

CodaLab Worksheets

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STATS 385 — Oct 21, 2019



The current research process

Problem 1: reproducibility

	Previous method	New method
Dataset 1	88% accuracy	92% accuracy

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Dataset 3	?	?

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Dataset 3	?	?
Dataset 4	?	?
...



Problem 2: efficiency

Step 1: come up with a good idea



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Step 2: execute on it

- Obtain data, clean it, convert between formats

Problem 2: efficiency

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Tradeoff?

efficiency

reproducibility

Folk wisdom: reproducibility slows down research.

Tradeoff?

efficiency - -



- - reproducibility

Folk wisdom: reproducibility slows down research.

Our claim: reproducibility accelerates research (with the right tool).

MLcomp.org (2008)

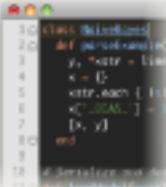
The screenshot shows the homepage of MLcomp.org. At the top, there's a dark header bar with the text "MLCOMP" in large white letters, "VERSION ALPHA" in smaller white letters, and "STATISTICS: 7066 USERS, 17482 DATASETS, 485 PROGRAMS, 34621 RUNS (2063 QUEUED, 0 RUNNING), 0 WORKERS" in light gray. Below the header is a navigation bar with links for "Home", "Programs", "Datasets", "Help", and "About Us". The "Home" link is highlighted with a brown background. The main content area has a light gray background. It features a text block about the site's purpose, followed by two sections with icons and text: one for evaluating programs and another for finding the best algorithm for datasets.

MLCOMP

VERSION ALPHA STATISTICS: 7066 USERS, 17482 DATASETS, 485 PROGRAMS, 34621 RUNS (2063 QUEUED, 0 RUNNING), 0 WORKERS

Home Programs Datasets Help About Us

MLcomp is a free website for **objectively comparing** machine learning programs across various datasets for multiple problem **domains**.

 Do a comprehensive evaluation of your new algorithm.
Upload your program and run it on existing datasets. Compare the results with those obtained by other programs.

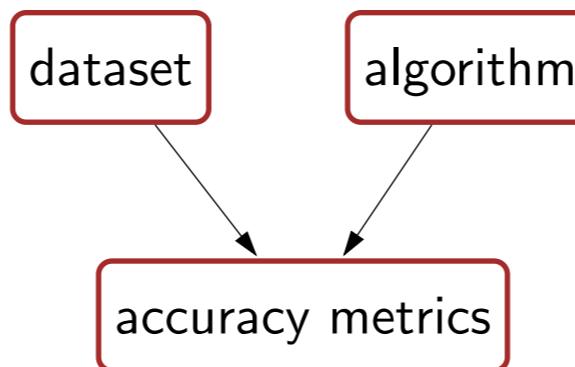
 Find the best algorithm (program) for your dataset.
Upload your dataset and run existing programs on it to see which one works best.

MLcomp paradigm

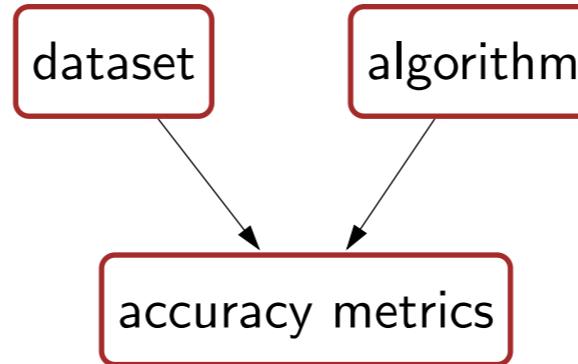
dataset

algorithm

MLcomp paradigm



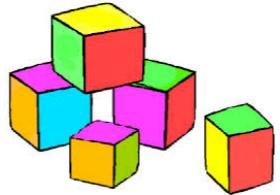
MLcomp paradigm



Problem: too rigid, doesn't help with the efficiency problem

CodaLab Worksheets (2013-present)

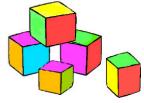
The screenshot shows the CodaLab website interface. At the top, there is a navigation bar with links for "Gallery", "My Home", "My Dashboard", "Help", and a user profile icon labeled "pliang". Below the navigation bar, the main content area features a large blue polygonal background. On the left side, there is a promotional message: "A collaborative platform for reproducible research." with two buttons: "MY HOME" and "MY DASHBOARD". On the right side, there is a preview of a published worksheet titled "CodaLab: A Collaborative Platform for ...". The preview shows the CodaLab logo and some placeholder text. Below the main content area, there is a call-to-action message: "Run your machine learning experiments in the cloud. Manage them in a digital lab notebook. Publish them so other researchers can reproduce your results."



Bundles



Worksheets

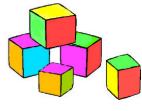


Bundles

Bundle: an **arbitrary** file/directory (code or data or results)

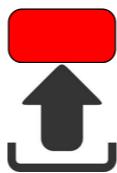


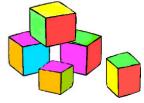
0x191aad8fa0ae4741b3123b15a8d59efa



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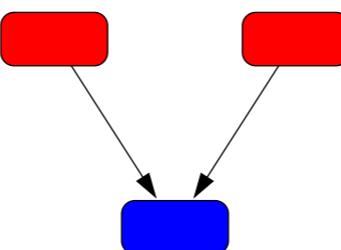


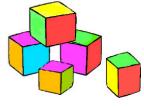
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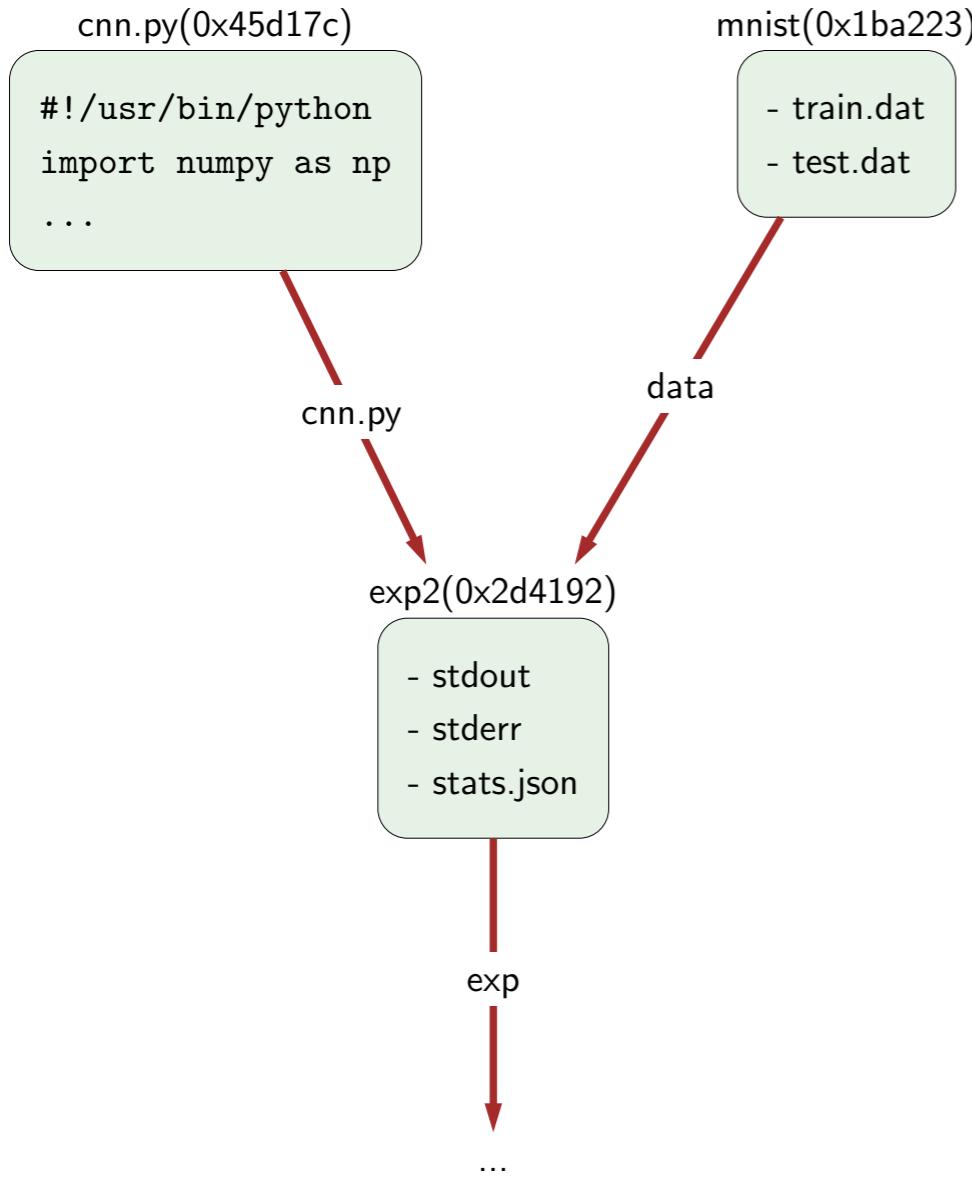


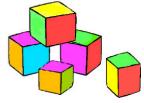
Derived by running an **arbitrary** command:



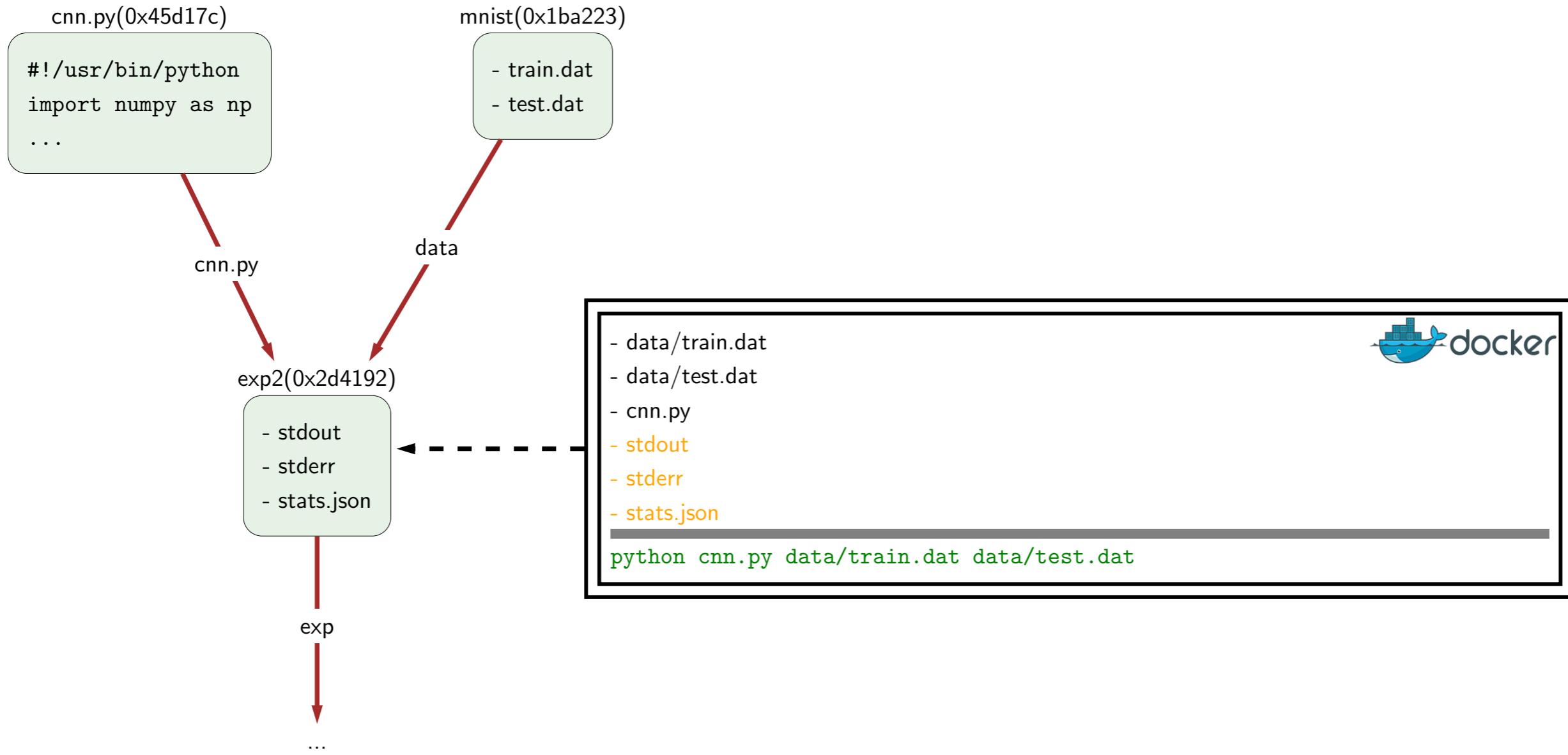


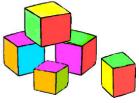
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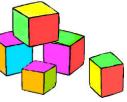




