Modelhub: Plug & Predict Solutions for Reproducible AI Research

www.modelhub.ai

Ahmed Hosny & Michael Schwier

NCI Containers and Workflows Interest Group Seminar - July 2018
Tumor Phenotyping in 2014

Decoding Tumour Phenotype by Noninvasive Imaging using a Quantitative Radiomics Approach
Nature Communications - 2014
Computational Radiomics System to Decode the Radiographic Phenotype

Cancer Research - 2017
Deep Learning

**a** Predefined engineered features + traditional machine learning

Feature engineering

- Histogram
- Texture
- Expert knowledge
- Shape

Selection → Classification

**b** Deep learning

Input → Hidden layers

Increasingly higher-level features → Output

- Convolution layers for feature map extraction
- Pooling layers for feature aggregation
- Fully connected layers for classification

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

Artificial Intelligence in Radiology

Nature Reviews Cancer - 2018
Deep Learning

Early efforts: AI with subhuman performance is occasionally used in commercial expert systems with varying degrees of utility.

Current state: Narrow task-specific AI has started to match and, in some instances, exceed human performance in tasks including conversational speech recognition, driving vehicles, playing Go and classifying skin cancer.

Future outlook: General AI exceeds human performance and reasoning in complex tasks, including writing best-selling novels and performing surgery. Human intelligence improves as we learn from AI.

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Artificial Intelligence in Radiology

Nature Reviews Cancer - 2018
Deep Learning

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

A Survey on Deep Learning in Medical Image Analysis

Medical Image Analysis - 2017
Deep Learning

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.
Reproducibility

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Matthew Hinton
Artificial Intelligence Faces Reproducibility Crisis
Science - 2018

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

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

Caffe: Convolutional Architecture for Fast Feature Embedding

arxiv.org/abs/1408.5093
Existing Solutions

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Samim and Graphisc

GitXiv—Collaborative Open Computer Science
gitxiv.com
Existing Medical Imaging Solutions

What is NiftyNet?

DLTK provides easy to use baselines for deep learning on medical images.

Getting Started.

DeepInfer 1.2 has released! New features added with support for new models for medical image analysis.

Submit your deep model for review and open-source reproducible research by sharing your deep learning models.

DeepInfer model store is growing collection of deep learning models for medical image analysis.
Existing Commercial Solutions

Cloud Vision API

Google allows developers to understand the content in images by using powerful machine learning models. This service, called Cloud Vision API, can classify images into thousands of categories (e.g., "flowers", "cat"). It can identify objects and faces within images and find and describe people within images. You can build custom image recognition models for your needs, context, or enable user marketing campaigns through image anomaly analysis.

Kairos

We Serve Businesses with Face Recognition

Create safer, more accessible customer experiences

Clarifai

The Leading AI Solution for Real-World Business Problems

This problem that your business encounters don't always have a clear solution. This way you can solve these problems just like with Clarifai.

Envoy AI

EnvoyAI adds best of breed clinical tools to PAC

We Make AI Work for Radiology
Components

- Scientific
- Intuitive
- Open-source
- Portable
- Tool agnostic

Modelhub: Plug & Predict Solutions for Reproducible AI Research
modelhub.ai
How it Works

published models

- contrib_src
  contributor pre-/post-processing, sample data and models

- frontend (optional)
  web interface + notebook

- backend
  modelhub engine + web app

framework

runtime environment

test drive
for everyone
run locally or remotely and quickly explore the model in your browser

jupyter notebook
for researchers
run modelhub dockers locally and test on your own data

API
for developers
deploy modelhub dockers and make API calls for model information & predictions

Ahmed Hony, Michael Schwier, Andriy Y Fedorov and Hugo JW L Aerts
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For Users

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API
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For Users

- test drive for everyone
- jupyter notebook for researchers
- API for developers

hosted on modelhub servers
For Users

- test drive for everyone

- jupyter notebook for researchers

- API for developers

- hosted on modelhub servers

  1. install docker
  2. choose model
  3. run it

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python API

REST API

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Modelhub: Plug & Predict Solutions for Reproducible AI Research
modelhub.ai
predict on url
predict on upload
get model config
get model IO
get license info
download model files
For Contributors

Modelhub: Plug & Predict Solutions for Reproducible AI Research
modelhub.ai
For Contributors

1. build docker image
   runtime environment

2. populate template
   model contribution
   - config
   - samples
   - (optional)
   - pre
   - post

3. run tests
   modelhub integration tests
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*
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
Community Outreach

info@modelhub.ai

co-authorship through model contributions
Thank you!