

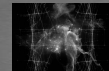
AI-BASED PROCESSING OF FINANCIAL DOCUMENTS

ONE STEP FURTHER

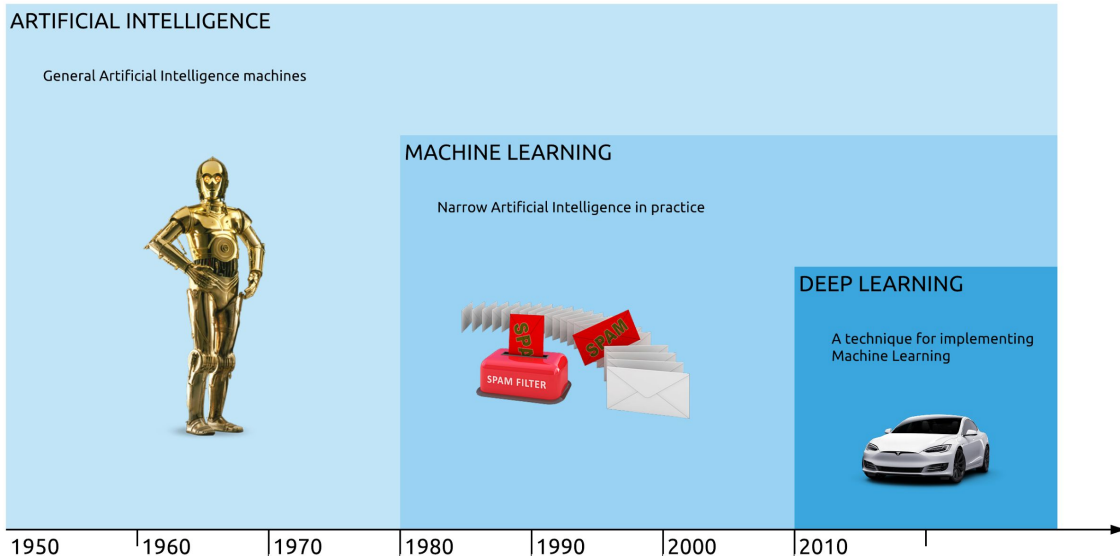




“ With the brush we merely tint, while *imagination* alone produces color. ”
-Théodore Géricault



AI...MACHINE LEARNING...DEEP LEARNING?

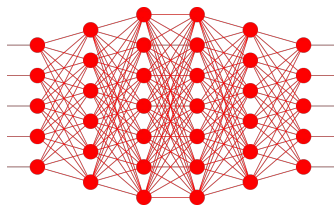


ONE STEP FURTHER



WHY IS ARTIFICIAL INTELLIGENCE SUDDENLY SO IMPORTANT?

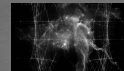
DEEP LEARNING



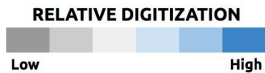
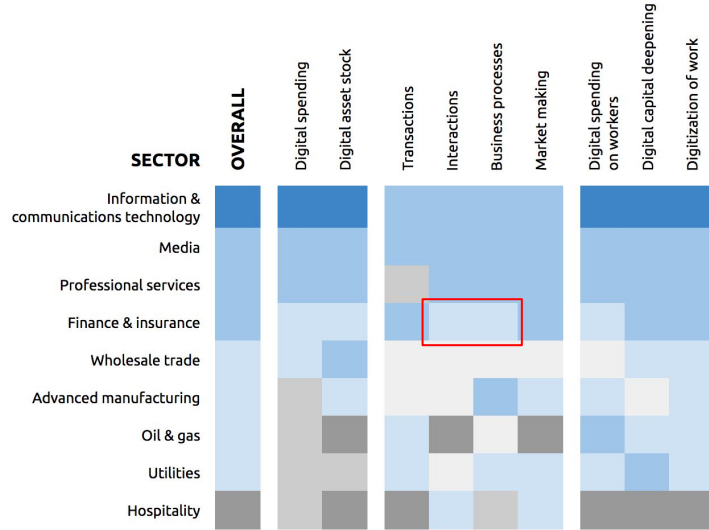
DEMOCRATIZATION



ONE STEP FURTHER

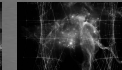


EFFICIENCY IN THE FINANCIAL SERVICES INDUSTRY

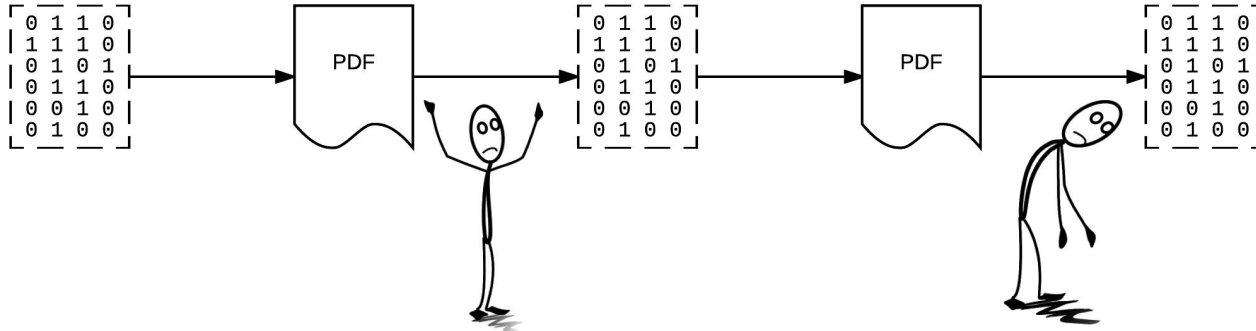
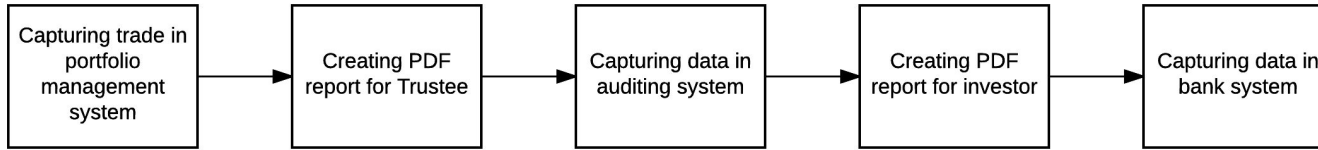


Source: Data Analysis and expert interviews conducted by the McKinsey Global Institute