Command-line Interface (CLI)

Search for existing code and data:

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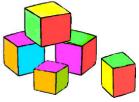
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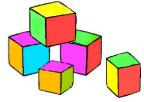
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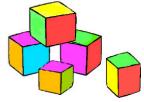
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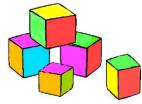
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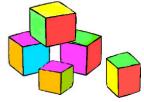
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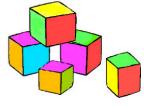
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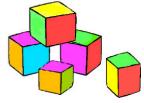
Copy from one CodaLab instance to another:

```
$ cl add bundle mnist stanford::pliang-demo main::pliang-demo
```



Modularity

Real-world problems require efforts of entire community

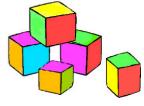


Modularity

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People specialize, contribute in decentralized way

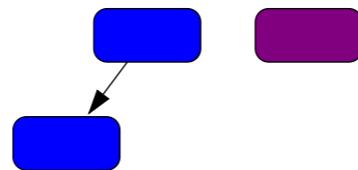


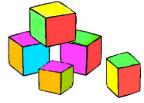


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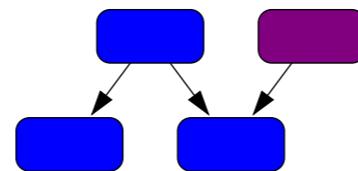


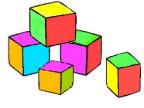


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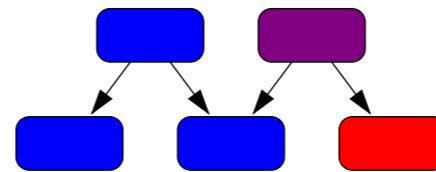


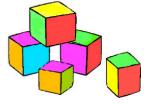


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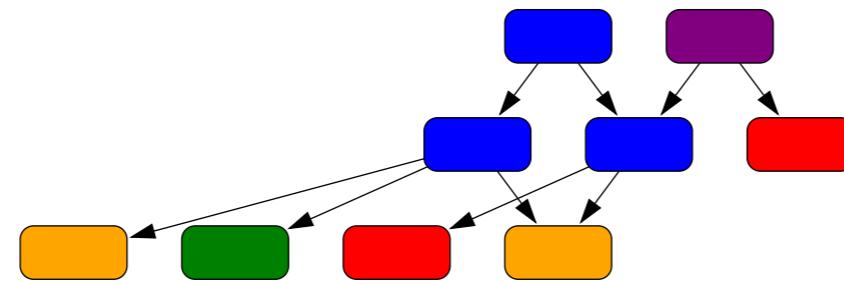


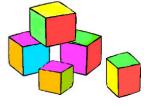


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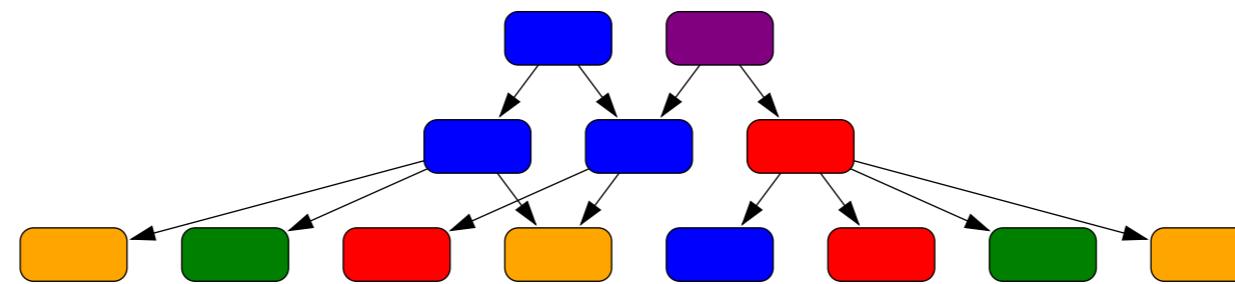


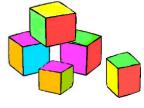


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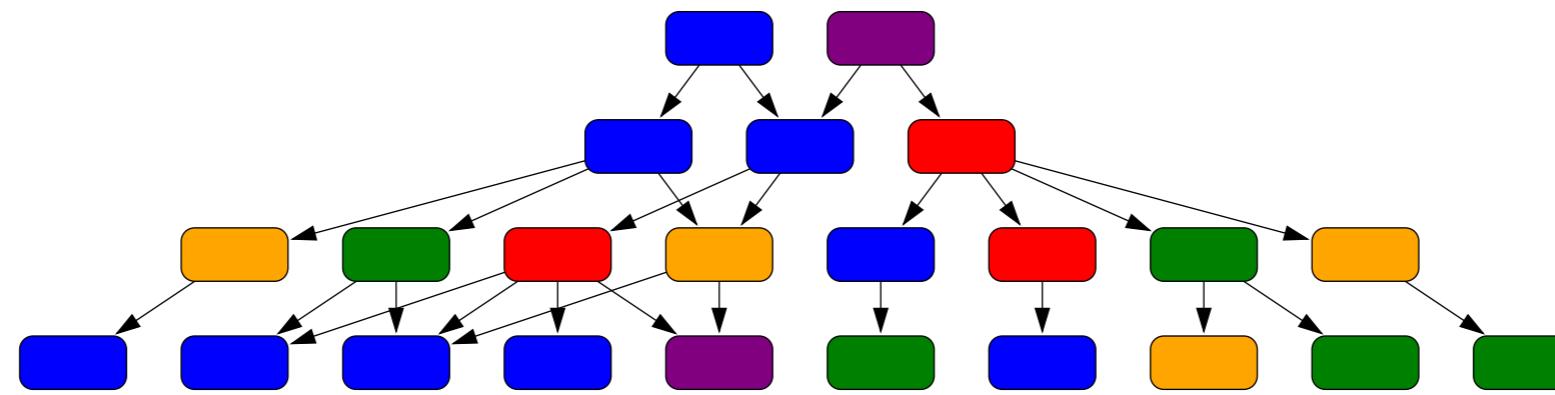


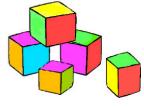


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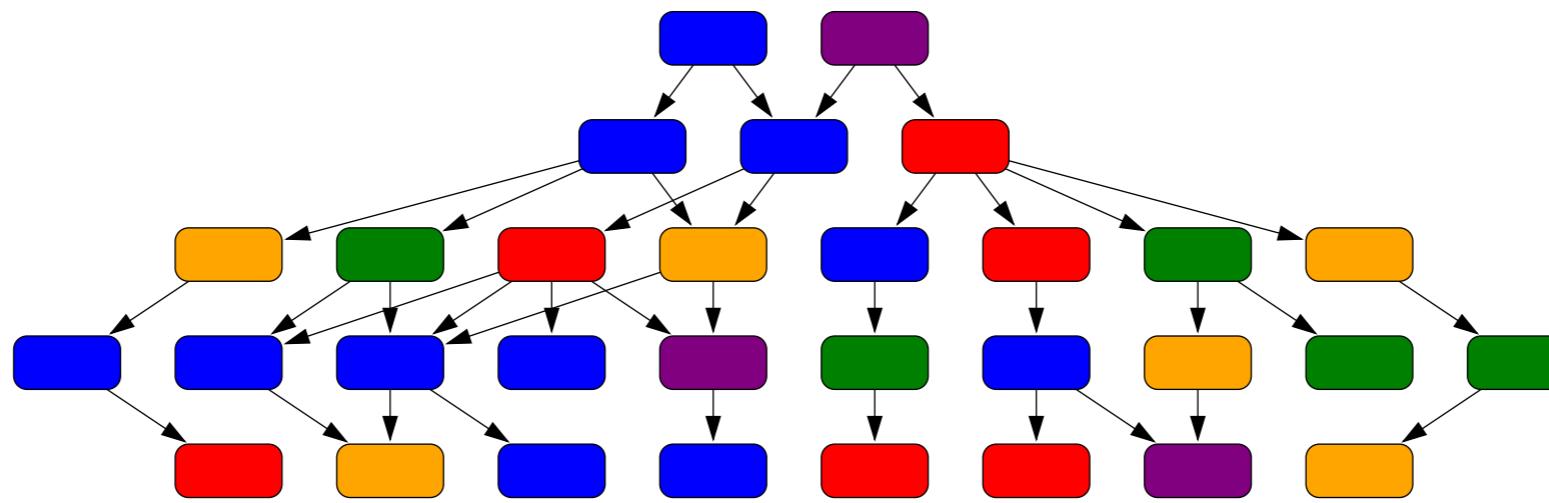


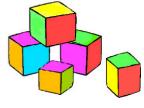


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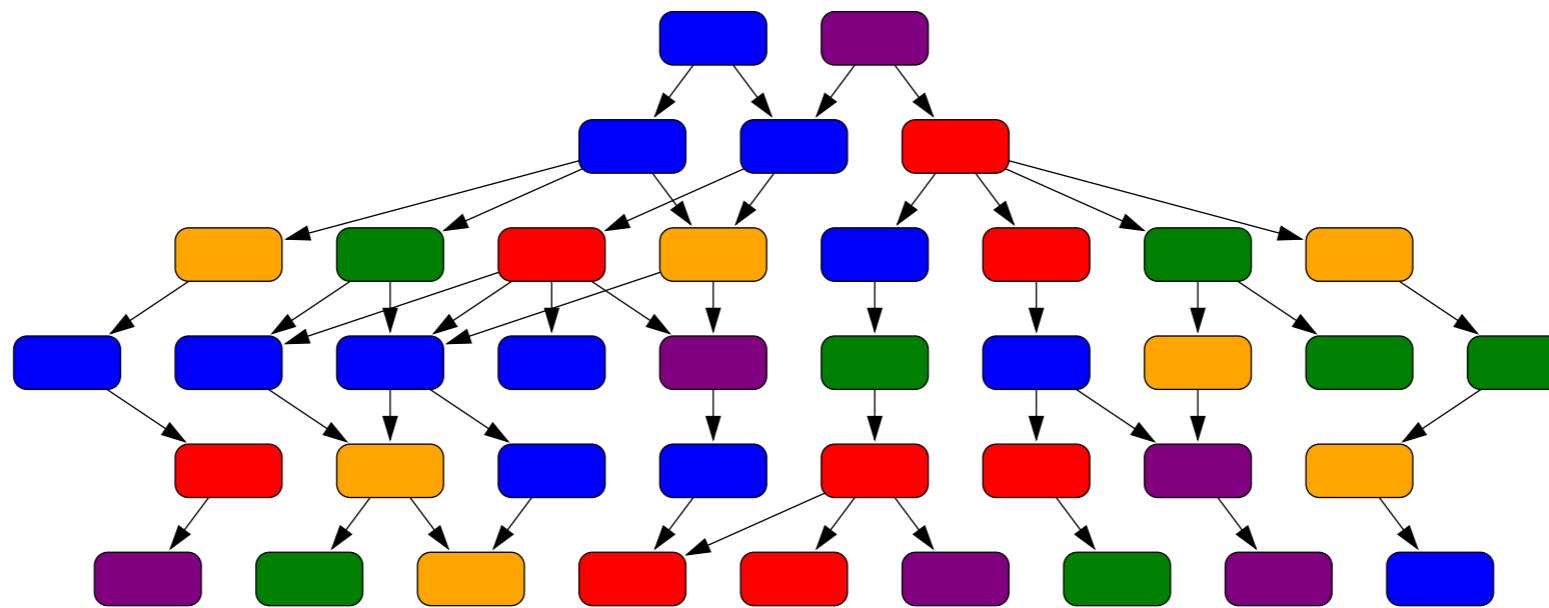


