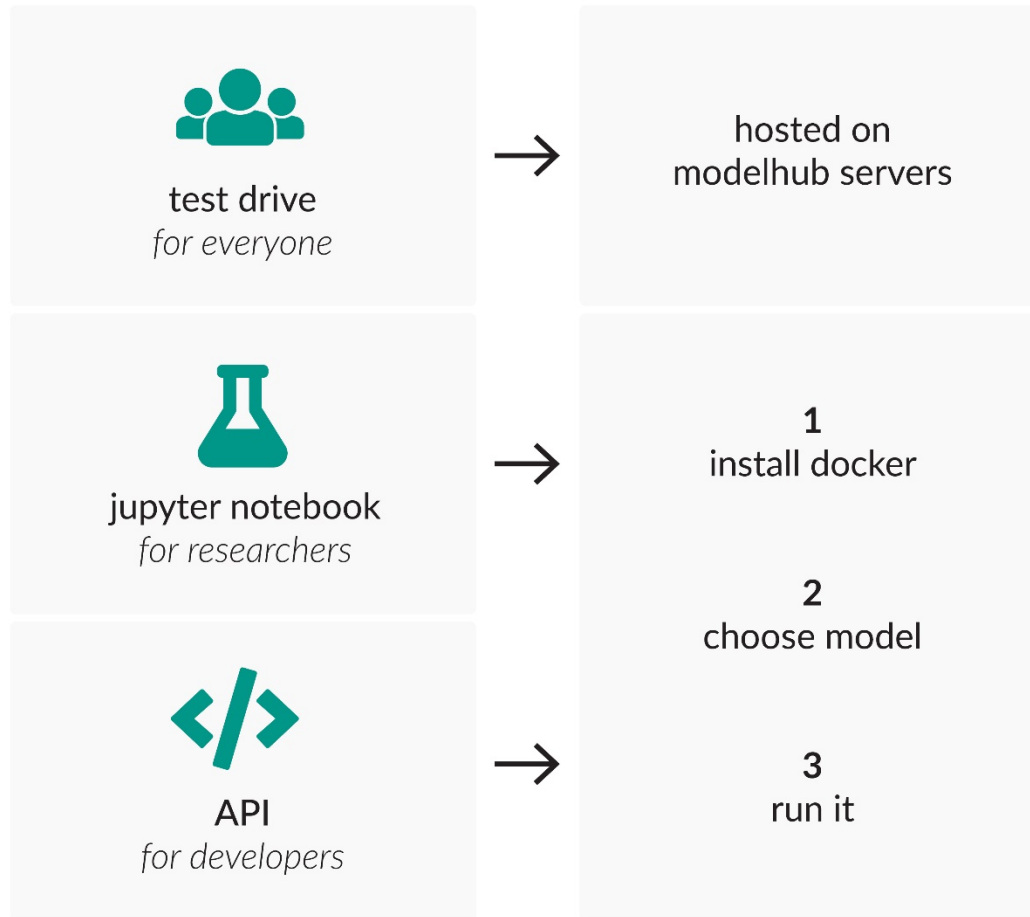
For Users