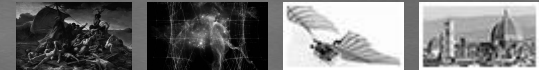
ONE STEP FURTHER



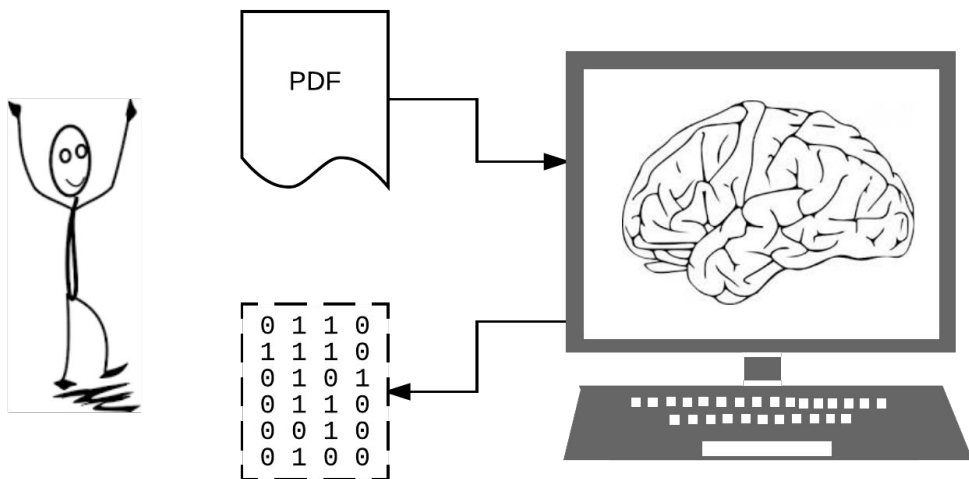
EXAMPLE: STRUCTURED CREDIT REPORTING



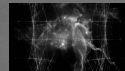
ONE STEP FURTHER



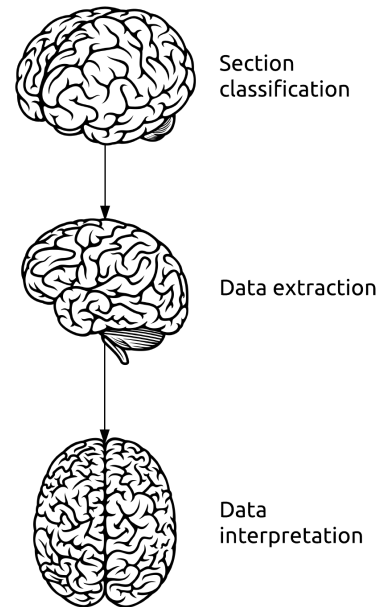
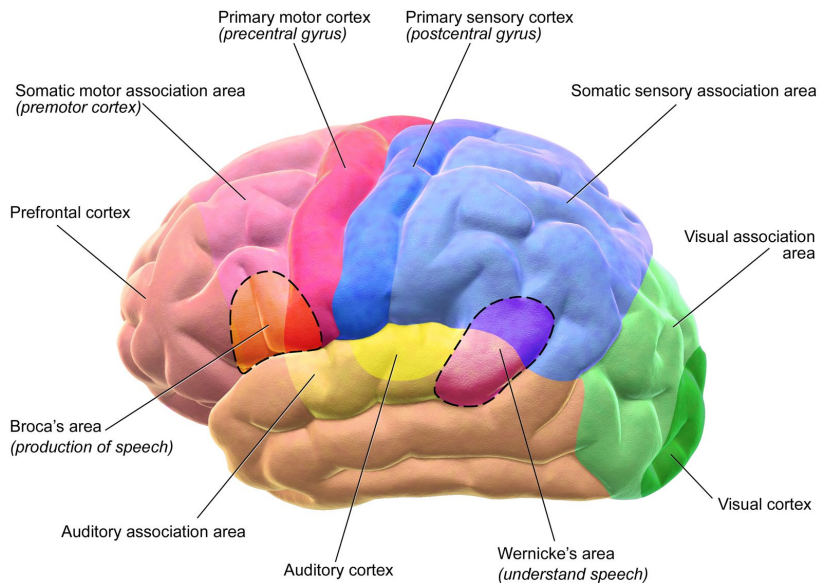
DEMOCRATIZATION OF VISION API FOR FINANCIAL DOCUMENTS



ONE STEP FURTHER



LEGEND OF THE SINGLE BRAIN



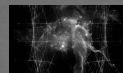
ONE STEP FURTHER



CHIHUAHUA DOG OR BLUEBERRY MUFFIN?



ONE STEP FURTHER



" We cannot solve our problems with the same *thinking* we used when we created them !!"

Albert Einstein

ONE STEP FURTHER

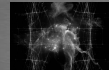



IMAGE REPRESENTATION

Image $I \in B$ as vector $x \in \mathcal{R}$

Distance Measures, i.e. L1 or L2

Similarity: Nearest Neighbor Classifier



What the computer sees

image classification

- 82% cat
- 15% dog
- 2% hat
- 1% mug

Test image

56	32	10	18
90	23	128	133
24	26	178	200
2	0	255	220

Training image

10	20	24	17
8	10	89	100
12	16	178	170
4	32	233	112

Pixel-wise absolute value differences

46	12	14	1
82	13	39	33
12	10	0	30
2	32	22	108

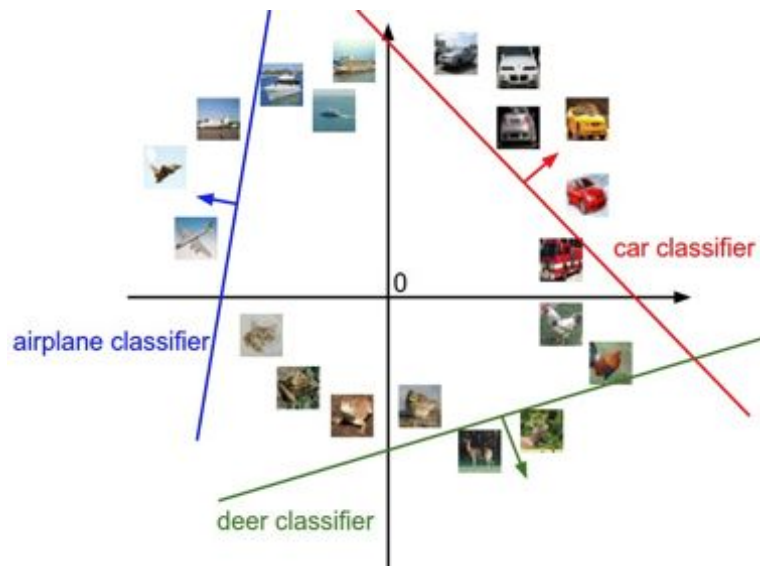
→ 456

ONE STEP FURTHER



IMAGE CLASSIFICATION

Linear classification function $f: R^D \rightarrow R^K$, $f(x) = Wx + b$ with score $s_j = w_j \cdot x$

