Bigelow | Laboratory for Ocean Sciences

Deep Learning Tutorial

OceanHackWeek 2021

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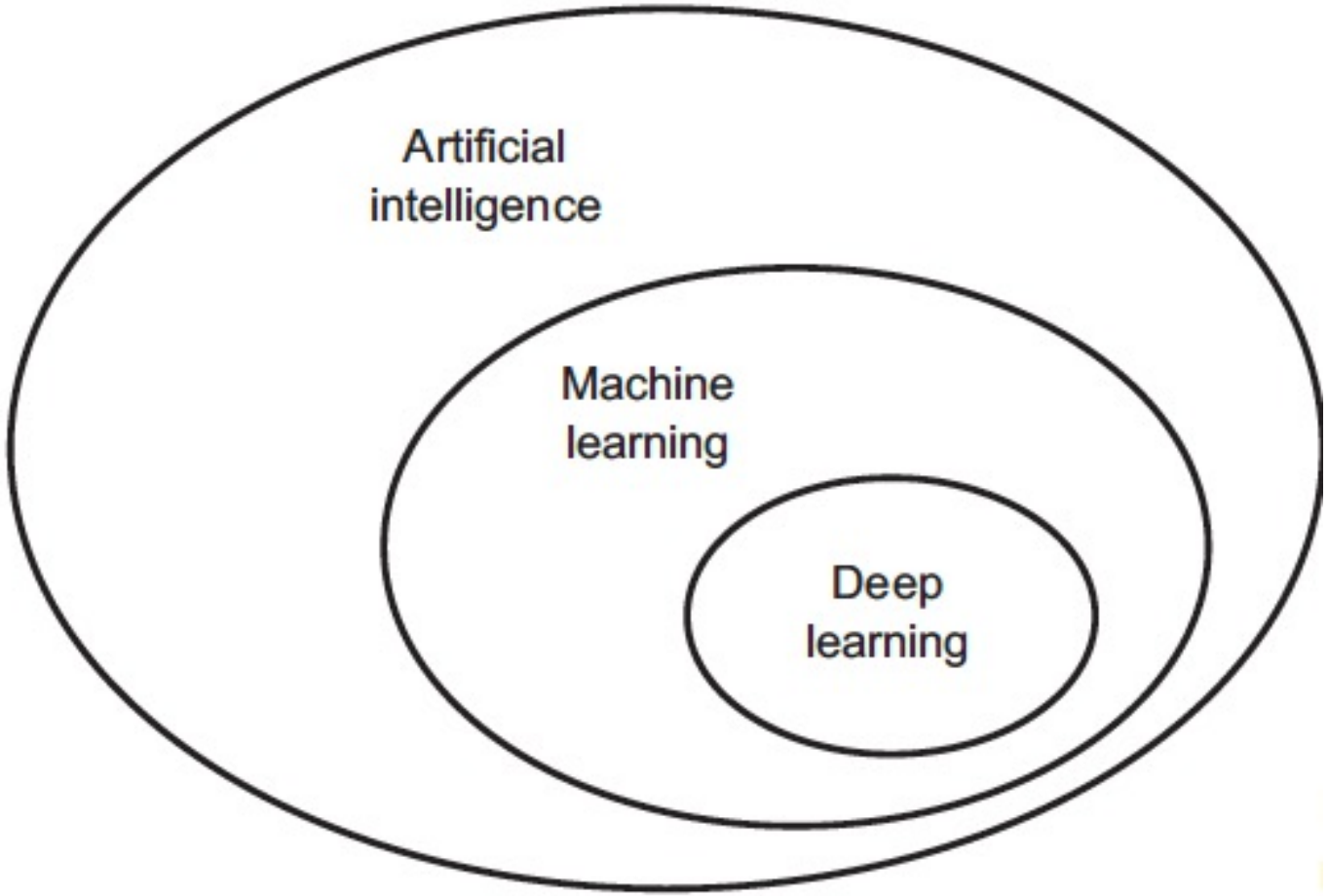
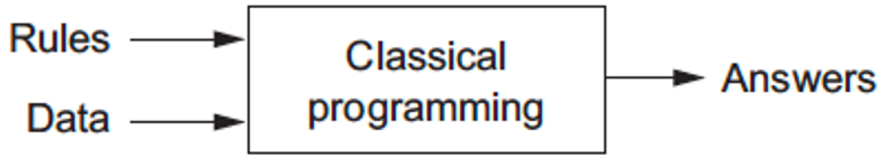
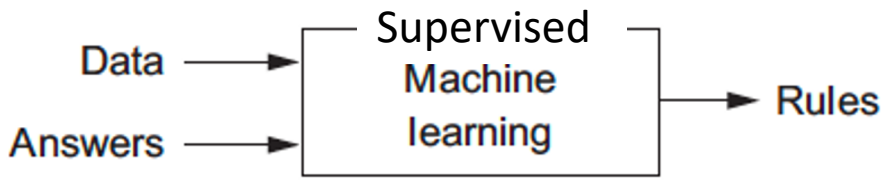
Tandy Center for Ocean Forecasting