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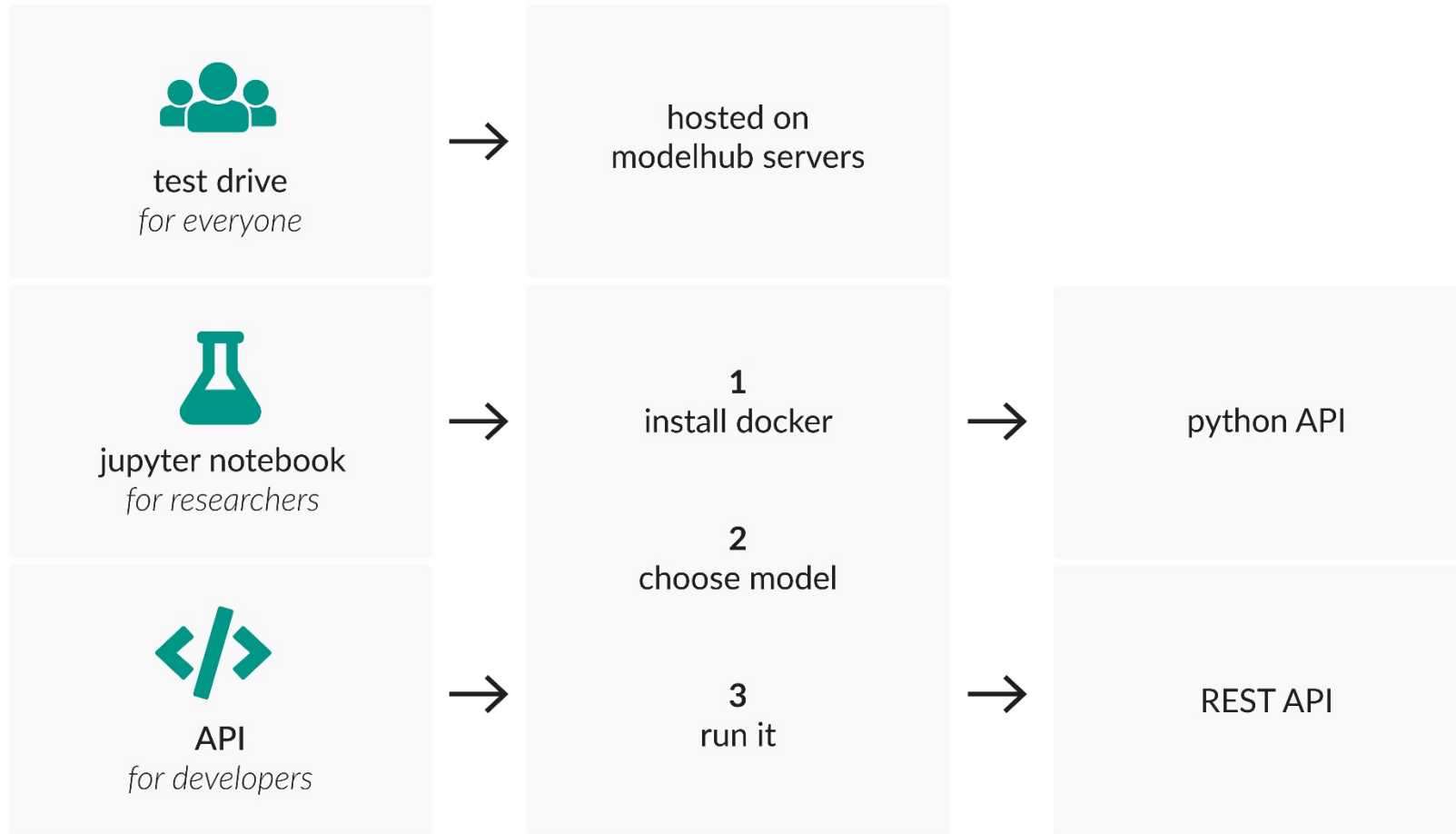
For Users