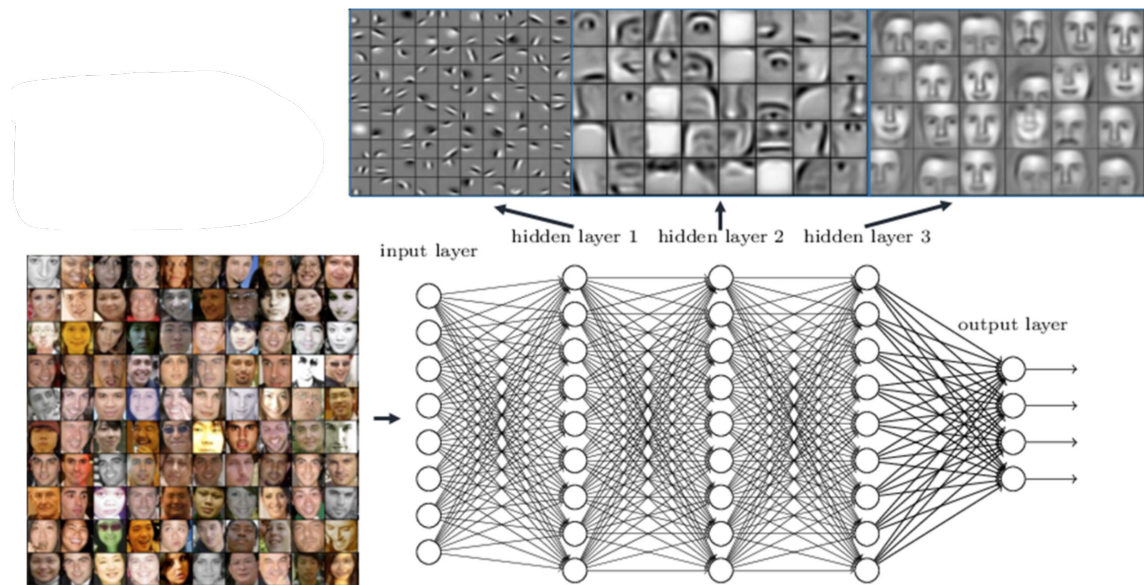


ONE STEP FURTHER

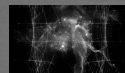


CONVOLUTIONAL NEURAL NETWORKS

Deep neural networks learn hierarchical features representations



ONE STEP FURTHER

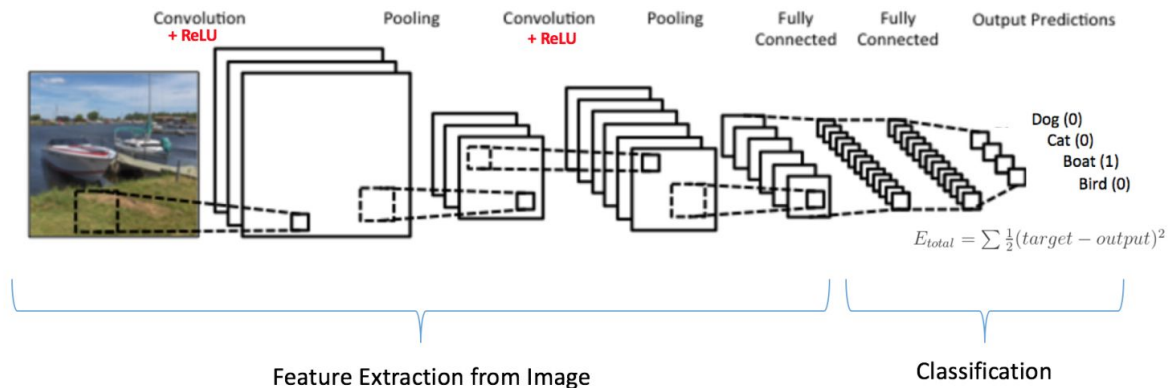


CONVOLUTIONAL NEURAL NETWORKS

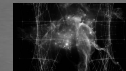
Building Invariance Properties into a Neural Network

Translations, scalings, small rotations

Nearby pixels of images are more strongly correlated than more distant pixels



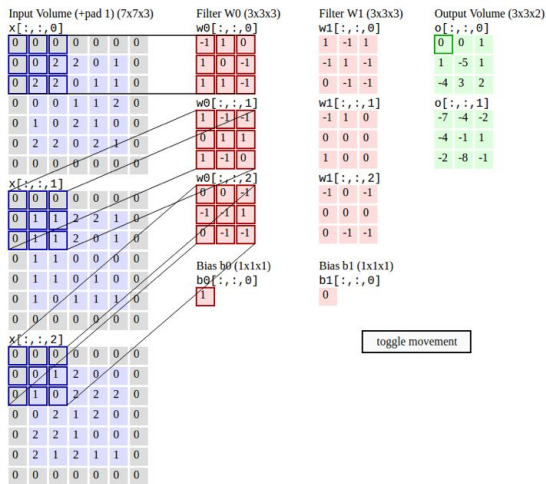
ONE STEP FURTHER










CONVOLUTIONAL NEURAL NETWORKS

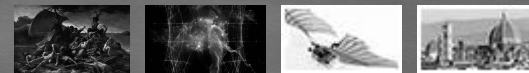
Convolution is a linear Operation

$$x_{ij}^k = \sum_{a=0}^{m-1} \sum_{b=0}^{m-1} w_{ab} x_{(i+a),(j+b)}^{k-1}$$



Operation	Filter	Convolved Image
Identity	$\begin{bmatrix} 0 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 0 \end{bmatrix}$	
Edge detection	$\begin{bmatrix} 1 & 0 & -1 \\ 0 & 0 & 0 \\ -1 & 0 & 1 \end{bmatrix}$	
	$\begin{bmatrix} 0 & 1 & 0 \\ 1 & -4 & 1 \\ 0 & 1 & 0 \end{bmatrix}$	
	$\begin{bmatrix} -1 & -1 & -1 \\ -1 & 8 & -1 \\ -1 & -1 & -1 \end{bmatrix}$	
Sharpen	$\begin{bmatrix} 0 & -1 & 0 \\ -1 & 5 & -1 \\ 0 & -1 & 0 \end{bmatrix}$	
Box blur (normalized)	$\frac{1}{9} \begin{bmatrix} 1 & 1 & 1 \\ 1 & 1 & 1 \\ 1 & 1 & 1 \end{bmatrix}$	
Gaussian blur (approximation)	$\frac{1}{16} \begin{bmatrix} 1 & 2 & 1 \\ 2 & 4 & 2 \\ 1 & 2 & 1 \end{bmatrix}$	

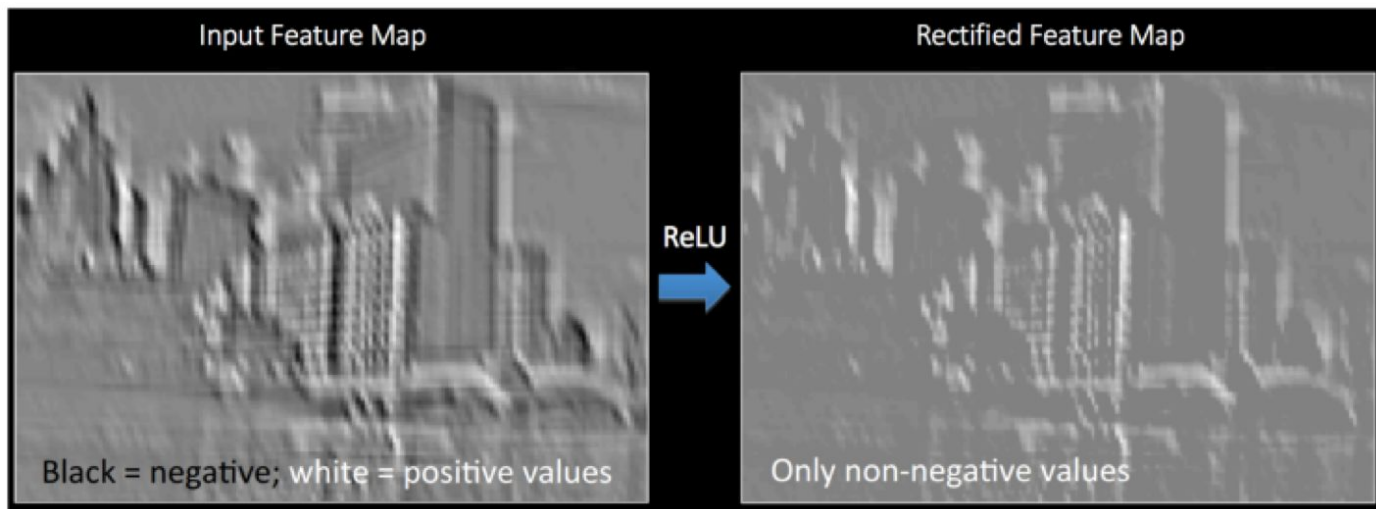
ONE STEP FURTHER



CONVOLUTIONAL NEURAL NETWORKS

Non Linearity

Example (ReLU): Output = $\text{Max}(0, \text{Input})$

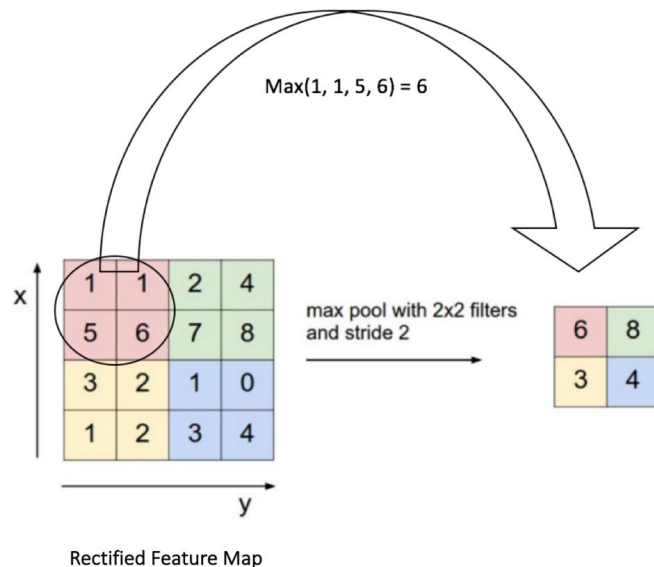


ONE STEP FURTHER



CONVOLUTIONAL NEURAL NETWORKS

Pooling reduces the dimensionality of each feature map but retains the most important information.
Max, Average, Sum etc.