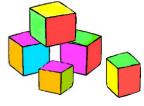


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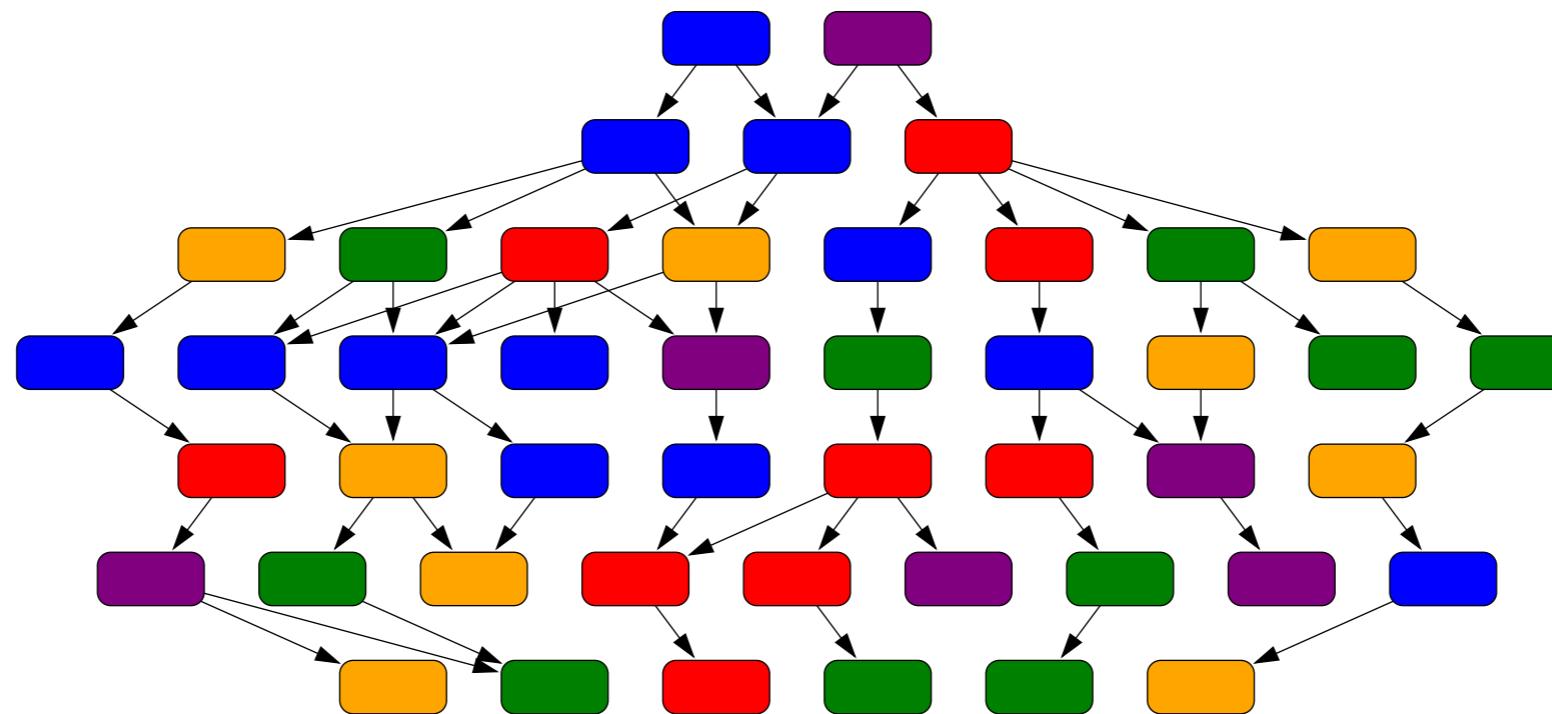


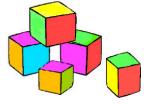


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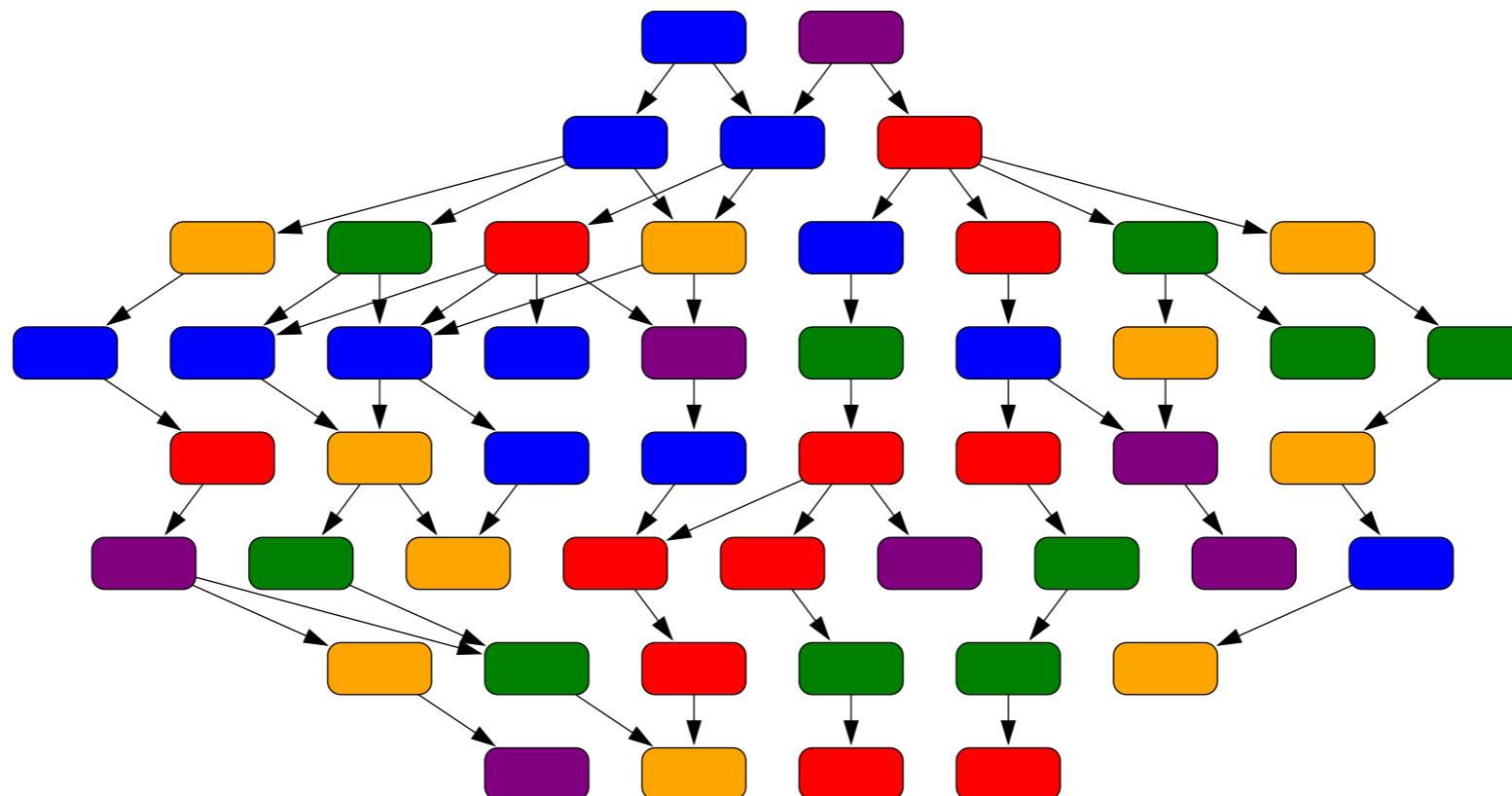


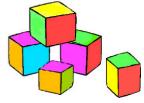


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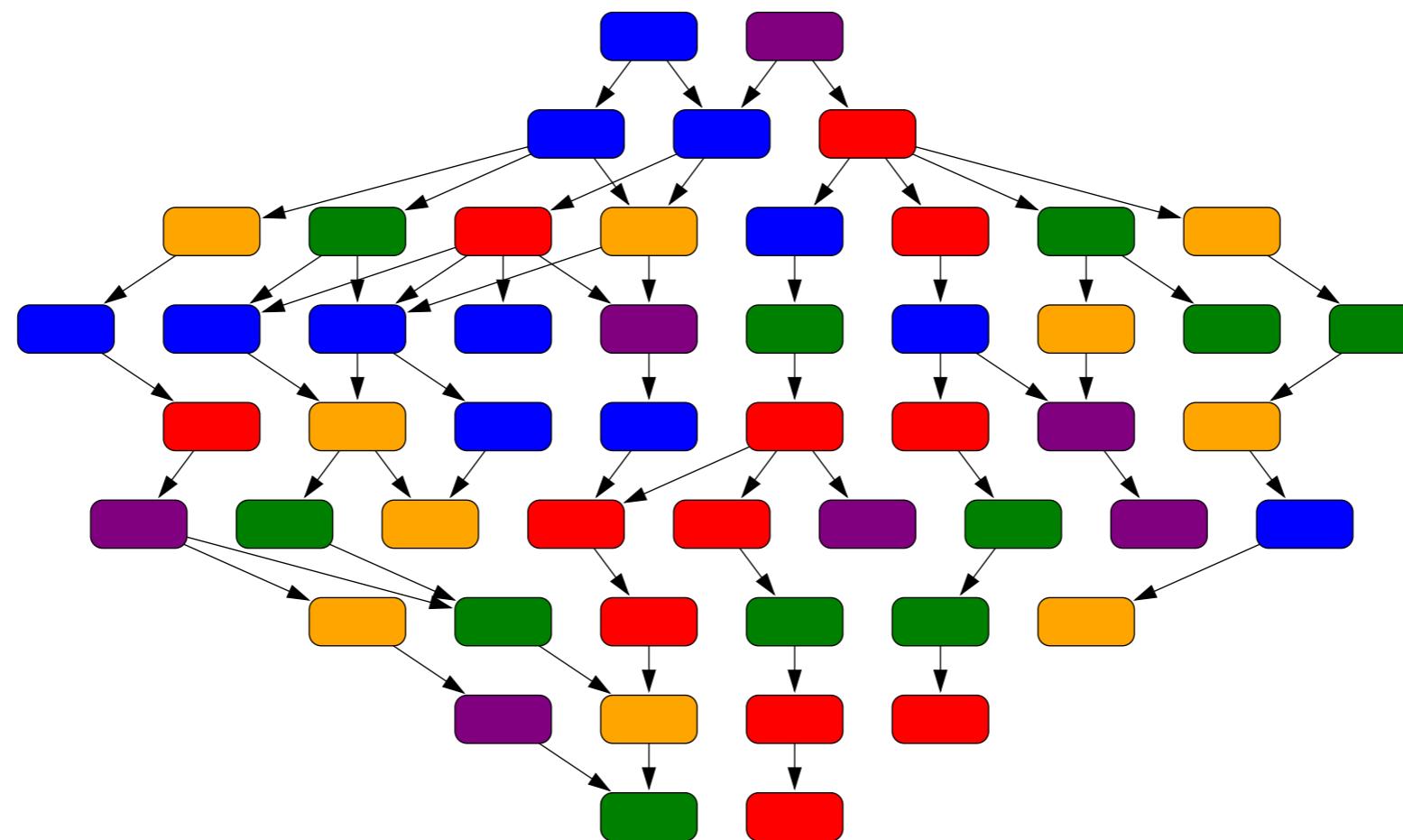


