

ThoughtWorks®

# DEEPLARNING.SCALA 面向程序员的开源深度学习框架的思考与实践

---

*By Yang Bo and Wang Xiaolei at ThoughtWorks*



# 关于我



史凯/凯哥

ThoughtWorks

Head of Data&AI



超过15年企业战略咨询及架构实施经验，曾任顶级咨询公司总监，科技

服务公司合伙人兼CTO

曾为众多大型企业提供流程再造、IT规划、ERP系统实施、云计算、大

数据平台架构实施服务，目前专注在数据和人工智能领域，用数字化技



---

# OUTLINE

---

- About ThoughtWorks Intelligent Empowerment Service
- Why DeepLearning.scala
- Neural Network is Functional Programming
- Monadic Deep Learning
- Expression Problem in Deep Learning



ThoughtWorks®

# INTELLIGENT EMPOWERMENT



# OUR HOLISTIC APPROACH TO INTELLIGENT EMPOWERMENT



**DATA STRATEGY**

Uncovering data opportunities and guiding the vision for transformation organizations to become data-led



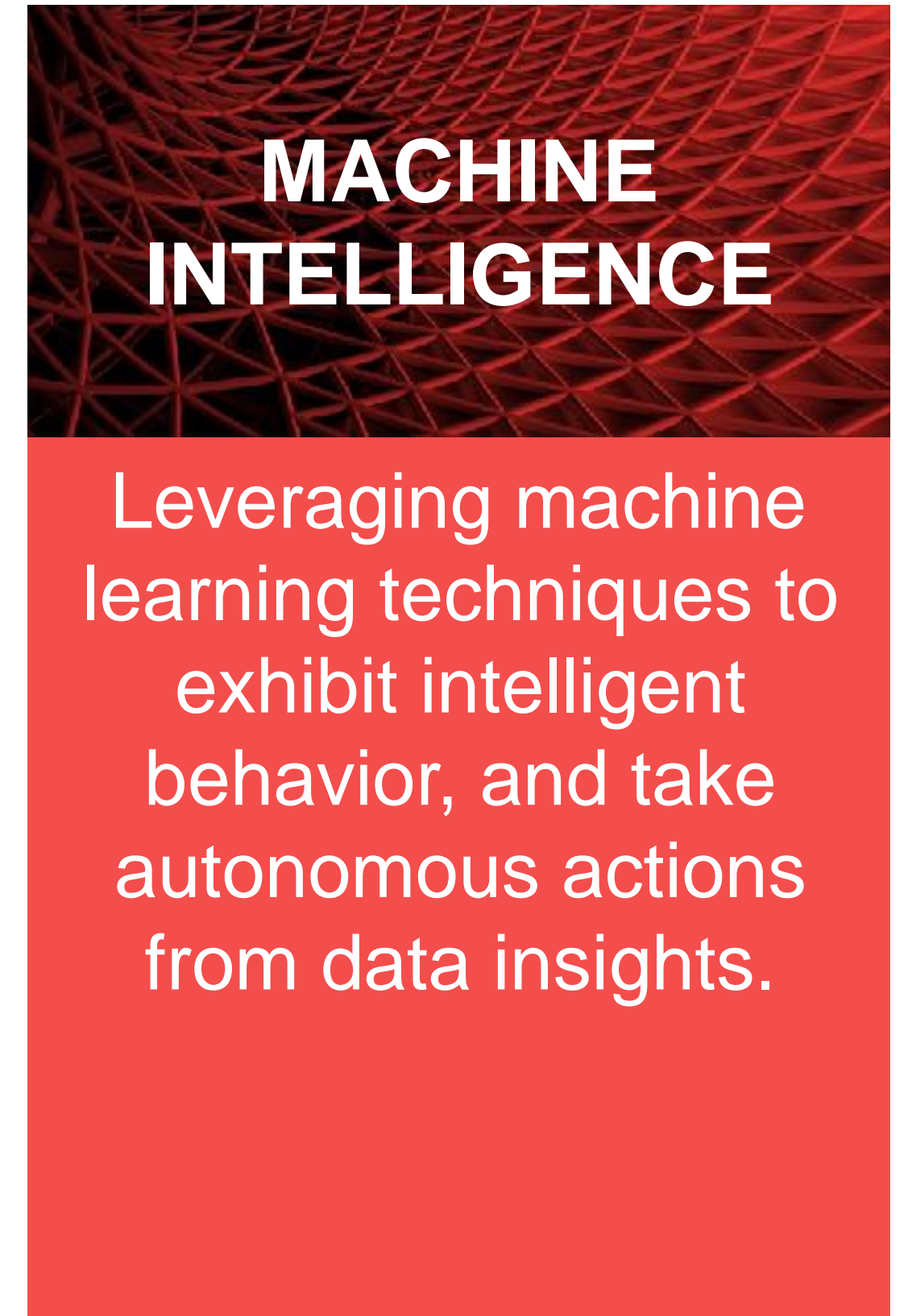
**DATA PLATFORM ENGINEERING**

Ability to design and build data platforms, collecting, streaming and managing enterprise-wide data, ready for analysis



**DATA INSIGHTS**

Gain insights from data to inform decision making, including descriptive and diagnostic analytics.



**MACHINE INTELLIGENCE**

Leveraging machine learning techniques to exhibit intelligent behavior, and take autonomous actions from data insights.