ONE STEP FURTHER



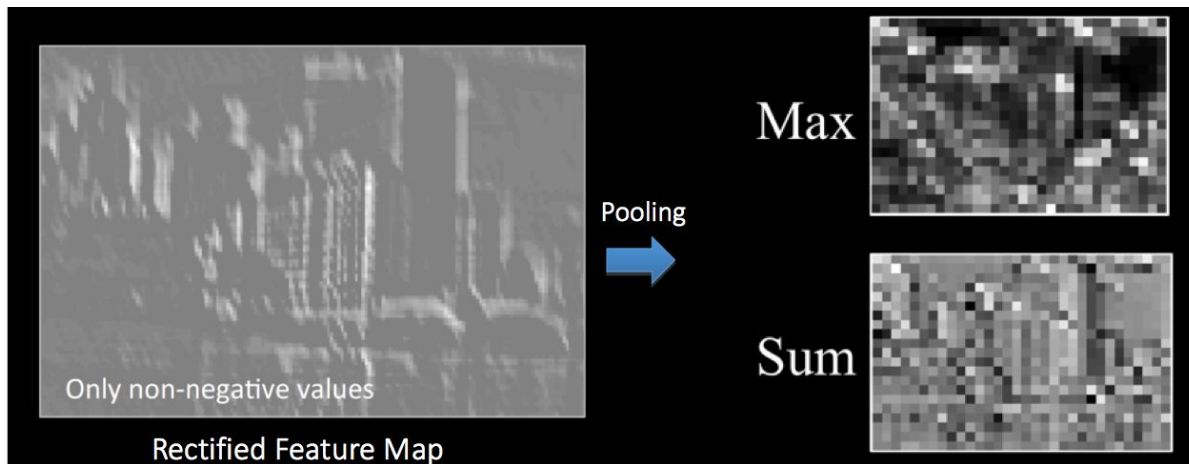
CONVOLUTIONAL NEURAL NETWORKS

Makes input representations smaller

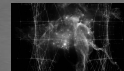
Reduces number of parameters and computations

Invariance to small transformations, distortions and translations in the input image

Almost scale invariant representation => we can detect objects in an image no matter where they are located

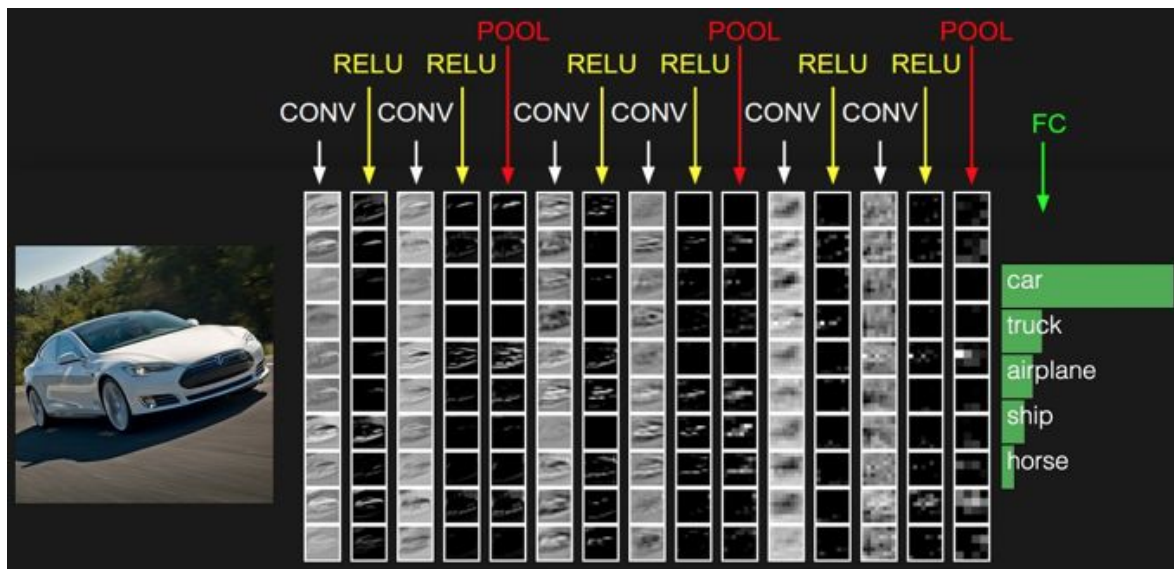


ONE STEP FURTHER



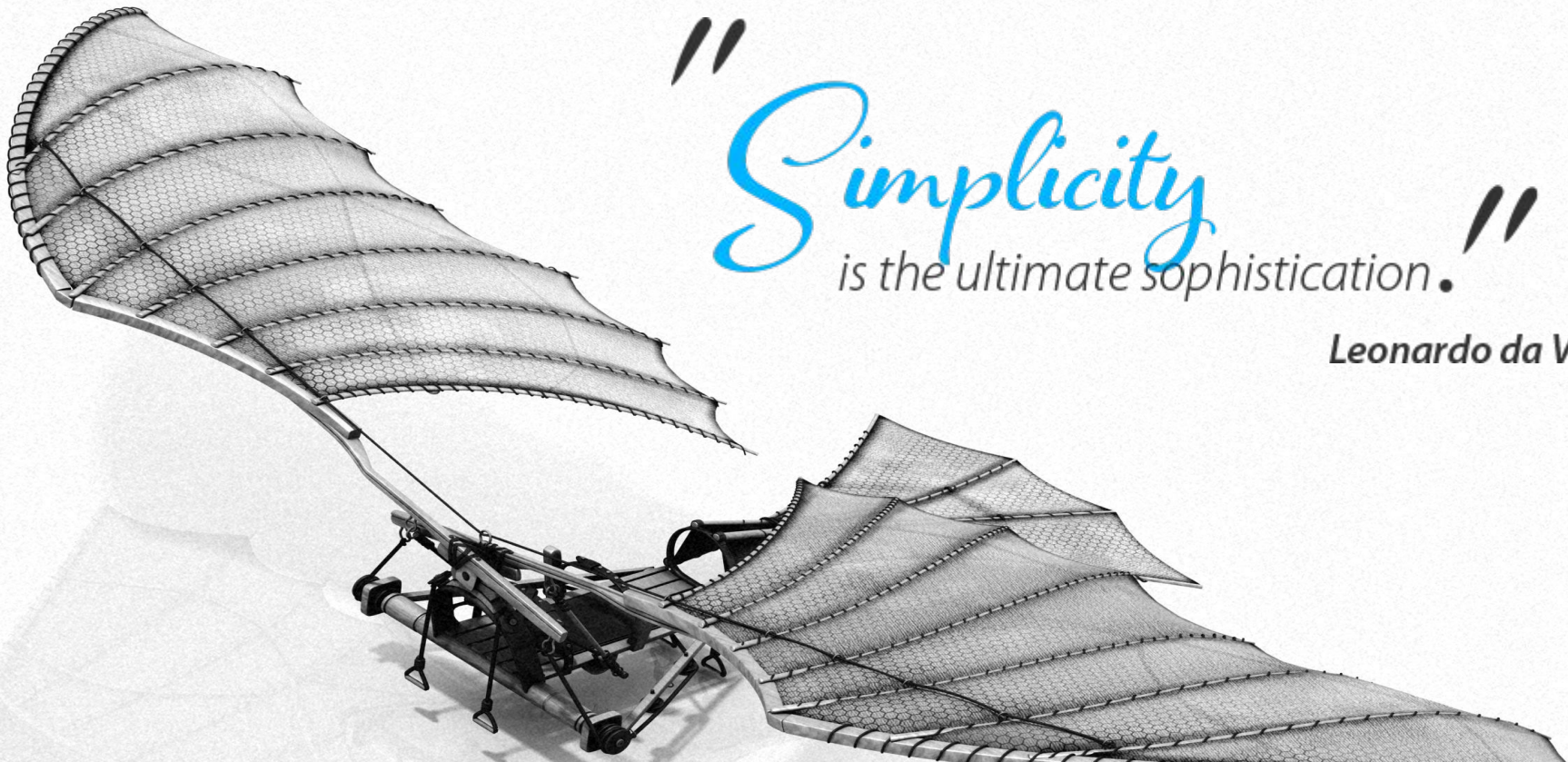
CONVOLUTIONAL NEURAL NETWORKS

Classification



ONE STEP FURTHER

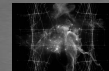




"
Simplicity
is the ultimate sophistication."
"