Artificial Intelligence – “the effort to automate tasks normally performed by humans”

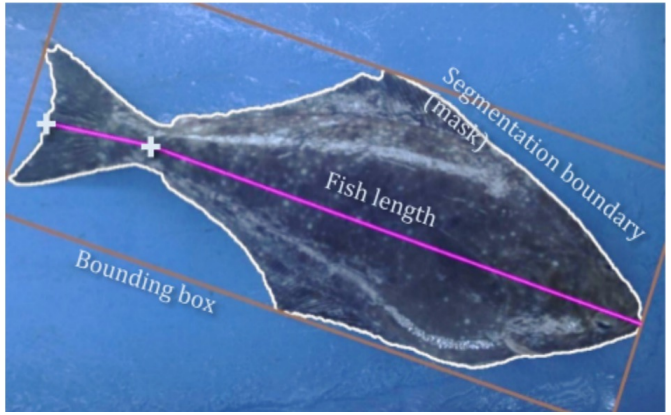
Deep Learning with R – Chollet, Allaire

Types of Machine Learning

- Supervised
  - Data with labels
- Unsupervised
  - Data without labels
- Reinforcement
  - Stream of data with reward/punishment system for decisions
- Self-supervised (instance of supervised)
  - Data is labeled by an algorithm, then used for learning

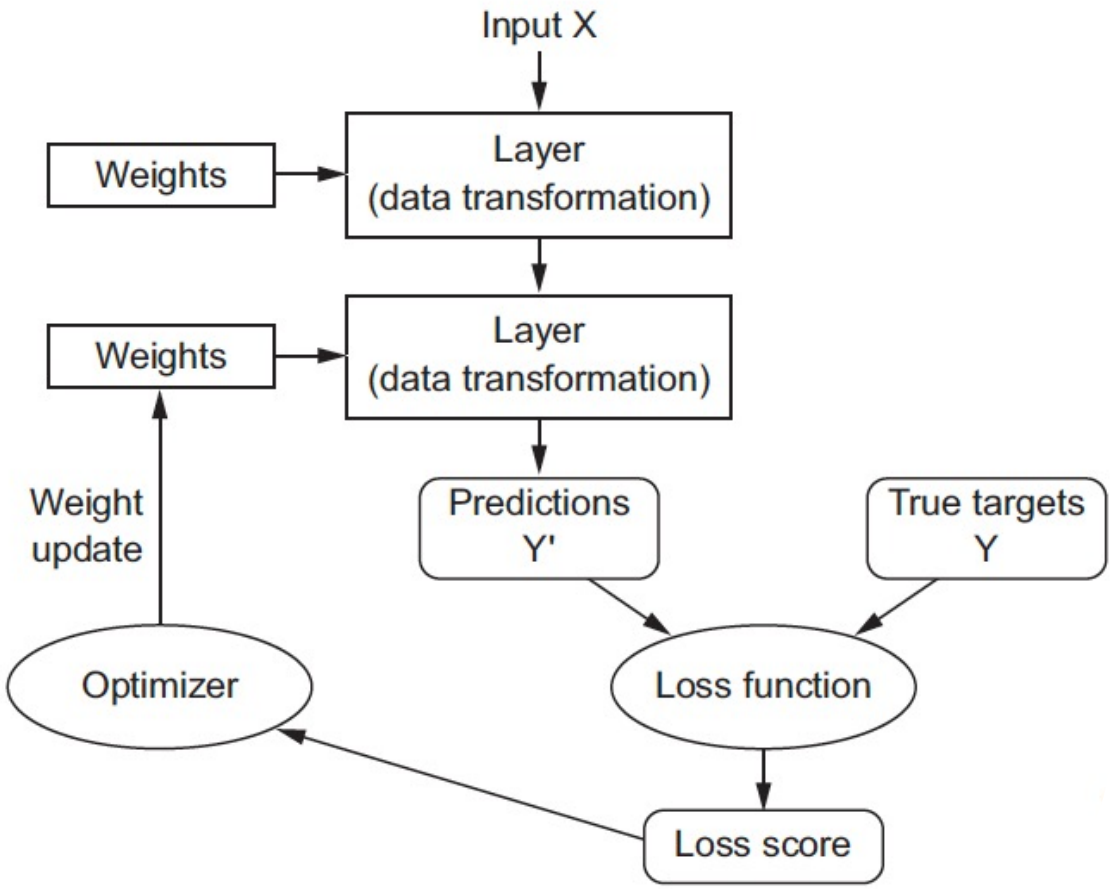
Other Ocean-related Machine Learning Examples