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For Users



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modelhub.ai

API

predict on url
predict on upload

get model config

get model IO

get license info

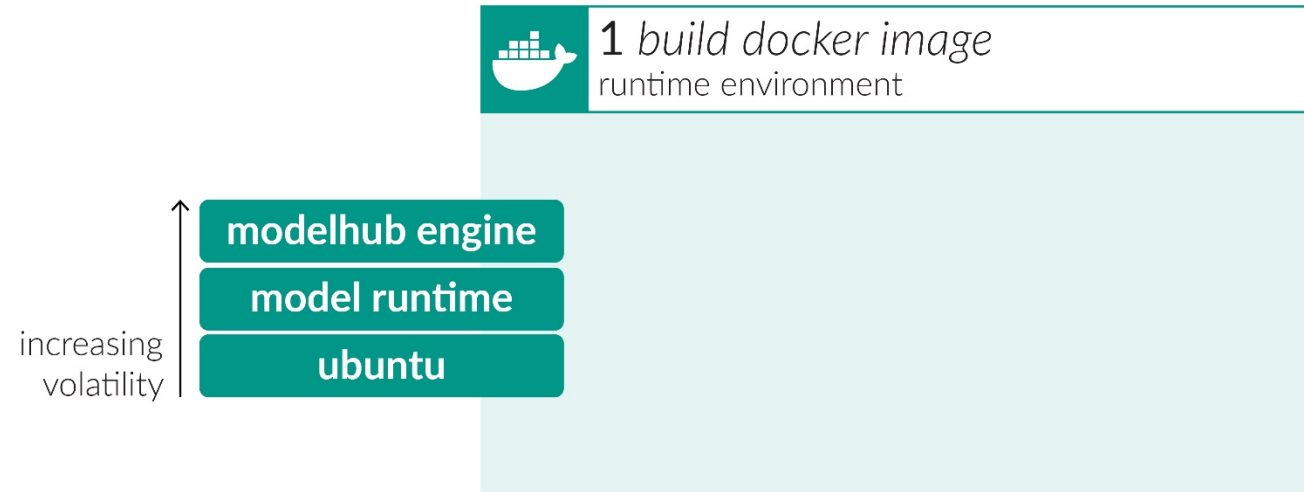
download model files

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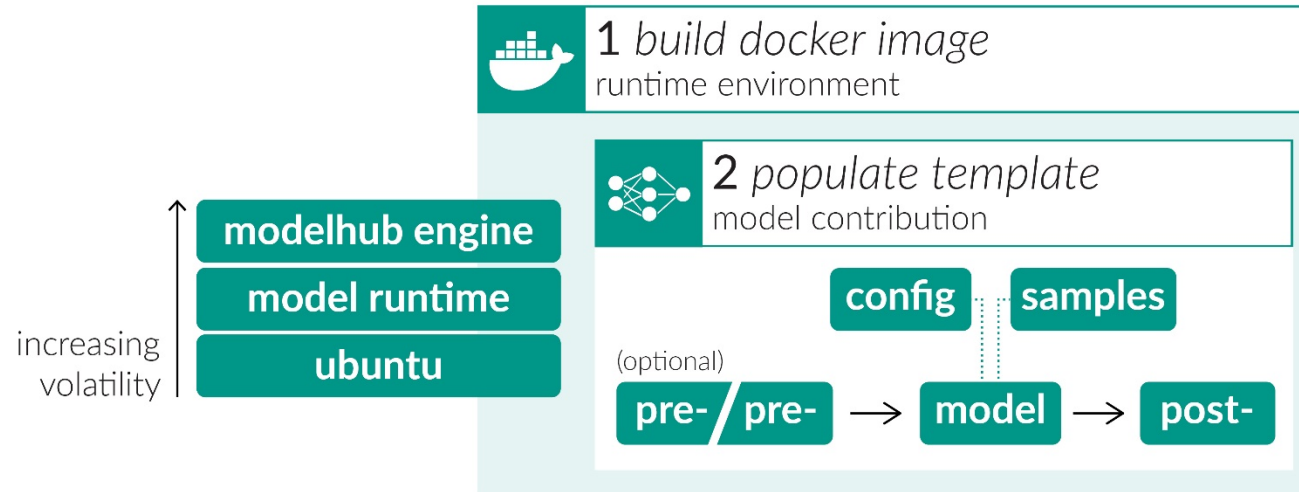
For Contributors