Leonardo da Vinci

ONE STEP FURTHER



DATA EXAMPLE - RESIDENTIAL MORTGAGE-BACKED SECURITY (RMBS) REPORT

Contact:

Distribution Date: 27-Mar-2017

Loan Trust
Asset Backed Pass-Through Certificates
Series 2006

28-Mar-2017 02:17:05 PM

Certificateholder Distribution Summary

Class	CUSIP	Record Date	Certificate Pass-Through Rate	Beginning Certificate Balance	Interest Distribution	Principal Distribution	Current Realized Loss	Ending Certificate Balance	Total Distribution	Cumulative Realized Losses
A-1	14453FAA7	03/24/2017	0.80833 %	0.00	0.00	0.00	0.00	0.00	0.00	0.00
A-2	14453FAB5	03/24/2017	0.86833 %	0.00	0.00	0.00	0.00	0.00	0.00	0.00
A-3	14453FAC3	03/24/2017	0.92833 %	90,681,257.74	65,474.99	3,142,820.01	0.00	87,538,437.72	3,208,295.00	0.00
A-4	14453FAD1	03/24/2017	1.01833 %	41,769,000.00	33,082.49	0.00	0.00	41,769,000.00	33,082.49	0.00
M-1	14453FAE9	03/24/2017	1.04833 %	41,424,000.00	33,775.79	0.00	0.00	41,424,000.00	33,775.79	0.00
M-2	14453FAF6	03/24/2017	1.06833 %	9,759,098.51	8,109.06	0.00	(14,069.13)	9,773,167.64	8,109.06	38,240,832.37
M-3	14453FAG4	03/24/2017	1.08833 %	0.00	0.00	0.00	0.00	0.00	0.00	17,886,999.99
M-4	14453FAH2	03/24/2017	1.12833 %	0.00	0.00	0.00	0.00	0.00	0.00	17,886,999.99
M-5	14453FAJ8	03/24/2017	1.15833 %	0.00	0.00	0.00	0.00	0.00	0.00	17,886,999.99
M-6	14453FAK5	03/24/2017	1.21833 %	0.00	0.00	0.00	0.00	0.00	0.00	16,946,000.00
M-7	14453FAL3	03/24/2017	1.28333 %	0.00	0.00	0.00	0.00	0.00	0.00	16,475,000.00
M-8	14453FAM1	03/24/2017	1.77833 %	0.00	0.00	0.00	0.00	0.00	0.00	12,239,000.00
M-9	14453FAN9	03/24/2017	2.62833 %	0.00	0.00	0.00	0.00	0.00	0.00	8,473,000.00
M-10	14453FAP4	03/24/2017	3.27833 %	0.00	0.00	0.00	0.00	0.00	0.00	10,827,000.00
CE	14453FAQ2	02/28/2017	0.00000 %	270,925.74	0.00	0.00	0.00	317,642.82	0.00	0.00
P	14453FAR0	02/28/2017	0.00000 %	100.00	0.00	0.00	0.00	100.00	0.00	0.00
R-I	14453FAS8	02/28/2017	0.00000 %	0.00	0.00	0.00	0.00	0.00	0.00	0.00
R-II	14453FAT6	02/28/2017	0.00000 %	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Totals				183,904,381.99	140,442.33	3,142,820.01	(14,069.13)	180,822,348.18	3,283,262.34	156,861,832.34

This report is compiled by:

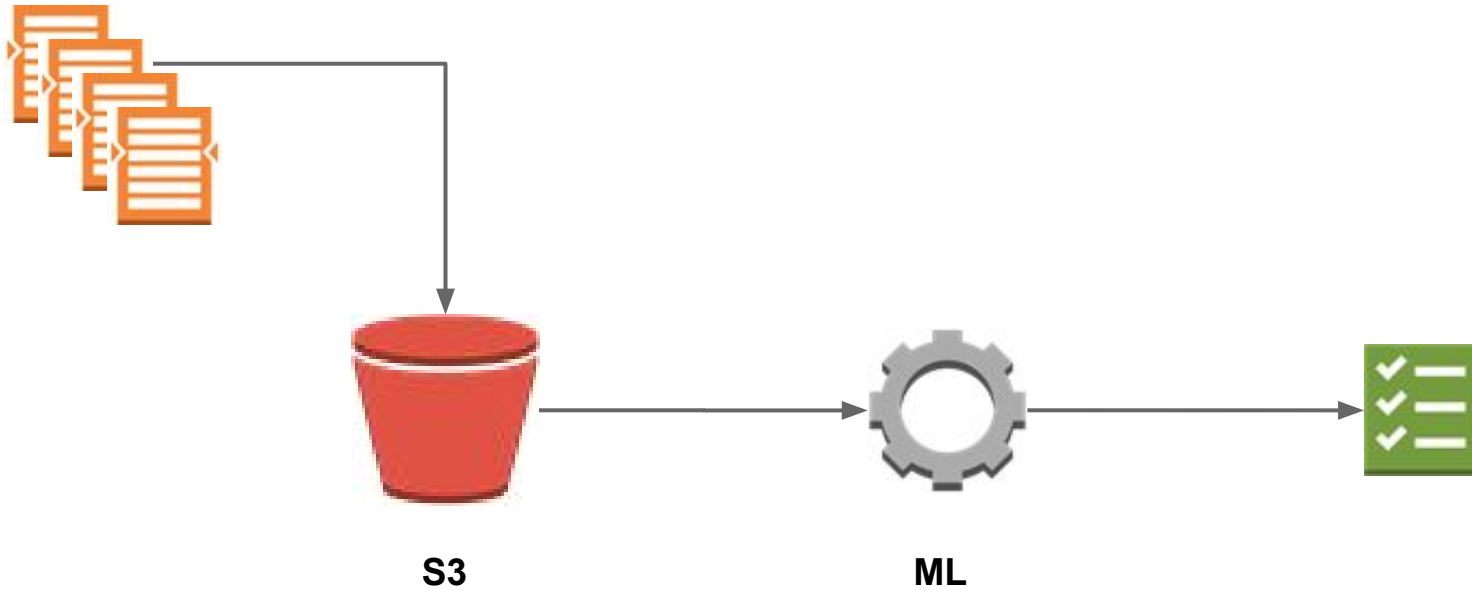
All Record Dates are based upon the governing documents and logic set forth as of closing.

NOTE: On April 4, 2007 details.

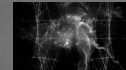
NOTE: Distributions include certain amounts received in respect of claims filed on behalf of the Trust in the bankruptcy proceedings of New Century and affiliates.