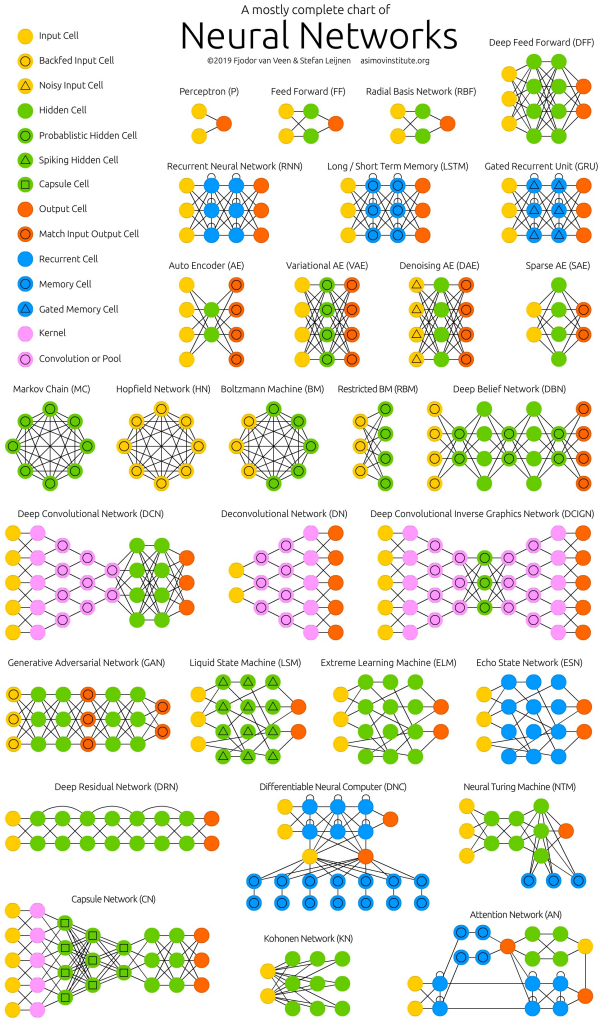
- Trawl Survey with Computer vision for fish ID and measurement
- Fisheries Electronic Monitoring
- Unmanned surface vehicles (USVs)



"Machine Learning to Improve Marine Science for the Sustainability of Living Ocean Resources" – NOAA Fisheries