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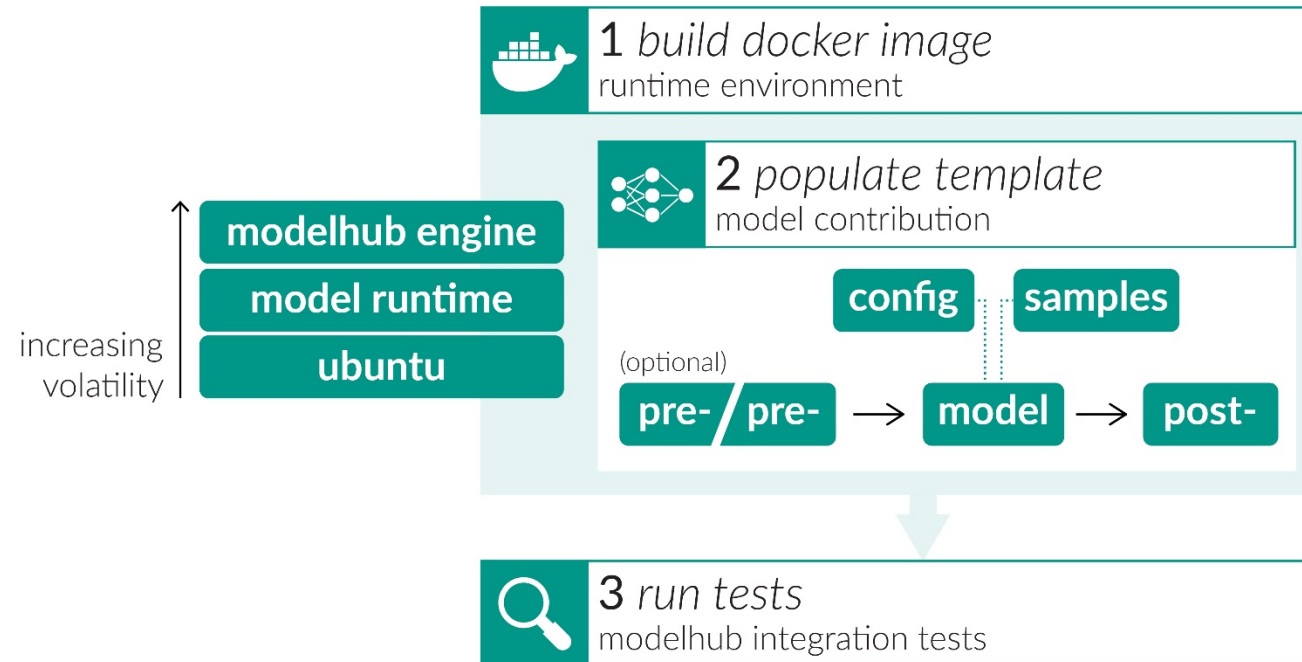


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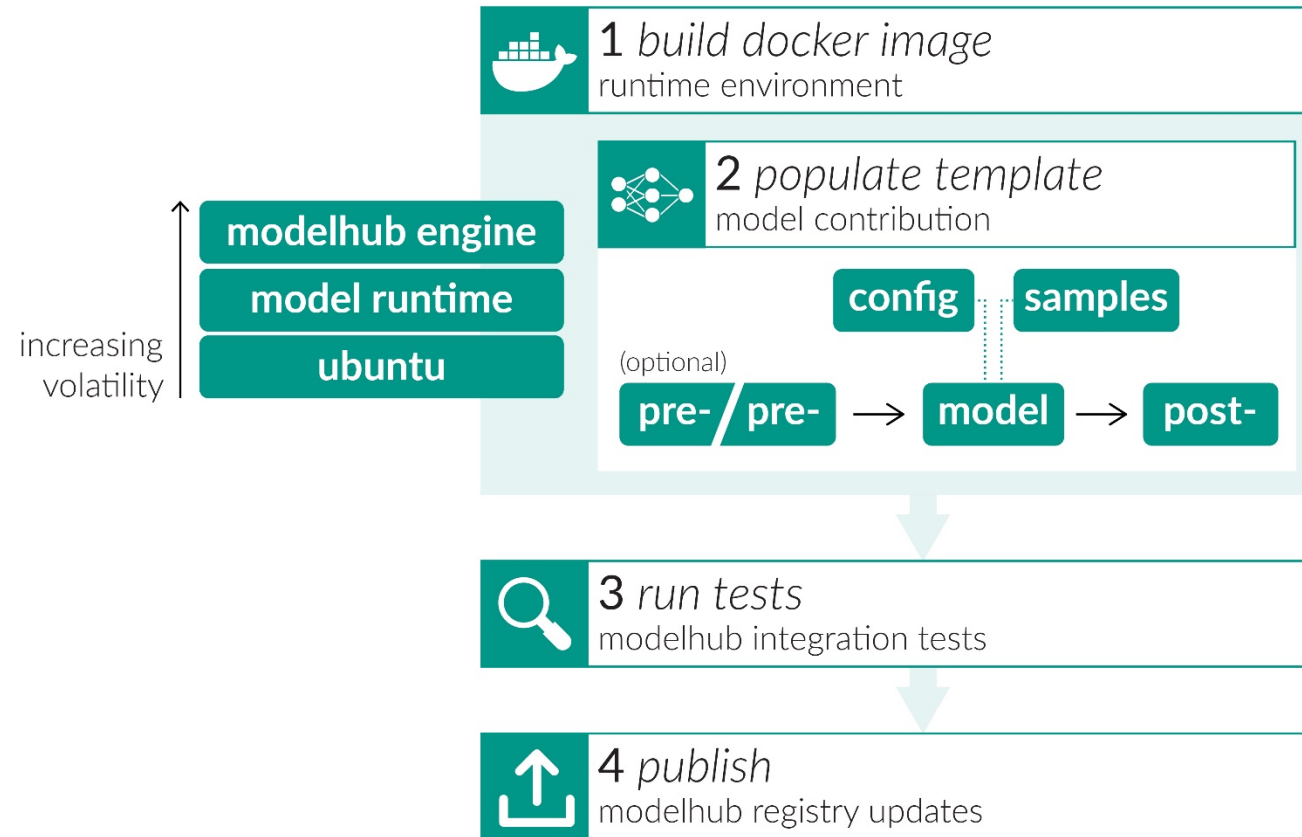