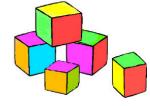


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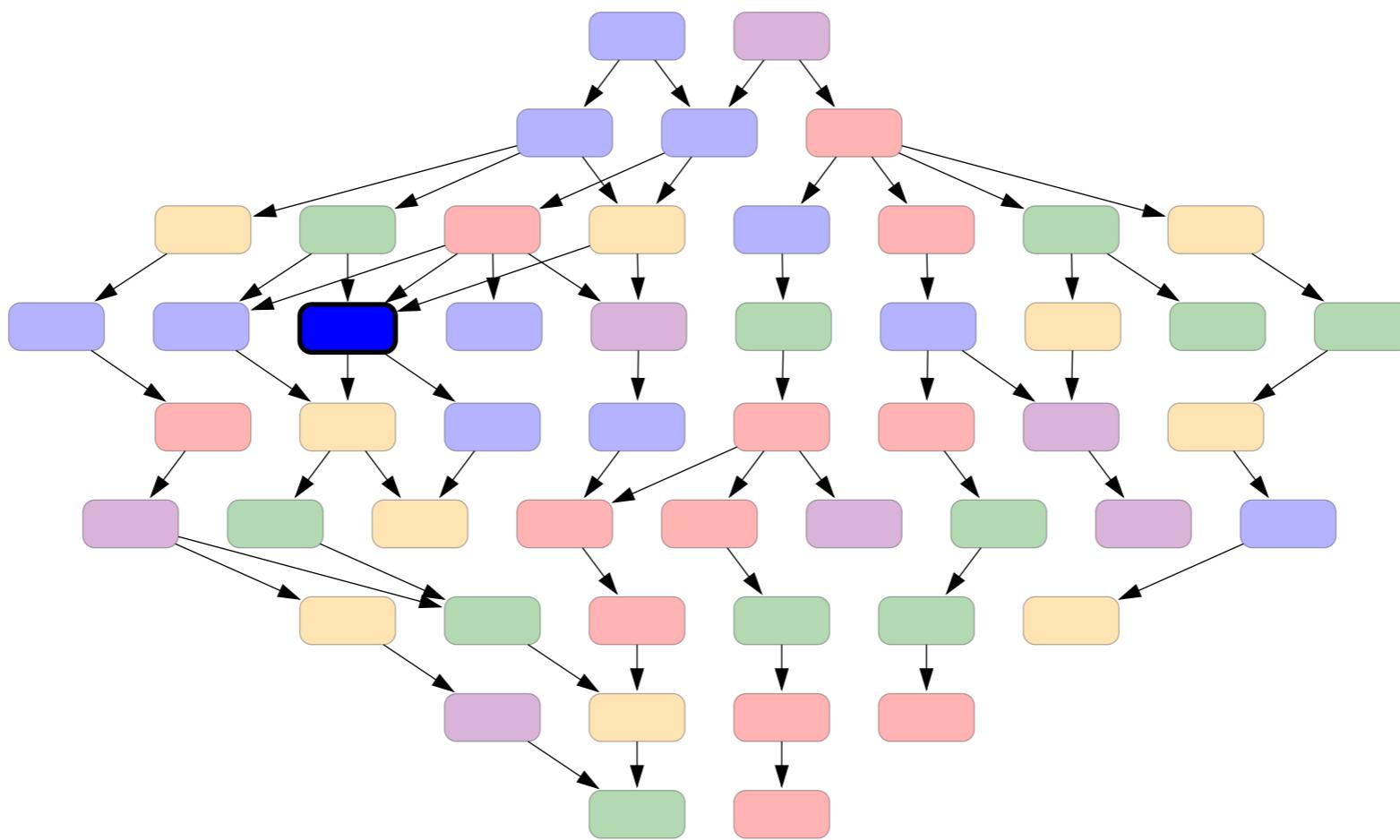
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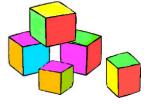




Intermediate tasks

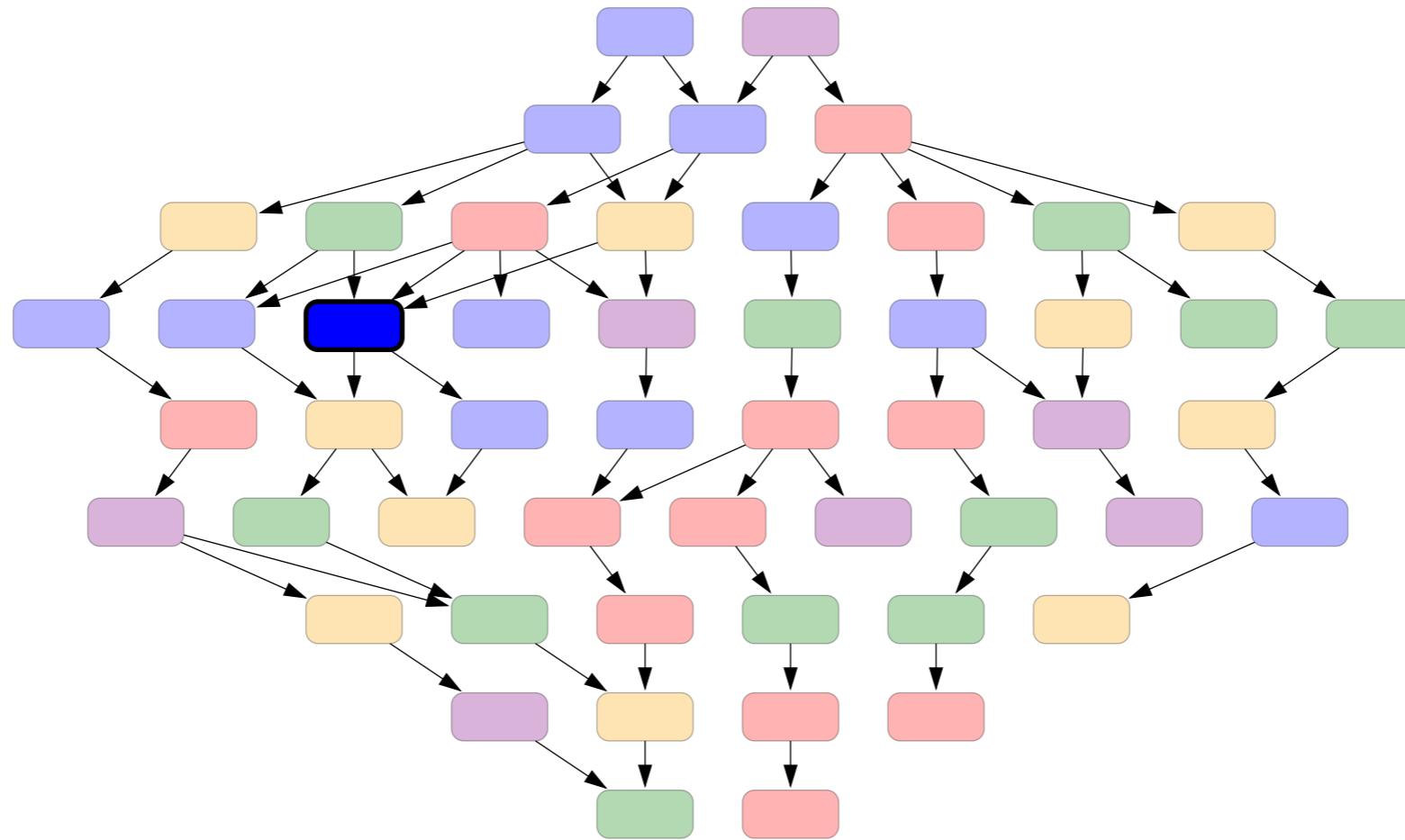
- **Old way:** use intermediate metrics, rhetoric

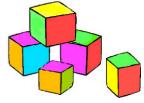




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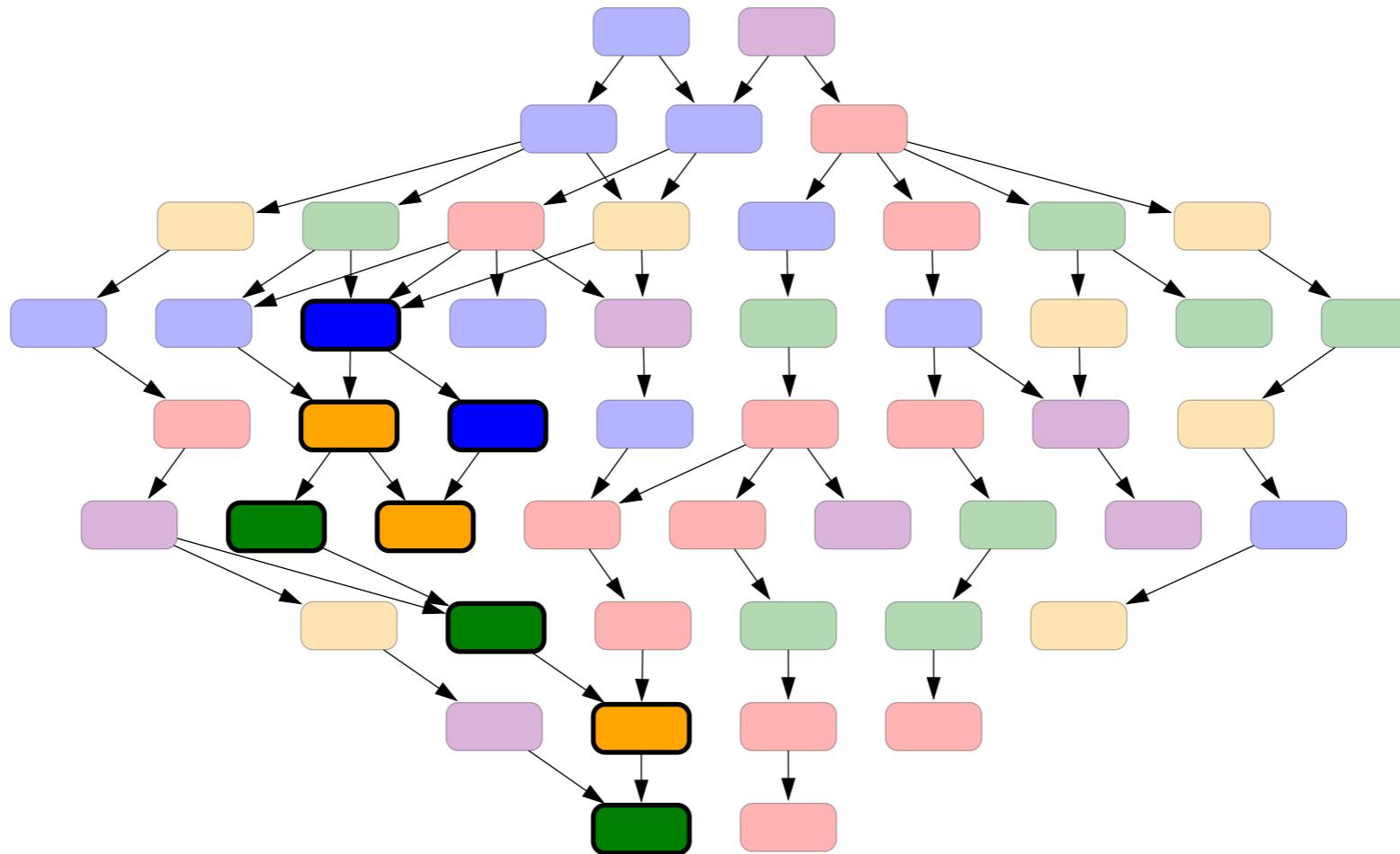
- Old way: use intermediate metrics, rhetoric
- New way: plug in and see ramifications **automatically**