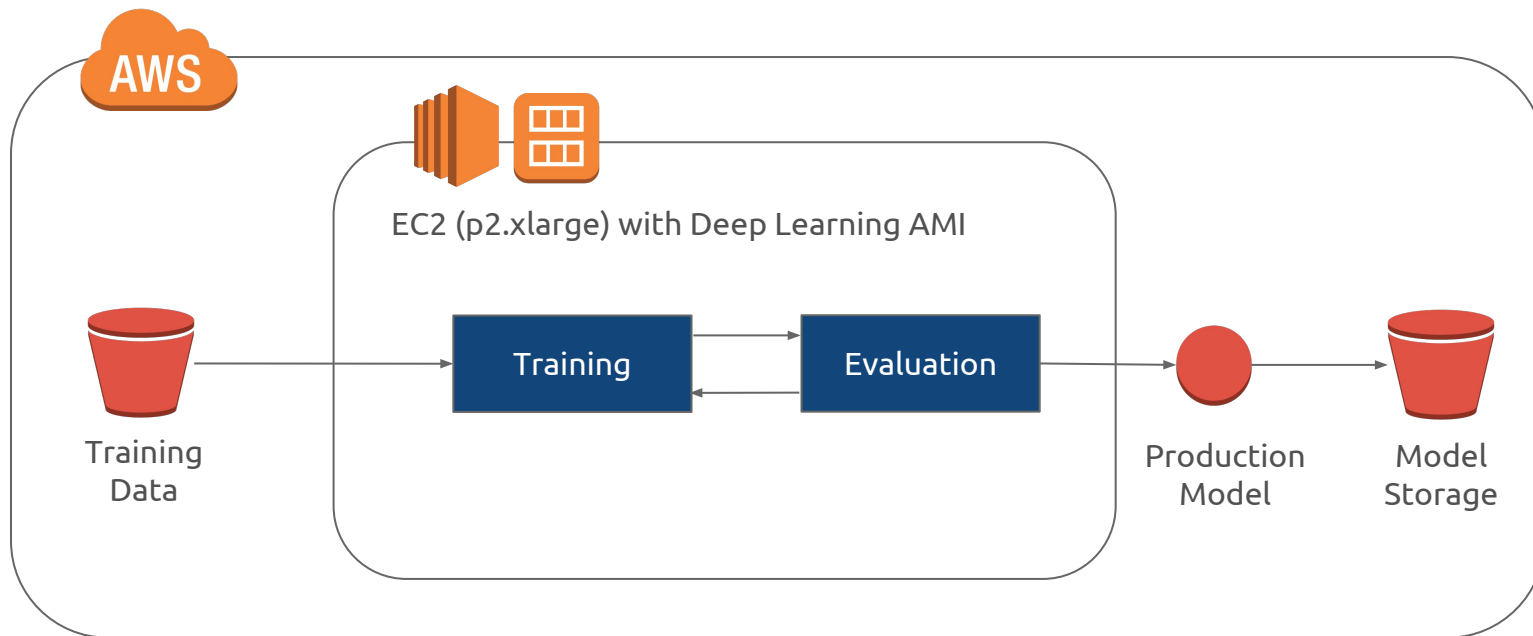
HIGH-LEVEL APPLICATION PROCESS



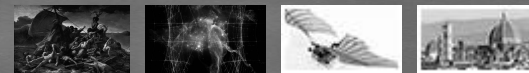
ONE STEP FURTHER



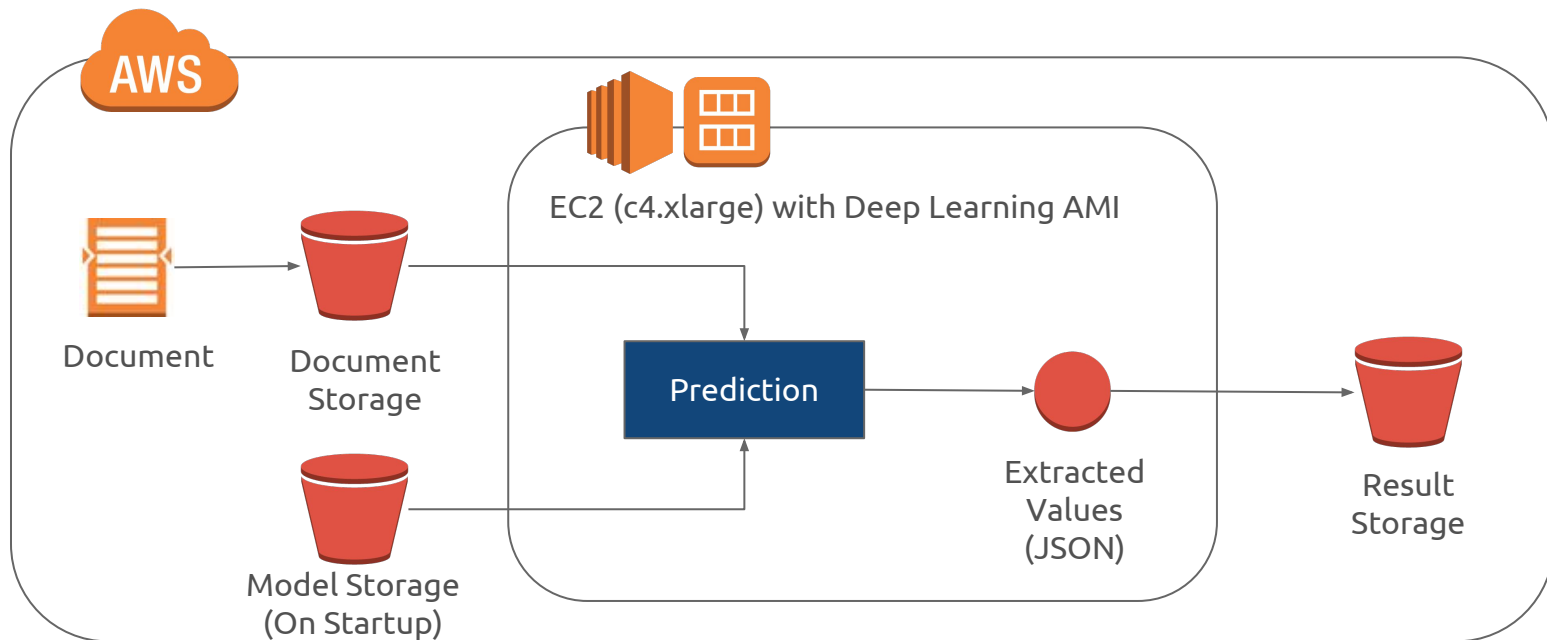
AWS ARCHITECTURE - MODEL FACTORY



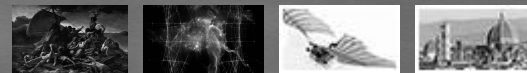
ONE STEP FURTHER



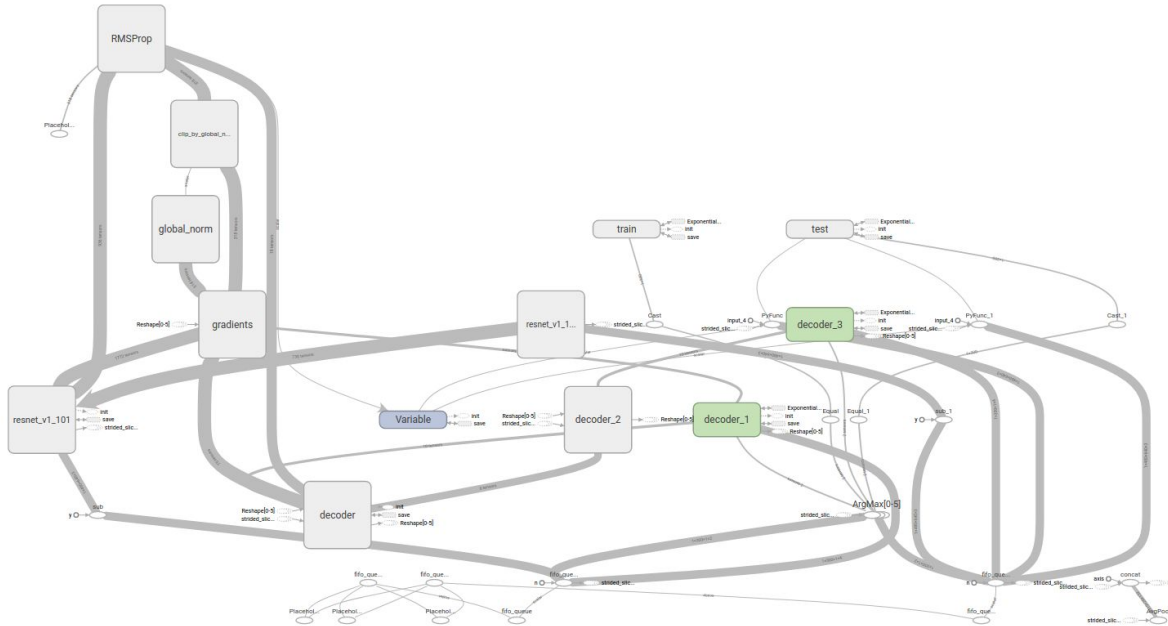
AWS ARCHITECTURE - PRODUCTION ENVIRONMENT