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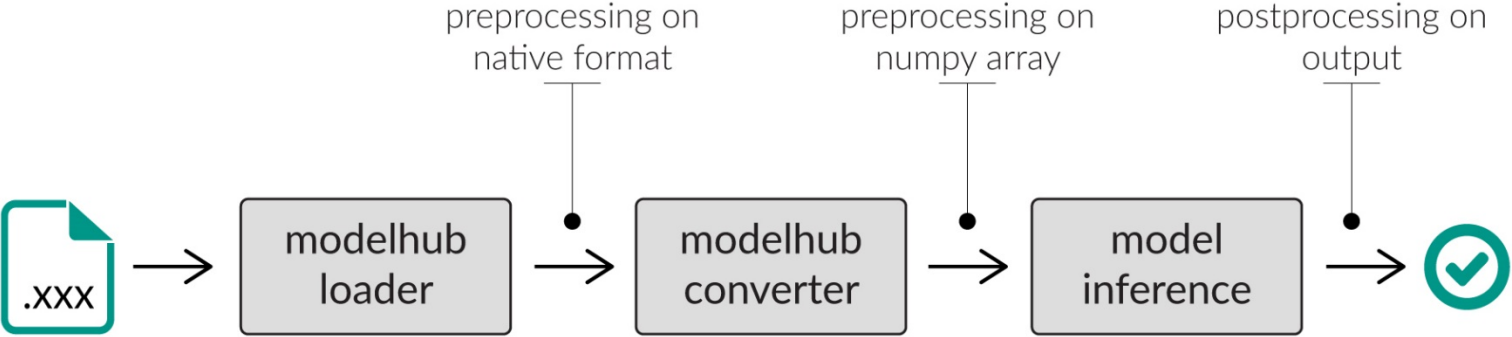


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Input Data Types



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Output Data Types



label_list
probabilities
.json



vector
1d vector
.npy



mask_image
2d or 3d, discrete values. 0 is always background, 1,2.. are labels.
.npy (overlay)



heatmap
2d or 3d, single- or multi-channel. If normalized, 1 is highest, 0 is lowest.
.npy (overlay)



image
2d or 3d, single- or multi-channel.
.npy

Code Structure

modelhub *Index/Registry of all models*

modelhub-app *Generic web frontend for a model*

modelhub-engine *Backend library, framework, and API*

model-template *Template structure for building modelhub compatible models*

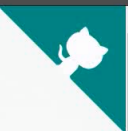
<model name> *A model implementation available via modelhub*

modelhub-ai.github.io *Modelhub webpage*

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deep learning models for
pathology.

COLLECTION

Challenges

- Docker strategy
- Version control
- Current volatility of deep learning frameworks and problems with 3rd party libraries
- ONNX as a standard model format

Future directions

- Contribution template and instructions
- New frontend encompassing all models
- Prebuilt docker images for different backends
- Modelhub Python/linux package

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Community Outreach



info@modelhub.ai

co-authorship through model contributions

Ahmed Hosny, Michael Schwier, Andriy Y Fedorov and Hugo JWL Aerts

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