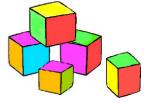




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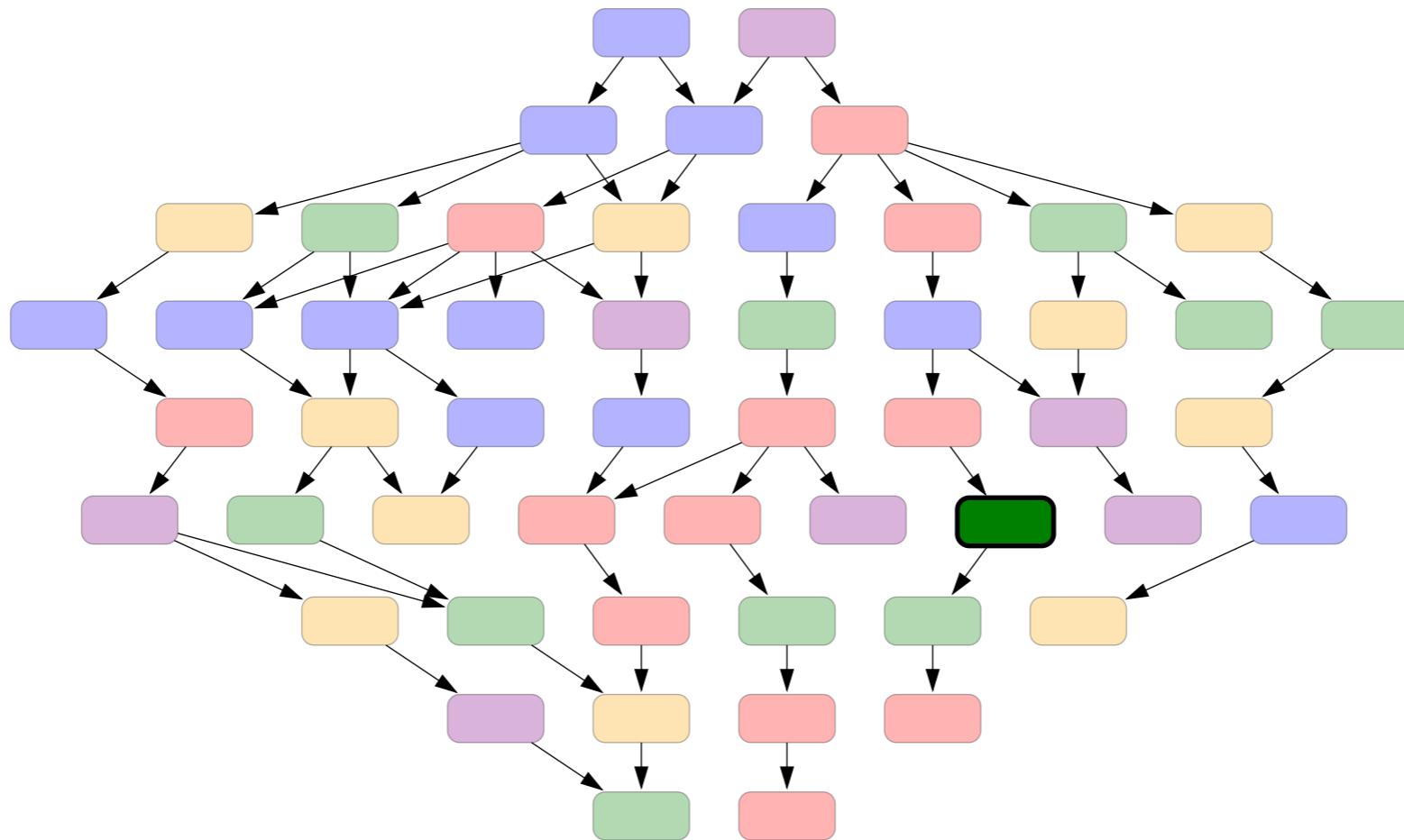
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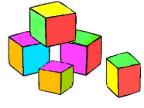




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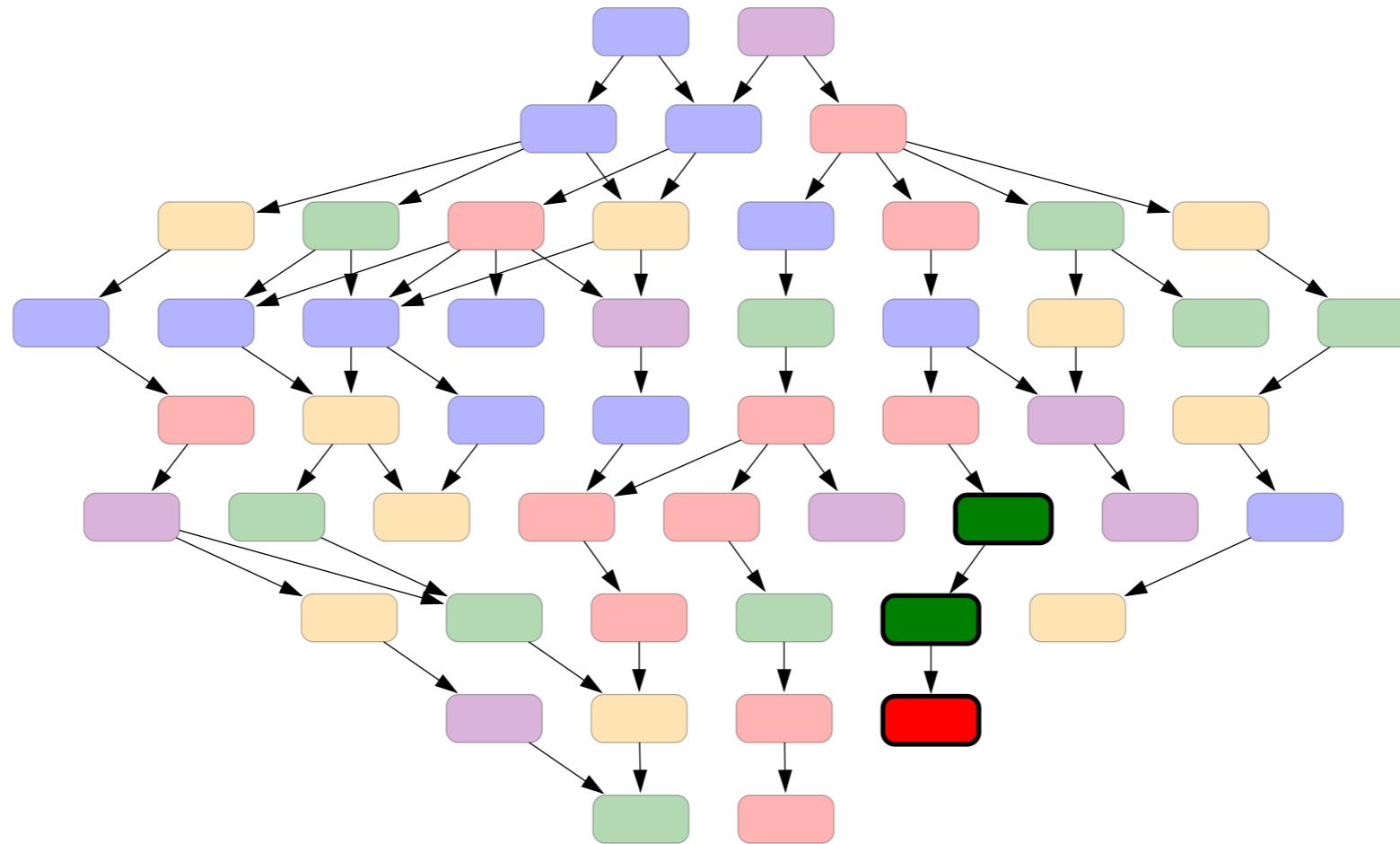
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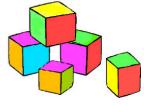




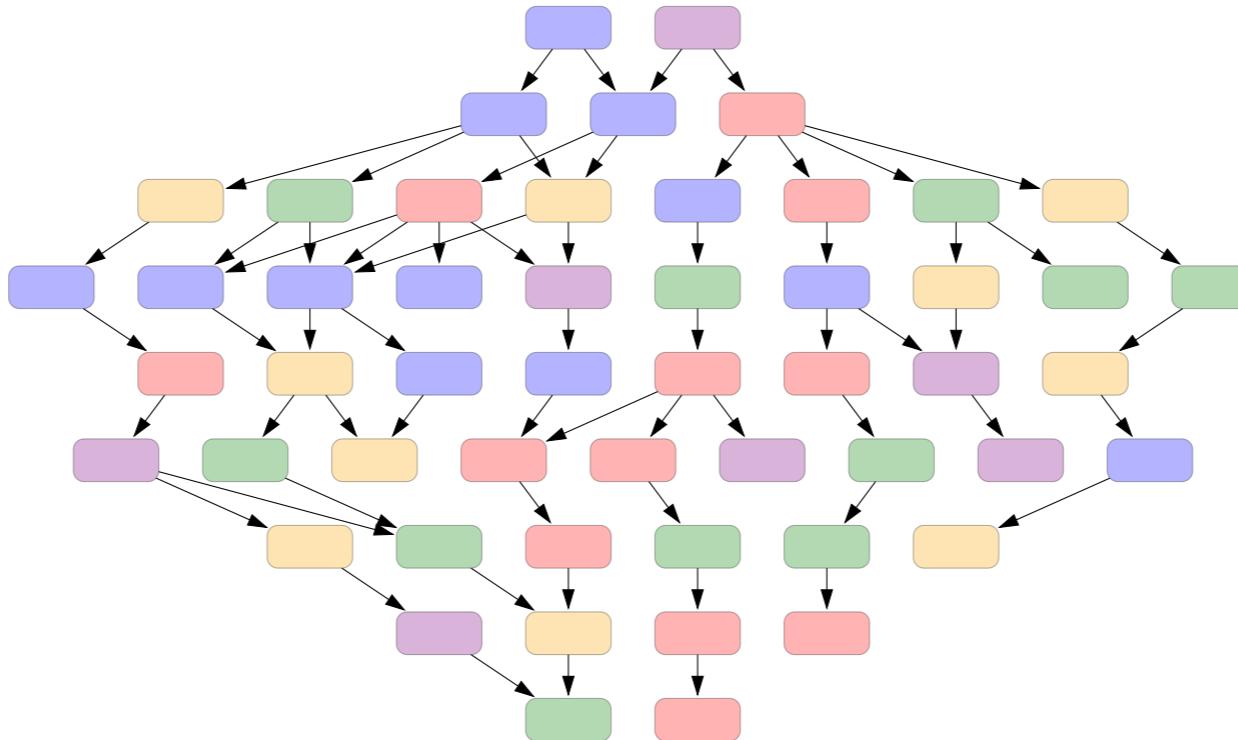
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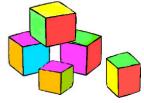