Deep Learning = Neural Networks





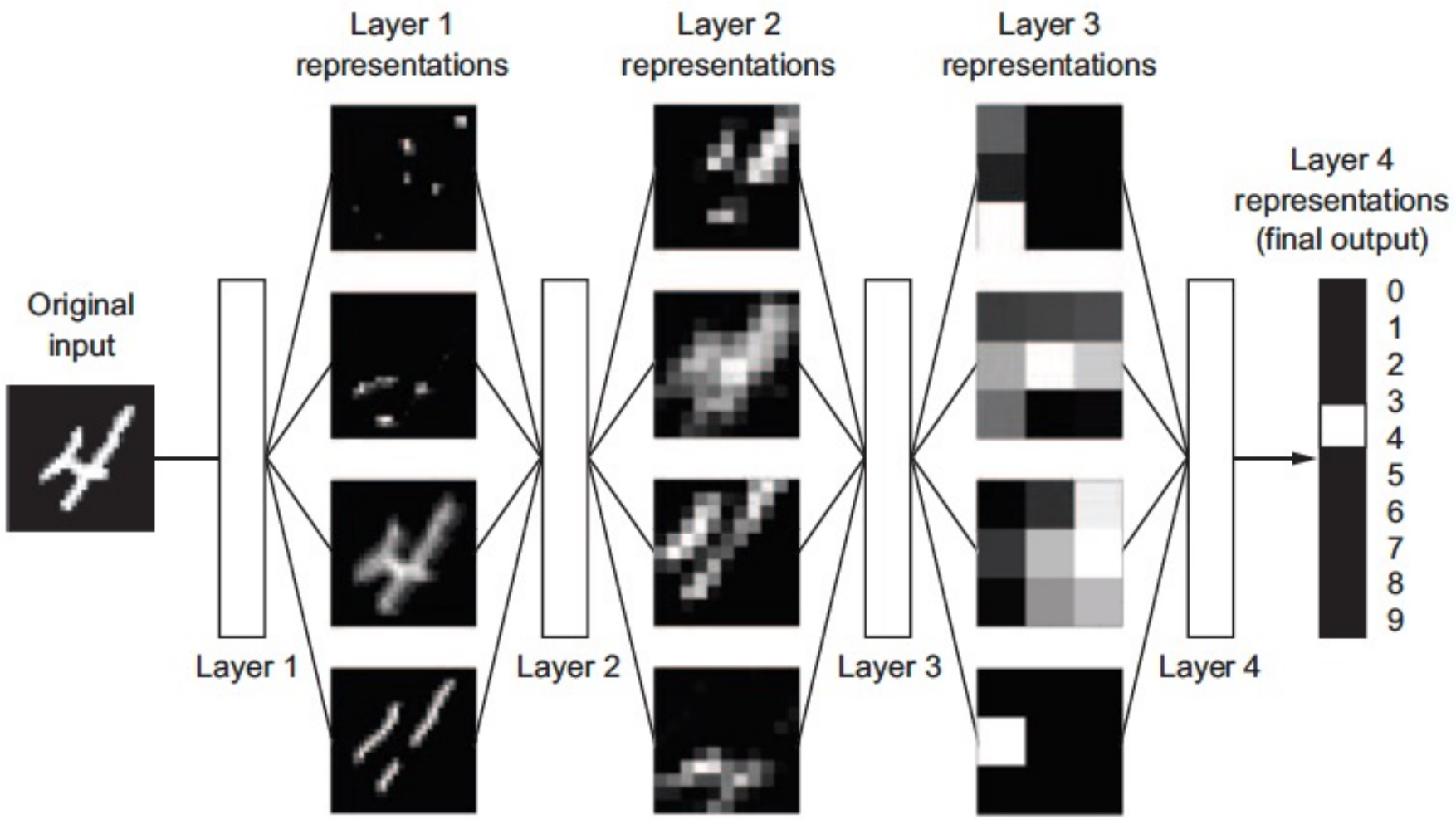
"Deep Learning with R" – Chollet, Allaire