ONE STEP FURTHER



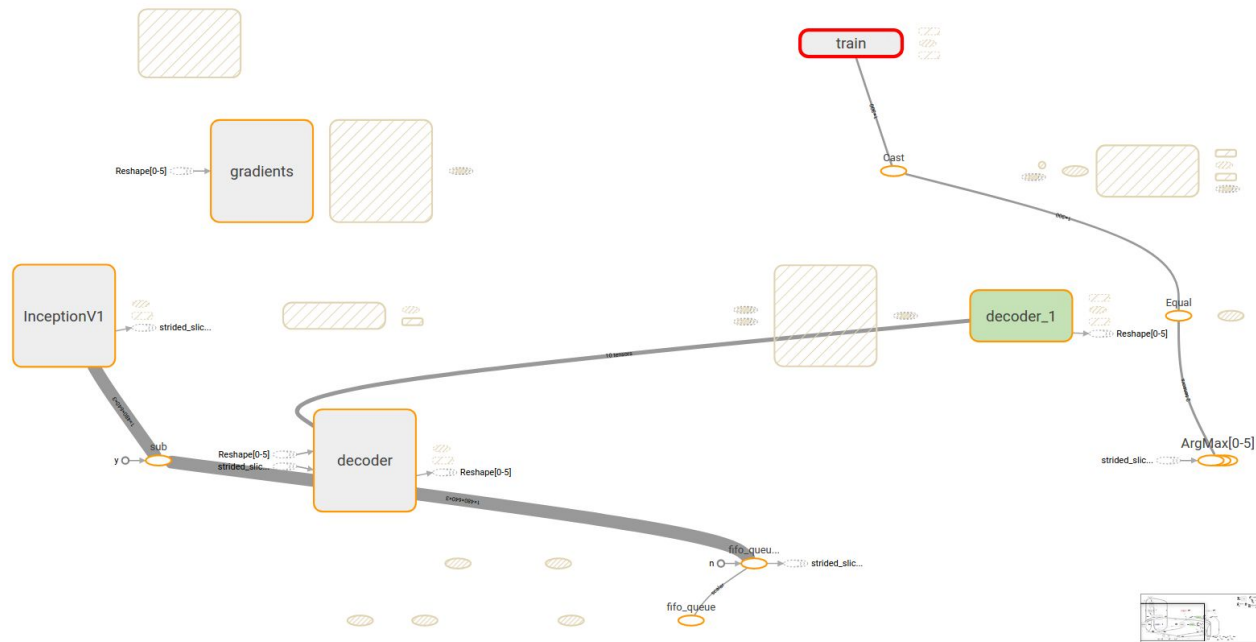
TENSOR FLOW MODEL GRAPH (I/II)



ONE STEP FURTHER



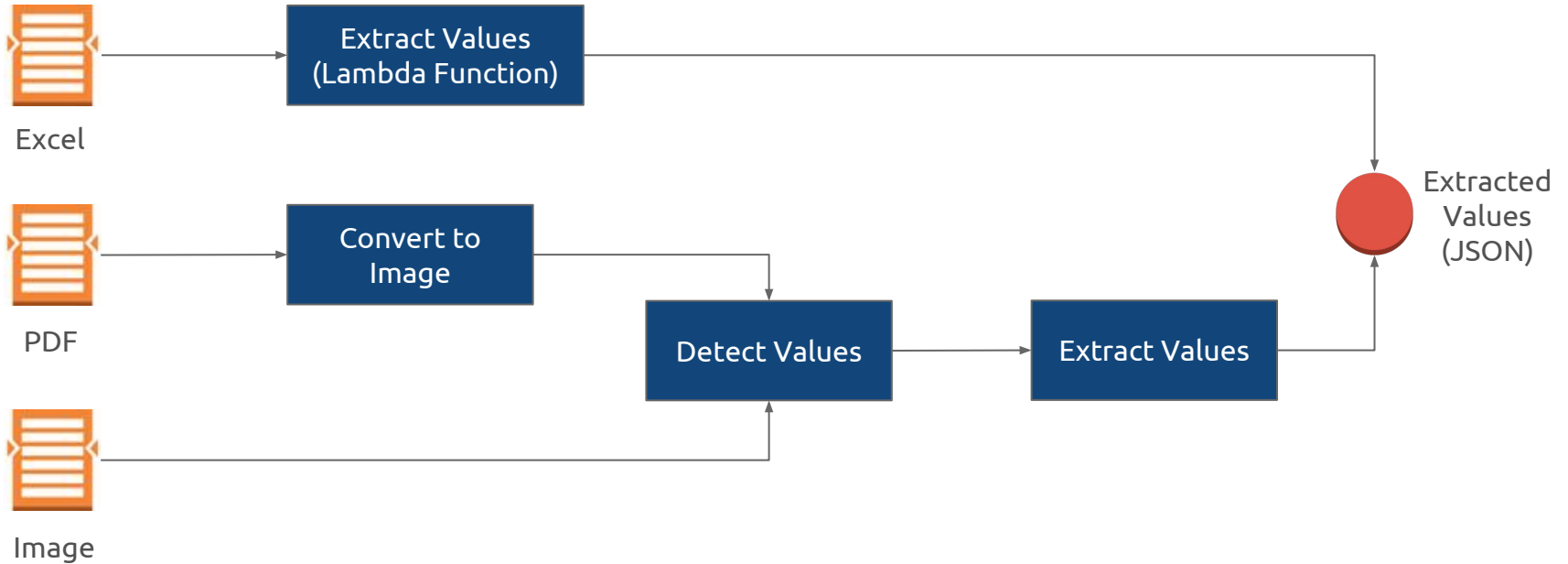
TENSOR FLOW MODEL GRAPH (II/II)



ONE STEP FURTHER



END-TO-END PROCESS



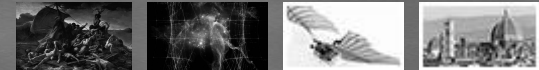
ONE STEP FURTHER



OBJECT DETECTION - WORKFLOW



ONE STEP FURTHER



OBJECT DETECTION - OUTPUT

Distribution Date: 27-Mar-2017

20-Mar-2017 02:17:05 PM

Class	CUSIP	Record Date	Certificate Pass-Through Rate
A-1	14453FAA7	03/24/2017	0.80833 %
A-2	14453FAB5	03/24/2017	0.86833 %
A-3	14453FAC3	03/24/2017	0.92833 %
A-4	14453FAD1	03/24/2017	1.01833 %
M-1	14453FAE9	03/24/2017	1.04833 %
M-2	14453FAF6	03/24/2017	1.06833 %
M-3	14453FAG4	03/24/2017	1.08833 %
M-4	14453FAH2	03/24/2017	1.12833 %
M-5	14453FAJ8	03/24/2017	1.15833 %
M-6	14453FAK5	03/24/2017	1.21833 %
M-7	14453FAL3	03/24/2017	1.62833 %
M-8	14453FAM1	03/24/2017	1.77833 %
M-9	14453FAN9	03/24/2017	2.62833 %
M-10	14453FAP4	03/24/2017	3.27833 %
CE	14453FAQ2	02/28/2017	0.00000 %
P	14453FAR0	02/28/2017	0.00000 %
R-I	14453FAS8	02/28/2017	0.00000 %
R-II	14453FAT6	02/28/2017	0.00000 %
Totals			

This report is compiled by:

All Record Dates are based upon the governing documents and logic set forth as of closing

NOTE: On April 4, 2007 details.