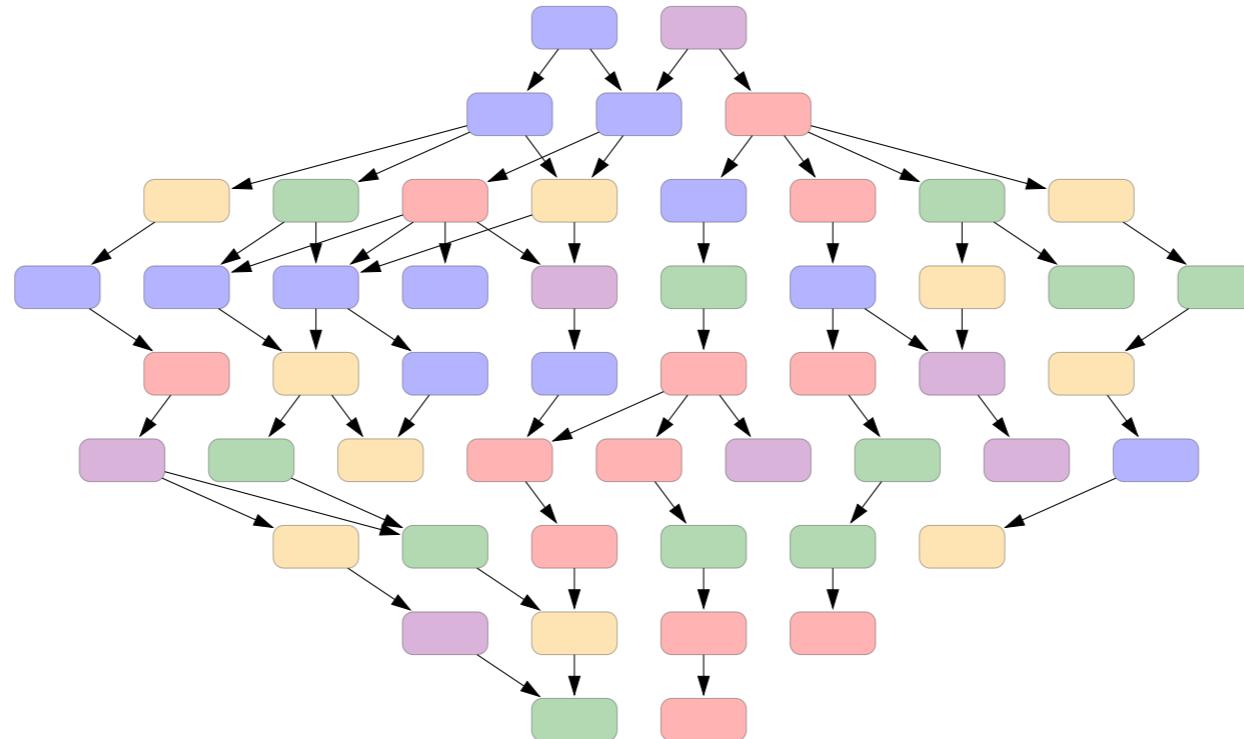
Immutability



Inspiration: Git version control system

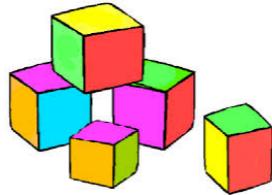


Immutability



Inspiration: Git version control system

- All programs/datasets/runs are write-once
- Enable collaboration without chaos
- Capture the research process in a **reproducible** way



Bundles



Worksheets



Literacy

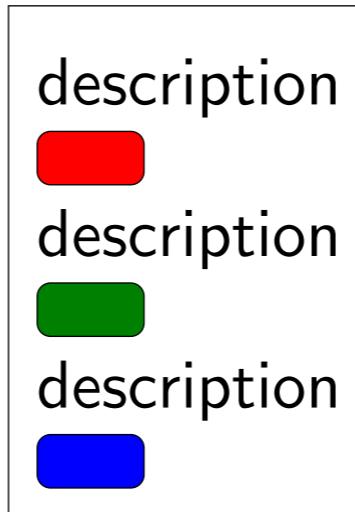
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Worksheet: an **arbitrary** document with embedded bundles

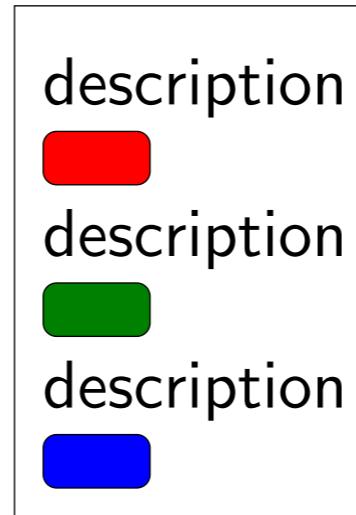




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Inspiration: Mathematica notebook, Jupyter notebook



A worksheet

We now train the classifier with more data.



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Program : **SVMlight**

Arguments : -n 2000

Dataset : **thyroid**

Error : 2.6%

Time : 1 second



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Notice that the error remains the same, suggesting that we've saturated our model.



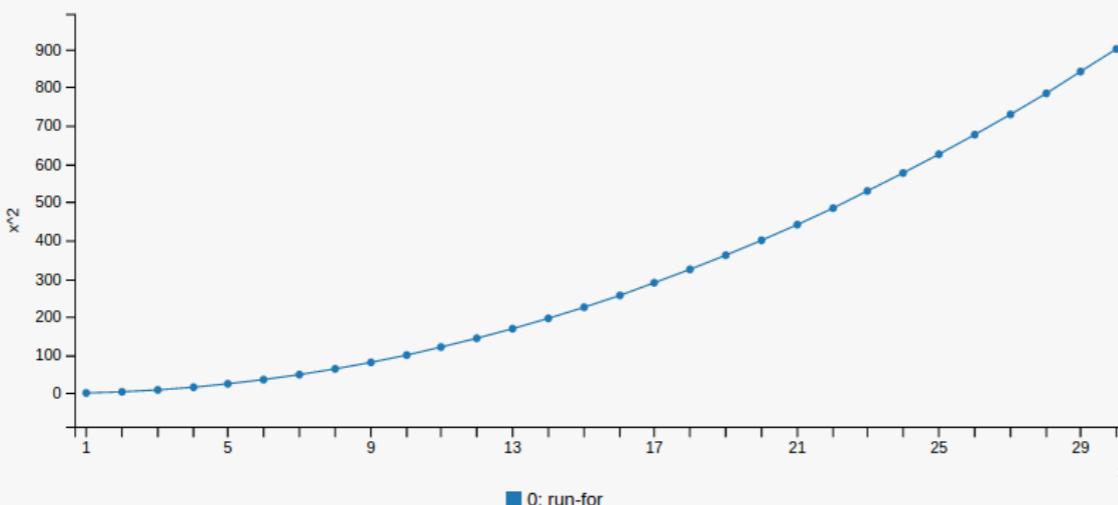
Heading

You can type in any markdown with any *LATEX*.

uuid	name	summary	state	desc.
0xc19b66	nanc-1m.txt	[uploaded]	ready	1 million sentences from the NANC corpus

Two New Orleans riverboat casinos declared bankruptcy in early June after just two months
One of the boats was owned by Harrah 's Jazz partner Christopher Hemmeter .

query	count
Montreal	415
Toronto	872



uuid	name	summary	data_size
0x96e9dc	stanford-corenlp-full-2015-01-30	[uploaded]	307m



Heading

You can type

uuid
0xc19b66

Two New Orleans boats were seized from Harrah's just two months after it filed for bankruptcy protection.

nanc-1m.txt(0xc19b66)

Two New Orleans boats were seized from Harrah's just two months after it filed for bankruptcy protection.

data

data

run1(0xad3d69)

- stdout
415

run2(0x992ced)

- stdout
872

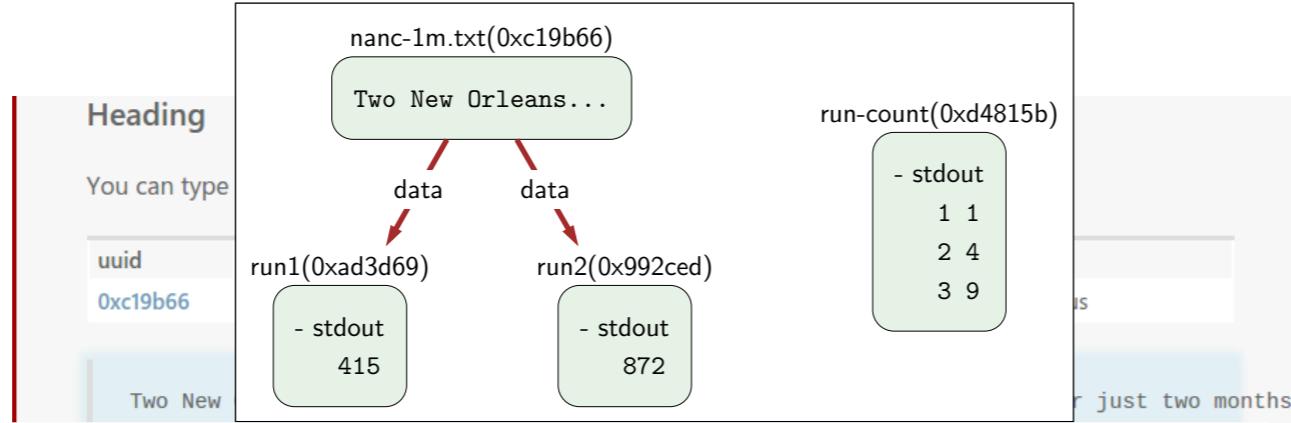
run-count(0xd4815b)

- stdout
1 1
2 4
3 9

query	count
Montreal	415
Toronto	872

A scatter plot showing a quadratic relationship. The x-axis is labeled 'x' and ranges from 1 to 30. The y-axis is labeled 'x^2' and ranges from 0 to 900. The data points form a perfect parabola, starting at (1, 1) and ending at (30, 900). A legend indicates the series is '0: run-for'.

uuid	name	summary	data_size
0x96e9dc	stanford-corenlp-full-2015-01-30	[uploaded]	307m



```
## Heading
```

You can type in **any** markdown with any \$ \LaTeX \$.

```
[dataset nanc-1m.txt]{0xc19b6600afe74e91a441e6d13e823ead}
```

embed bundles

```
% display contents / maxlines=2
```

render bundle contents

```
[dataset nanc-1m.txt]{0xc19b6600afe74e91a441e6d13e823ead}
```

```
% schema mySchema
```

customize table schema

```
% add query command "s/.*grep / | s/...wc.*/"
```

```
% add count /stdout
```

```
% display table mySchema
```

```
[run data:nanc-1m.txt : cat data | grep Montreal | wc -l]{0xad3d69e373eb4702ab89dc4991aa0f82}
```

```
[run data:nanc-1m.txt : cat data | grep Toronto | wc -l]{0x992ced33e6e848aa8cfb8988c12bb221}
```

```
% display graph /stdout xlabel=time ylabel=accuracy maxlines=30
```

graph points in a TSV file

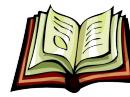
```
[run : for x in {1..50}; do echo -e "$x $((x*x))"; done]{0xd4815bf677bc4ab492a4c28744224c87}
```

Largest bundles:

```
% display table uuid:uuid:[0:8] name summary data_size
```

```
% search size=.sort-.limit=3
```

embed search results



Use case: executable papers

Learning with Relaxed Supervision.

Jacob Steinhardt and Percy Liang.

Advances in Neural Information Processing Systems (NIPS), 2015.

Volodymyr Kuleshov and Percy Liang.