https://www.asimovinstitute.org/neural-network-zoo/

Tensorflow Input

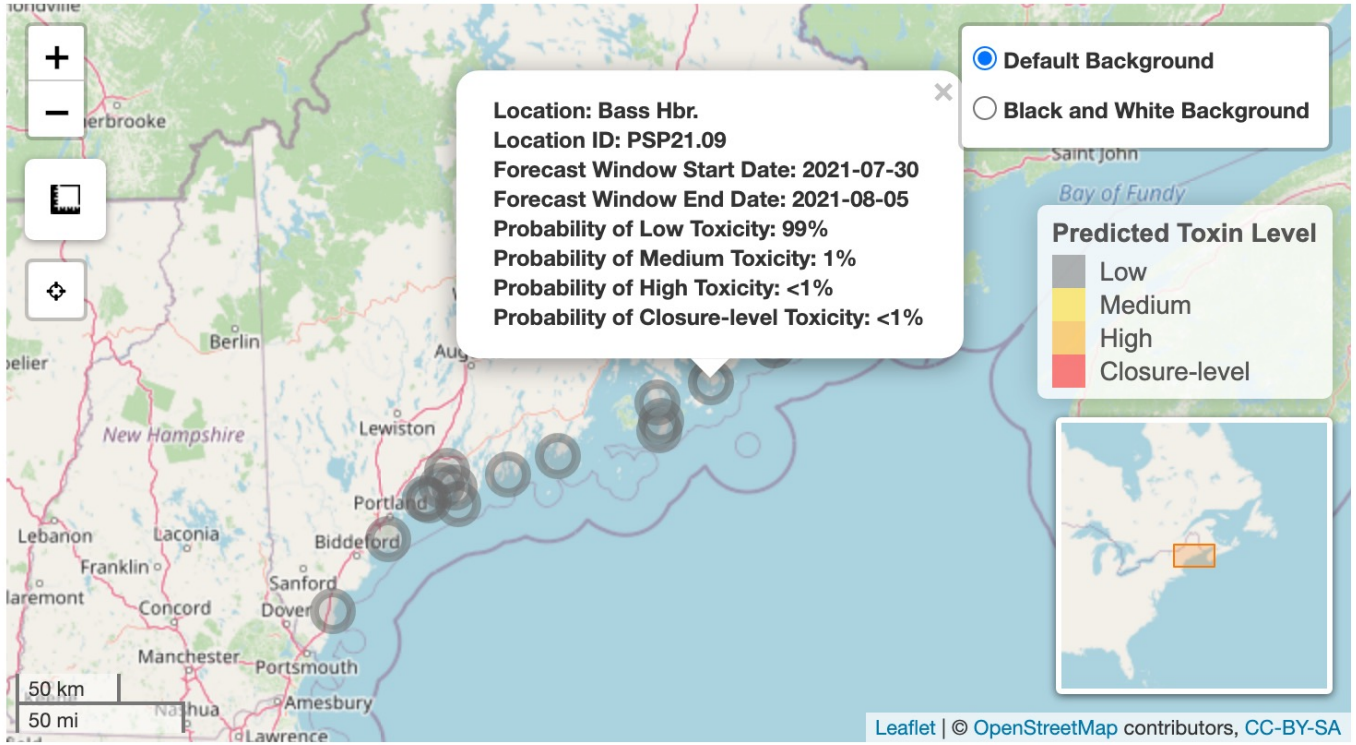
- Tensors = multidimensional arrays
  - 2D - Structured data (samples, features)
  - 3D - Timeseries forecasting (samples, features, timesteps)
  - 4D - Image (images, height, width, color channels)
  - 5D - Video (videos, height, width, color channels, frames)

First Tutorial



"Deep Learning with R" – Chollet, Allaire

Experimental Coastal Maine Shellfish PSP Toxicity 4 - 10 Day Forecast



Each week, DMR conducts their shellfish sampling across the coast of Maine. These samples all make their way to Bigelow Analytic Services where they are analyzed for total toxicity. By Friday, we get all of the results back from the week and are able to run the new data through our model and make predictions for the following week. Our forecast is site-specific, so each circle marker represents a unique sampling location, and its forecast. Sampling takes place on a roughly weekly basis, however, this varies and can really be anywhere in the 4-10 day window. Therefore, each of our predictions has a start and end date, which will be 4-10 days from the last time each site was sampled. **Reminder: The forecast is in an experimental phase and should not be the basis for decision making at this point.**

Data Format

Unique ID	Location ID	Date	Total Toxicity	T1	T2	T3	E1	E2	E3	Gap	Classification
PSP10.1_7_30	PSP10.1	7/30	65	t_1	t_1	t_1	e_1	e_1	e_1	0	2
PSP10.1_8_5	PSP10.1	8/5	105	t_2	t_2	t_2	e_2	e_2	e_2	6	3
PSP10.1_8_13	PSP10.1	8/13	5	t_3	t_3	t_3	e_3	e_3	e_3	7	0
PSP10.1_8_20	PSP10.1	8/20	21	t_4	t_4	t_4	e_4	e_4	e_4	7	1
PSP10.1_8_25	PSP10.1	8/25	55	t_5	t_5	t_5	e_5	e_5	e_5	5	2
PSP10.1_9_2	PSP10.1	9/2	70	t_6	t_6	t_6	e_6	e_6	e_6	8	2
PSP10.1_9_14	PSP10.1	9/14	250	t_7	t_7	t_7	e_7	e_7	e_7	7	3