NOTE: Distributions include certain amounts received in respect of claims filed on behalf



Distribution Date: 27-Mar-2017

20-Mar-2017 02:17:05 PM

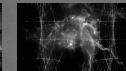
Class	CUSIP	Record Date	Certificate Pass-Through Rate
A-1	14453FAA7	03/24/2017	0.80833 %
A-2	14453FAB5	03/24/2017	0.86833 %
A-3	14453FAC3	03/24/2017	0.92833 %
A-4	14453FAD1	03/24/2017	1.01833 %
M-1	14453FAE9	03/24/2017	1.04833 %
M-2	14453FAF6	03/24/2017	1.06833 %
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M-9	14453FAN9	03/24/2017	2.62833 %
M-10	14453FAP4	03/24/2017	3.27833 %
CE	14453FAQ2	02/28/2017	0.00000 %
P	14453FAR0	02/28/2017	0.00000 %
R-I	14453FAS8	02/28/2017	0.00000 %
R-II	14453FAT6	02/28/2017	0.00000 %
Totals			

This report is compiled by:

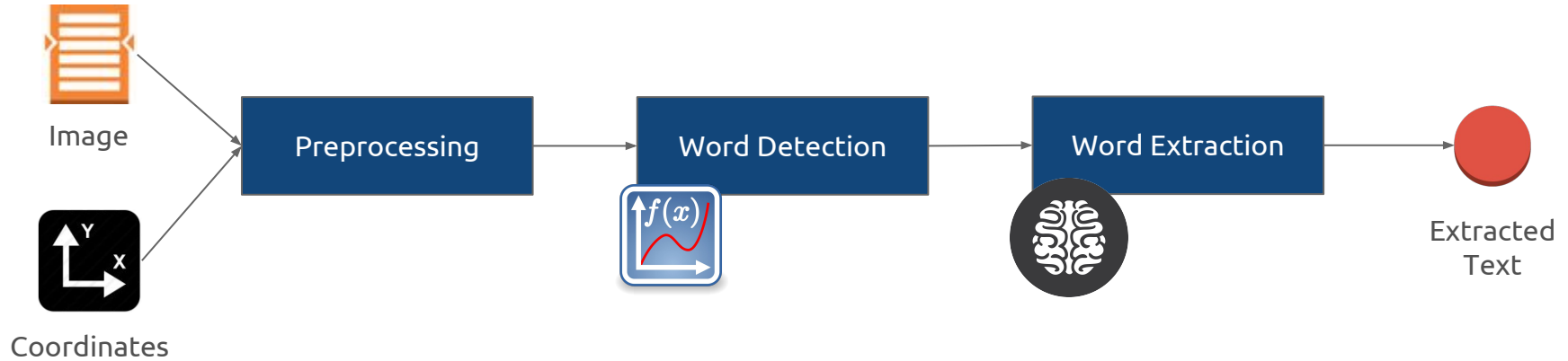
All Record Dates are based upon the governing documents and logic set forth as of closing

NOTE: On April 4, 2007 details.

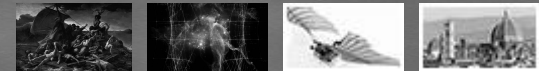
NOTE: Distributions include certain amounts received in respect of claims filed on behalf



OPTICAL CHARACTER RECOGNITION (OCR) - WORKFLOW



ONE STEP FURTHER



OPTICAL CHARACTER RECOGNITION (OCR) - OUTPUT

Distribution Date: 27-Mar-2017

20-Mar-2017 02:17:05 PM

Class	CUSIP	Record Date	Certificate Pass-Through Rate
A-1	14453FAA7	03/24/2017	0.80833 %
A-2	14453FAB5	03/24/2017	0.86833 %
A-3	14453FAC3	03/24/2017	0.92833 %
A-4	14453FAD1	03/24/2017	1.01833 %
M-1	14453FAE9	03/24/2017	1.04833 %
M-2	14453FAF6	03/24/2017	1.06833 %
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M-5	14453FAJ8	03/24/2017	1.15833 %
M-6	14453FAK5	03/24/2017	1.21833 %
M-7	14453FAL3	03/24/2017	1.62833 %
M-8	14453FAM1	03/24/2017	1.77833 %
M-9	14453FAN9	03/24/2017	2.62833 %
M-10	14453FAP4	03/24/2017	3.27833 %
CE	14453FAQ2	02/28/2017	0.00000 %
P	14453FAR0	02/28/2017	0.00000 %
R-1	14453FAS8	02/28/2017	0.00000 %
R-II	14453FAT6	02/28/2017	0.00000 %
Totals			

This report is compiled by:

All Record Dates are based upon the governing documents and logic set forth as of clos

NOTE: On April 4, 2007 details.

NOTE: Distributions include certain amounts received in respect of claims filed on behalf

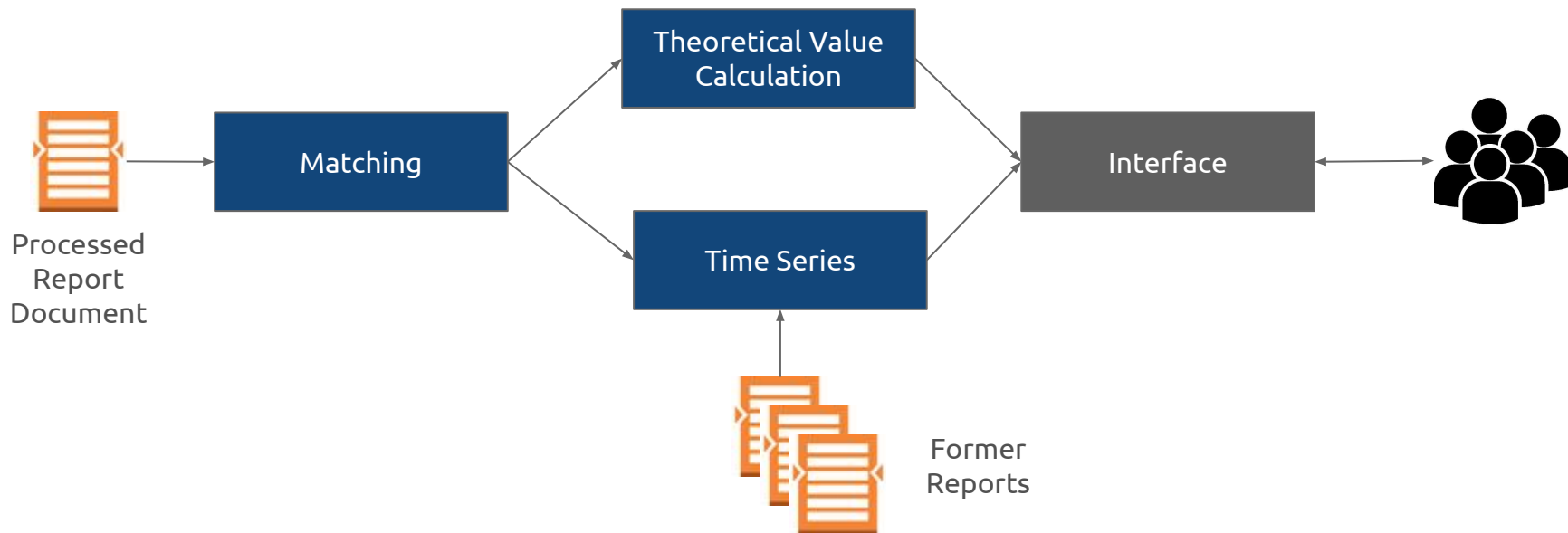


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  "14453FAB5",
  "14453FAC3",
  "14453FAD1",
  "14453FAE9",
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  "14453FAH2",
  "14453FAJ8",
  "14453FAK5",
  "14453FAL3",
  "14453FAM1",
  "14453FAN9",
  "14453FAP4",
  "14453FAQ2",
  "14453FAR0",
  "14453FAS8",
  "14453FAT6"
],
```

```
"Ending Tranche Balance":
  "14612693.71",
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PROCESSING THE EXTRACTED VALUES



ONE STEP FURTHER

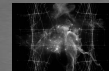


“ Only the *artist*, not the fool,
discovers that which nature hides .”

Filippo Brunelleschi



ONE STEP FURTHER



THANK YOU.

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“ With the brush we merely tint, while *imagination* alone produces color. ”
-Théodore Géricault