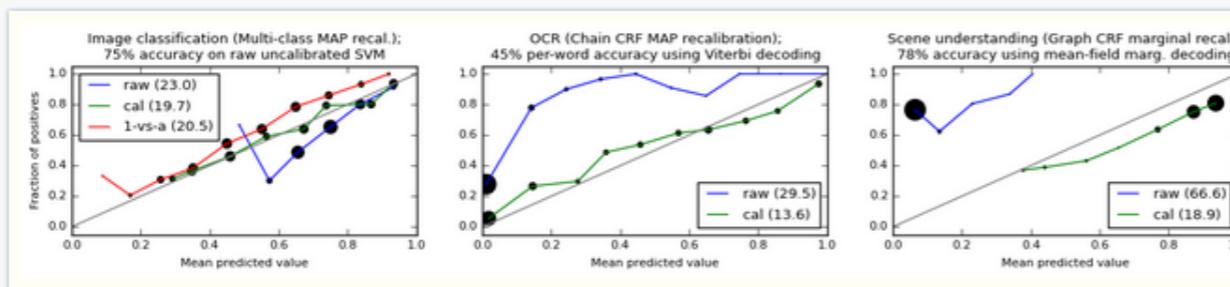
Calibrated Structured Prediction.

Advances in Neural Information Processing Systems (NIPS), 2015.

Structured prediction presents new challenges for calibration: the output space is large, and users may issue many types of probability queries (e.g., marginals) on the structured output. To address these challenges,

- We extend the notion of calibration so as to handle various subtleties pertaining to the structured setting, and then provide a simple recalibration method that trains a binary classifier to predict probabilities of interest.
- We explore a range of classifier features appropriate for structured recalibration, and demonstrate their efficacy on three real-world datasets.

uuid	name	description	bundle_type	created	dependencies	command	data_size	state
0xbef082	run-bash		run	2015-10-30 21:57:09	b1:codalab,b2:data	bash b1/experiments/gen-datafig1.sh b1 b2	913K	ready



The above figure shows that our predictions (green line) are well-calibrated in every setting. In the multiclass setting, we outperform an existing approach which individually recalibrates one-vs-all classifiers and normalizes their probability estimates. This suggests that recalibrating for a specific event (e.g. the highest scoring class) is better than first estimating all the multiclass probabilities.

ry, we unfortunately cannot make it available on CodaLab, but have a copy of SNOPT, the same scripts should work to install it (note: permissions; e-mail jsteinhardt@cs.stanford.edu if you need help

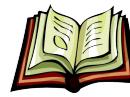
created	dependencies	command	data_size	state

kefile:

d	dependencies	command	data_size	state
2015-10-30 08:44:24			58.9K	ready

ble correctly:

dependencies	command	data_size	state
:src;snopt	export SNOPT_HOME=snopt/snopt7; cp src/* ; make	323K	ready
bin/main		99.8K	ready

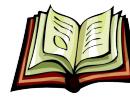


Use case: benchmarking results

predictions	#questions	avg recall	avg precision	f1 of avg R and avg P	avg f1 (accuracy)
webquestions-predictions-emnlp2013	2032	0.413	0.480	0.444	0.357
webquestions-predictions-acl2014	2032	0.466	0.405	0.433	0.399
webquestions-predictions-jhu-acl2014	2032	0.458	0.517	0.486	0.330
webquestions-predictions-jhu-acl2014-sp-workshop	2032	0.480	0.337	0.396	0.354
webquestions-predictions-msr2014	2032	0.525	0.447	0.483	0.453
webquestions-predictions-kitt-ai-naacl2015	2032	0.545	0.526	0.535	0.443
webquestions-predictions-aqqu-cikm2015	2032	0.604	0.498	0.546	0.494
webquestions-predictions-agenda-tacl2015	2032	0.557	0.505	0.530	0.497
webquestions-predictions-acl2015-msr-stagg	2032	0.607	0.528	0.565	0.525

If you have run your system on WebQuestions, please upload your predictions to your own worksheet (click 'My Worksheet'). Then type the following commands:

```
cl upload <webquestions-predictions-file> # Or just click 'Upload bundle'  
cl macro webquestions/eval <webquestions-predictions-file> -n <webquestions-evaluation-file>
```



Use case: software tutorials

TensorFlow

name: tensorflow
uuid: 0xf04bb563380d4049a72d297a87522678
owner: pliang
permissions: you(all) public(read)

? Keyboard Shortcuts

Mode: **View** Edit source

TensorFlow is Google's new deep learning library. Conveniently, a docker image with all the dependencies has already been created, so to use TensorFlow in CodaLab, all you have to do is to upload your program and run it.

Example 1: artificial data

uuid	name		data_size	desc.		
0x543b83	tf-example.py		809			
uuid	name	summary	data_size	time	state	desc.
0x6b96ca	run-python	! python tf-example.py(0x54)	4.7k	6.0s	ready	

Example 2: MNIST

uuid	name		data_size	desc.		
0x447d9e	mnist		11.1m	classic digits dataset		
0x6d6d8d	src		10.7k	simple linear classifier		
uuid	name	summary	data_size	time	state	desc.
0x2ebd30	run-python	! python src[0x6d]/linear.py	12.6k	33.0s	ready	run on GPUs



Use case: research development environment

> run rnn.py:0xf421264a206142fa97f7bebdac7bb09e "python rnn.py --task sum --num-iters 1000000 --n-input 20 --step-size 0.0001"

Recurrent Neural Networks

name: pliang-rnn
uuid: 0x6bad41bbd9a6471ba0cf7776582fdb
owner: pliang
permissions: you(all) public(read)

Mode: View Edit source

2015-12-05

Just playing around with RNNs on some toy data...

uuid	task	model	n_hidden	n_input	n_time	step_size	iter	num_iters	error	time	state	description
0xf42126											ready	my program
0xfaee92	sum	rnn	5	2	10	0.001	29000	30000	2.6634	1m10s	ready	baseline
0x8e8f03	sum	rnn	5	2	10	0.001	29000	30000	2.2810	1m43s	ready	
0xd3302b	sum	rnn	5	4	10	0.005	99000	100000	0.1187	2m27s	ready	
0x60aab5	sum	rnn	5	4	10	0.005	334000	1000000	4.4134	3m37s	running	increase #iters
0xae4ff2	sum	rnn	5	20	10	0.005	311000	1000000	11.0963	4m16s	running	
0x062bab	sum	rnn	5	20	10	0.001	264000	1000000	12.5704	2m57s	running	decrease step size
0xae4472	sum	rnn	5	20	10	0.0001		1000000		43.0s	running	decrease step size

Upload bundle

run-python

Description: decrease step size
uuid: 0x062bab75226d4db0875ac613c6de8575
owner: pliang
permissions: you(all) public(read)
command: python rnn.py --task sum --num-iters 1000000 --n-input 20 --step-size 0.001
state: running

dependencies

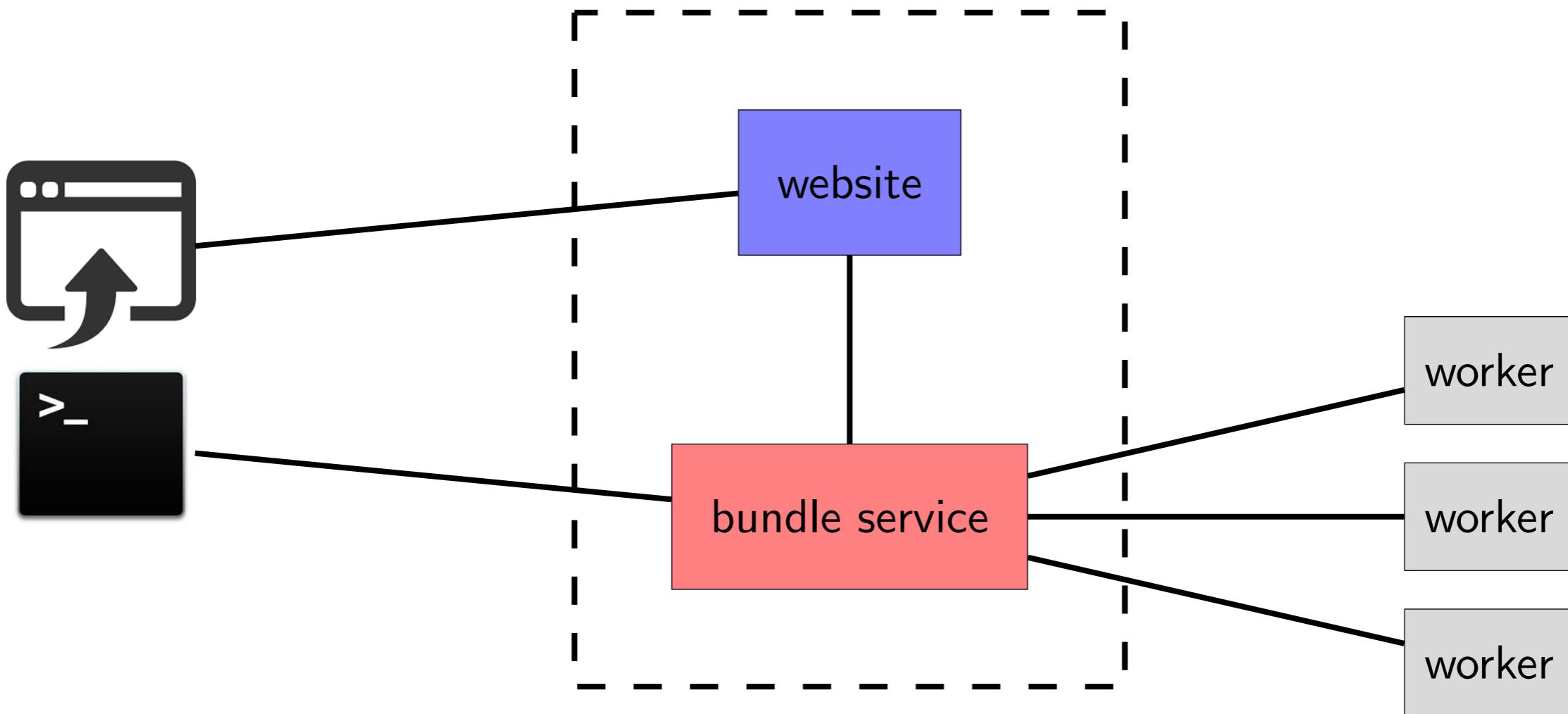
rnn.py → rnn.py(0xf42126)

Contents ► File Browser ▾

/	
errors.txt	5.8k
options.map	135
output.map	32
rnn.py	4.5k
stderr	845
stdout	0

[demo]

System architecture



Note: workers can be run by the user

Running your own CodaLab server

Check out the repo:

```
$ git clone https://github.com/codalab/codalab-worksheets
```

Start the full stack:

```
$ cd codalab-worksheets; ./codalab_service.py start
```

Try it out:

```
$ open http://localhost
```

A case study...

SQuAD dataset for reading comprehension

In meteorology, precipitation is any product of the condensation of atmospheric water vapor that falls under **gravity**. The main forms of precipitation include drizzle, rain, sleet, snow, **graupel** and hail... Precipitation forms as smaller droplets coalesce via collision with other rain drops or ice crystals **within a cloud**. Short, intense periods of rain in scattered locations are called “showers”.