Classification	Shellfish Toxicity ($\mu g\ 100\ g^{-1}$ shellfish)	Description
0	0-10	Low
1	10-30	Medium
2	30-80	High
3	>80	Closure Level

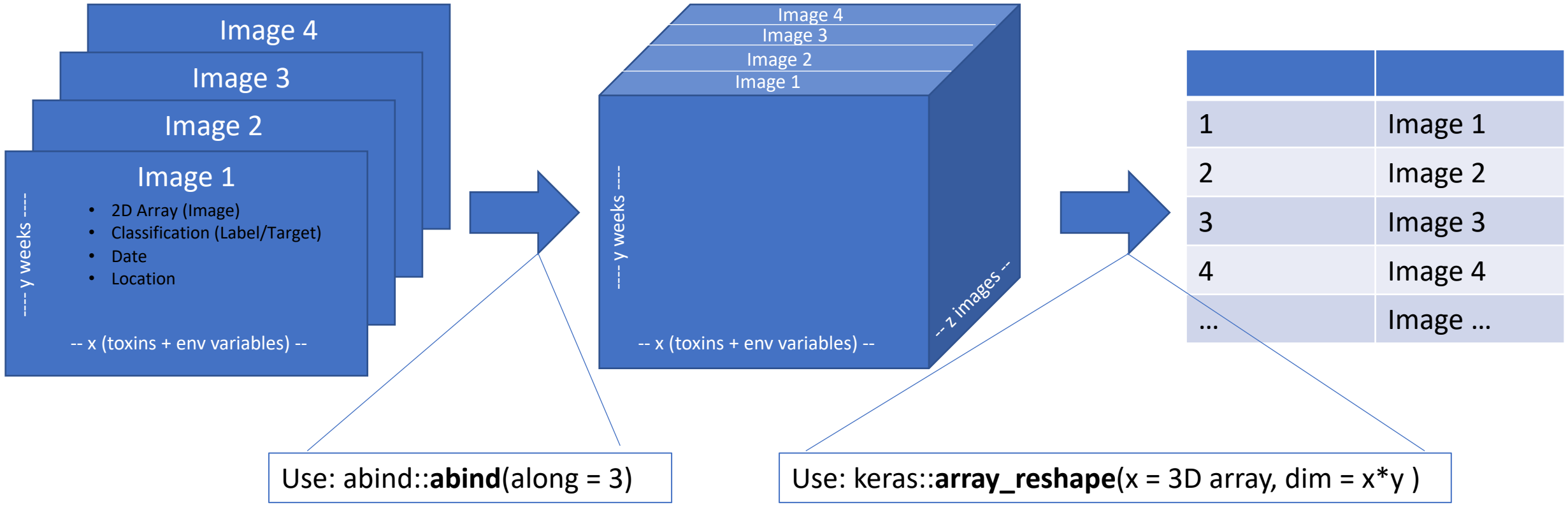
Images pulled from raw data

x (toxins + environmental observations)

y weeks

Unique ID	Location ID	Date	Total Toxicity	T1	T2	T3	E1	E2	E3	Gap	Classification
PSP10.1_7_30	PSP10.1	7/30	65	t_1	t_1	t_1	e_1	e_1	e_1	0	2
PSP10.1_8_5	PSP10.1	8/5	105	t_2	t_2	t_2	e_2	e_2	e_2	6	3
PSP10.1_8_13	PSP10.1	8/13	5	t_3	t_3	t_3	e_3	e_3	e_3	7	0
PSP10.1_8_20	PSP10.1	8/20	21	t_4	t_4	t_4	e_4	e_4	e_4	7	1
PSP10.1_8_25	PSP10.1	8/25	55	t_5	t_5	t_5	e_5	e_5	e_5	5	2
PSP10.1_9_2	PSP10.1	9/2	70	t_6	t_6	t_6	e_6	e_6	e_6	8	2
PSP10.1_9_14	PSP10.1	9/14	250	t_7	t_7	t_7	e_7	e_7	e_7	7	3

List of 2D Arrays : 3D Array : 2D Array



Tensorflow Input –
2D Array of Images with Labels

	T1	T2	T3	E1	E2	E3	T1	T2	T3	E1	E2	E3	T1	T2	T3	E1	E2	E3	Label
1	t_1	t_1	t_1	e_1	e_1	e_1	t_2	t_2	t_2	e_2	e_2	e_2	t_3	t_3	t_3	e_3	e_3	e_3	1
2	t_2	t_2	t_2	e_2	e_2	e_2	t_3	t_3	t_3	e_3	e_3	e_3	t_4	t_4	t_4	e_4	e_4	e_4	2
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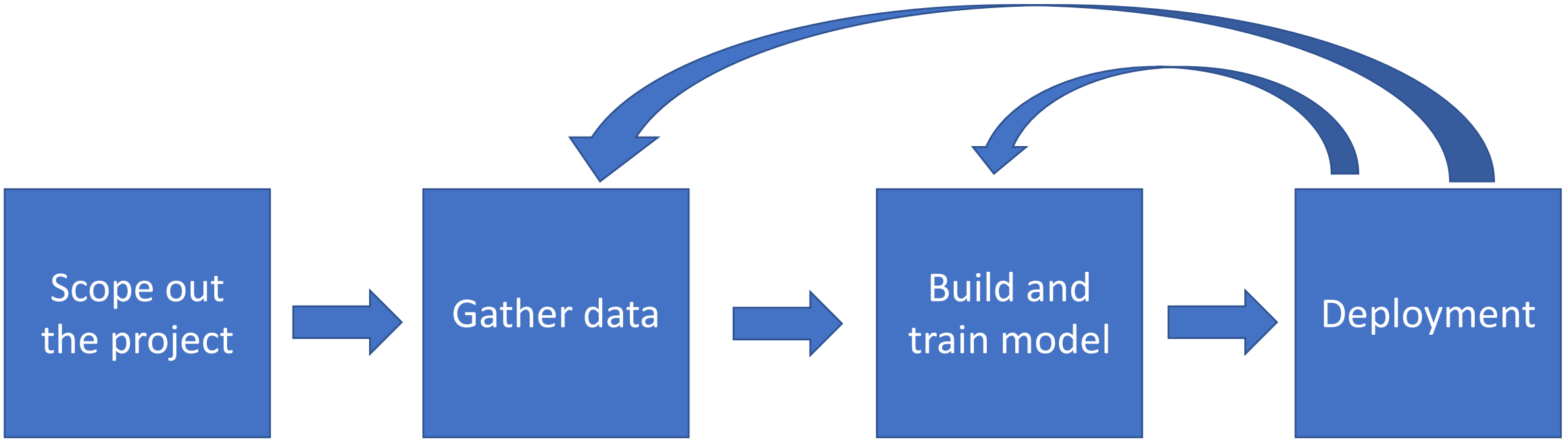
4	t_4	t_4	t_4	e_4	e_4	e_4	t_5	t_5	t_5	e_5	e_5	e_5	t_6	t_6	t_6	e_6	e_6	e_6	3

Unique ID	Location ID	Date	Total Toxicity	T1	T2	T3	E1	E2	E3	Gap	Classification
PSP10.1_7_30	PSP10.1	7/30	65	t_1	t_1	t_1	e_1	e_1	e_1	0	2
PSP10.1_8_5	PSP10.1	8/5	105	t_2	t_2	t_2	e_2	e_2	e_2	6	3
PSP10.1_8_13	PSP10.1	8/13	5	t_3	t_3	t_3	e_3	e_3	e_3	7	0
PSP10.1_8_20	PSP10.1	8/20	21	t_4	t_4	t_4	e_4	e_4	e_4	7	1
PSP10.1_8_25	PSP10.1	8/25	55	t_5	t_5	t_5	e_5	e_5	e_5	5	2
PSP10.1_9_2	PSP10.1	9/2	70	t_6	t_6	t_6	e_6	e_6	e_6	8	2
PSP10.1_9_14	PSP10.1	9/14	250	t_7	t_7	t_7	e_7	e_7	e_7	7	3

Forecasting with Deep Learning Tutorial

Steps to deploying an AI product



Deep Learning with R

Lot’s of content in this talk came from this book