What causes precipitation to fall?

gravity

What is another main form of precipitation besides drizzle, rain, snow, sleet and hail?

graupel

Where do water droplets collide with ice crystals to form precipitation?

within a cloud

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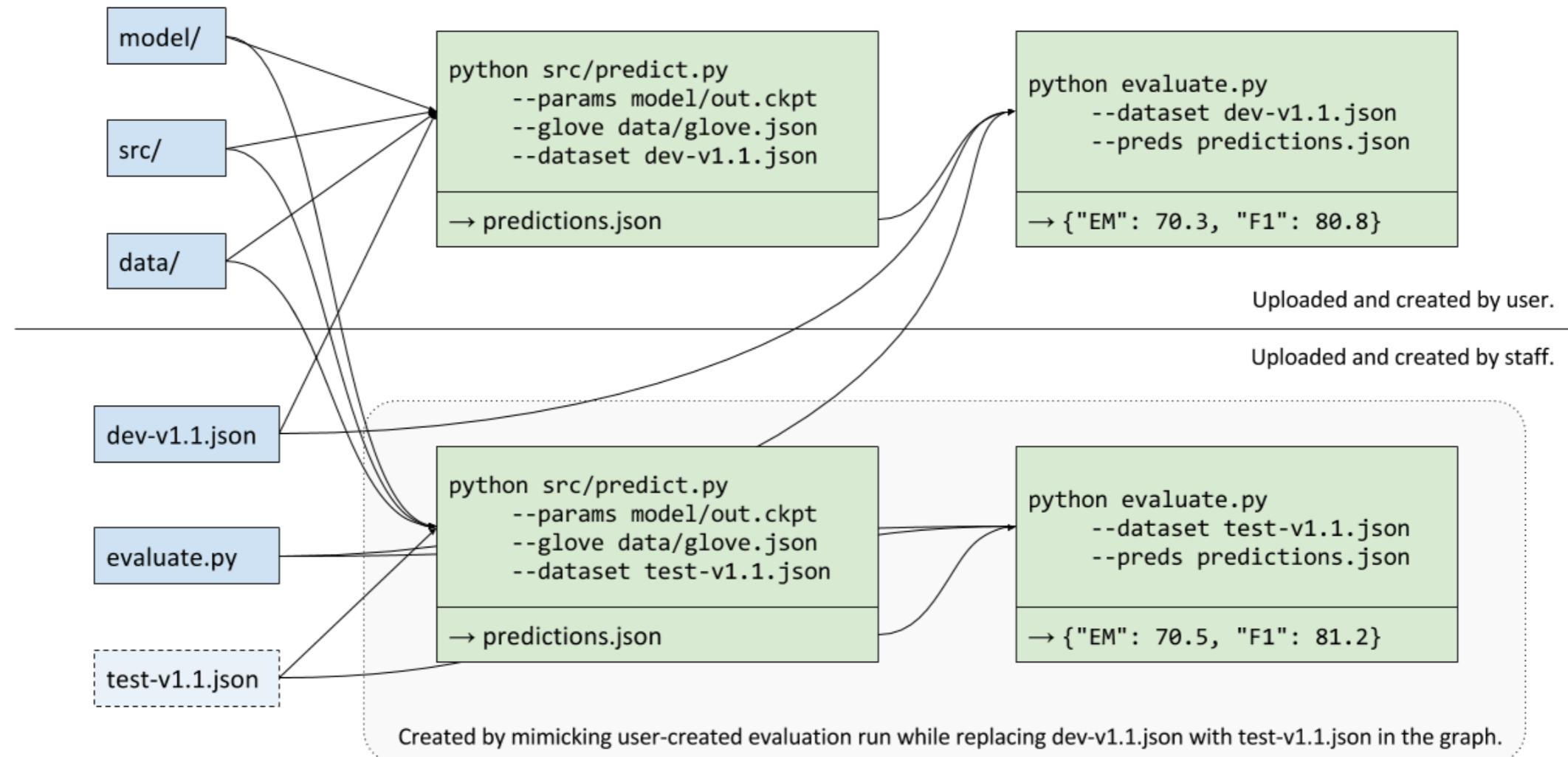
Where do water droplets collide with ice crystals to form precipitation?

within a cloud

Rank	Model	EM	F1
1 Sep 20, 2017	AIR-FusionNet (ensemble) Microsoft Business AI Solutions Team	78.842	85.936
2 Aug 16, 2017	DCN+ (ensemble) Salesforce Research	78.706	85.619
3 Jul 25, 2017	Interactive AoA Reader (ensemble) Joint Laboratory of HIT and iFLYTEK Research	77.845	85.297
3 Sep 01, 2017	r-net (ensemble) Microsoft Research Asia http://aka.ms/rnet	78.244	85.206
4 Aug 21, 2017	Reinforced Mnemonic Reader (ensemble) NUDT and Fudan University https://arxiv.org/abs/1705.02798	77.678	84.888
5 Sep 08, 2017	AIR-FusionNet (single model) Microsoft Business AI Solutions team	75.968	83.900
6 Jul 17, 2017	r-net (single model) Microsoft Research Asia http://aka.ms/rnet	75.705	83.496
6 Jul 14, 2017	smarnet (ensemble) Eigen Technology & Zhejiang University	75.989	83.475
7 Aug 18, 2017	Reg-RaSoR (single model) Google NY, Tel-Aviv University	75.789	83.261
8 Jul 10, 2017	DCN+ (single model) Salesforce Research	74.866	82.806
8	SLQA (ensemble model) Microsoft Research Asia	75.212	82.681

Must submit model on CodaLab to evaluate on test set

Evaluation using "mimic"

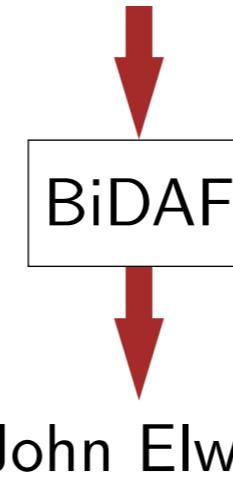


Rank	Model	EM	F1
	Human Performance <i>Stanford University (Rajpurkar et al. '16)</i>	82.304	91.221
1 Mar 19, 2018	QANet (ensemble) <i>Google Brain & CMU</i>	83.877	89.737
2 May 10, 2018	MARS (ensemble) <i>YUANFUDAO research NLP</i>	83.520	89.612
3 Mar 06, 2018	QANet (ensemble) <i>Google Brain & CMU</i>	82.744	89.045
4 May 09, 2018	MARS (single model) <i>YUANFUDAO research NLP</i>	82.587	88.880
4 Jan 22, 2018	Hybrid AoA Reader (ensemble) <i>Joint Laboratory of HIT and iFLYTEK Research</i>	82.482	89.281
4 Feb 19, 2018	Reinforced Mnemonic Reader + A2D (ensemble model) <i>Microsoft Research Asia & NUDT</i>	82.849	88.764
5 Jan 03, 2018	r-net+ (ensemble) <i>Microsoft Research Asia</i>	82.650	88.493
5 Feb 02, 2018	Reinforced Mnemonic Reader (ensemble model) <i>NUDT and Fudan University https://arxiv.org/abs/1705.02798</i>	82.283	88.533
5 Feb 27, 2018	QANet (single model) <i>Google Brain & CMU</i>	82.209	88.608
5 Jan 05, 2018	SLQA+ (ensemble) <i>Alibaba iDST NLP</i>	82.440	88.607
6 Dec 17, 2017	r-net (ensemble) <i>Microsoft Research Asia http://aka.ms/rnet</i>	82.136	88.126

Adversarial evaluation

Peyton Manning became the first quarterback ever to lead two different teams to multiple Super Bowls. He is also the oldest **quarterback** ever to play in a Super Bowl at age 39. The past record was held by **John Elway**, who led the Broncos to victory in **Super Bowl XXXIII** at age **38** and is currently Denver's Executive Vice President of Football Operations and General Manager.

What is the name of the quarterback who was 38 in Super Bowl XXXIII?

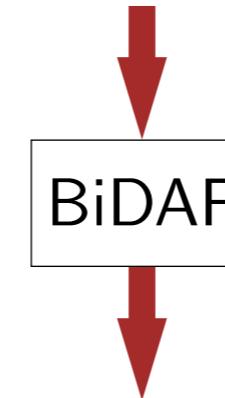




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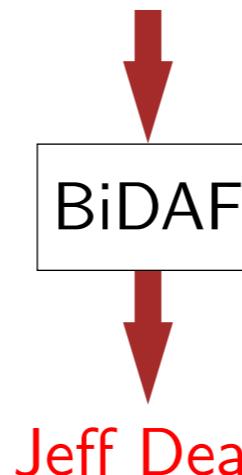




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Results on public models on CodaLab

Model	Original F1	Adversarial F1
ReasoNet-E	81.1	49.8
SEDT-E	80.1	46.5
BiDAF-E	80.0	46.9
Mnemonic-E	79.1	55.3
Ruminating	78.8	47.7
jNet	78.6	47.0
Mnemonic-S	78.5	56.0
ReasoNet-S	78.2	50.3
MPCM-S	77.0	50.0
RaSOR	76.2	49.5
BiDAF-S	75.5	45.7

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RaSOR	76.2	49.5
BiDAF-S	75.5	45.7
Humans	92.6	89.2

New research enabled by CodaLab

Other competitions on CodaLab

- SQuAD [[instructions](#)]: question answering
- HotpotQA [[instructions](#)]: multi-hop question answering
- QAngaroo [[instructions](#)]: multi-hop question answering (WikiHop and MedHop)
- MultiRC [[instructions](#)]: multi-hop question answering
- CoQA [[instructions](#)]: conversational question answering
- QuAC [[instructions](#)]: conversational question answering
- ShARC [[instructions](#)]: conversational question answering
- QANTA [[instructions](#)]: question answering on Quizbowl
- KorQuAD [[instructions](#)]: Korean question answering
- RecipeQA [[instructions](#)]: multimodal comprehension of cooking recipes
- MRQA2019 [[instructions](#)]: question answering
- CMRC2018 [[instructions](#)]: Chinese question answering
- SMP2018 [[instructions](#)]: Chinese dialogue
- Spider [[instructions](#)]: semantic parsing
- COIN [[instructions](#)]: commonsense inference
- HYPE [[instructions](#)]: image generation
- CheXpert [[instructions](#)]: chest x-ray interpretation
- MURA [[instructions](#)]: bone x-ray interpretation

Note: separate from CodaLab Competitions

Final remarks

Q: *What programming language can I use?*

A: Anything: Python, C++, Java, Julia, etc.

We run **arbitrary** Unix commands in a docker container.

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You can connect your own worker or setup a local installation.

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CodaLab building blocks are bundles and are immutable.

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CodaLab encapsulates these.

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CodaLab encapsulates these.

Q: *What's the relationship to CodaLab Competitions?*

A: It's a sister project led by Isabelle Guyon.

Competitions brings people together and bundles/worksheets provides a rich foundation.

Open challenges

Reproducibility (community):

What's the incentive to upload an executable paper?

How do we encourage creation of reusable modules?

How do we build a community?

Open challenges

Reproducibility (community):

What's the incentive to upload an executable paper?

How do we encourage creation of reusable modules?

How do we build a community?

Productivity (individual):

Is there enough flexibility to support interactive development?

Can we scale to really large-scale experiments?

Tradeoff?

efficiency

reproducibility

Folk wisdom: reproducibility slows down research.

Tradeoff?

efficiency - -



- - reproducibility

Folk wisdom: reproducibility slows down research.

Our claim: reproducibility accelerates research (with the right tool).

CodaLab contributors

Shaunak Kishore	Christophe Poulain	Eric Carmichael
Francis Cleary	Justin Carden	Scott Kovach
Pujun Bhatnagar	Stephen Koo	Eric Li
Konstantin Lopyrev	Max Wang	Fabian Chan
Kerem Goksel	Dennis Jeong	Nikhil Bhattasali
Hao Wu	Jane Ge	Ashwin Ramaswami
Levi Lian	Yipeng He	

We're looking for strong developers!

CodaLab Worksheets

Supported by:



Thank you!