## SOFTWARE EXCELLENCE AND PRODUCT THINKING



# APPLICATION OF INTELLIGENT EMPOWERMENT TO MEET BUSINESS NEEDS

## EMPOWERED BUSINESSES:

- Pricing Strategies
- Risk & Compliance
- Fraud Detection
- Supply Chain Optimisation
- Demand Forecasting
- Anomaly Detection
- Predictive Maintenance
- Staff Scheduling
- Aircraft Scheduling
- Operations/Logistics Optimisation

## EMPOWERED CUSTOMERS:

- Conversational Commerce
- Hyper-Personalisation
- Recommendation Engines
- Image Search
- Customer Support
- Language Translation
- Voice Control

## EMPOWERED EMPLOYEES:

- Document Classification
- Trend Analysis
- Process Automation
- Forecasting
- Image Classification
- Predictive Analytics
- Speech Recognition
- Information Summarisation
- Natural Language Analytics
- Sentiment Analysis



# WE MAKE IT REAL

DATA SCIENCE AND MACHINE LEARNING  
ARE EASY TO START IN THE LAB...

We *operationalize* these  
techniques with *software excellence*

ACCESS TO ALGORITHMS  
IS DEMOCRATIZED...

*Choosing the right one*  
is a sought-after skill

STORAGE AND COMPUTING  
ARE A COMMODITY...

*Effective data & platform*  
*strategy* is anything but



# Why are Data Science and Machine Learning Projects special? (I/II)

---

## Software Development Project

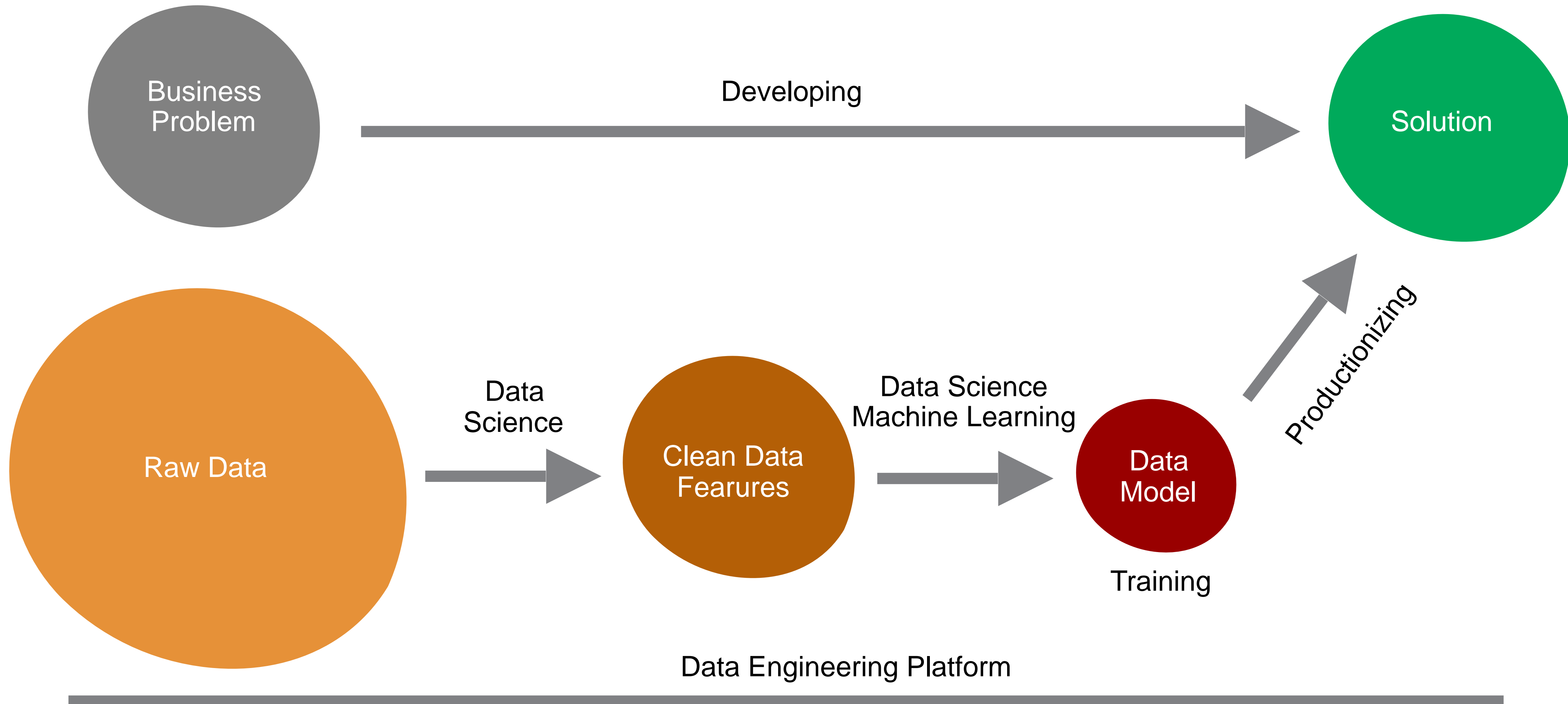




# Why are Data Science and Machine Learning Projects special? (II/II)

---

## Data Science and Machine Learning Project





# 人工智能领域工程能力 最强的团队

*CIES@ThoughtWorks*



**杨博 (Yang Bo)**

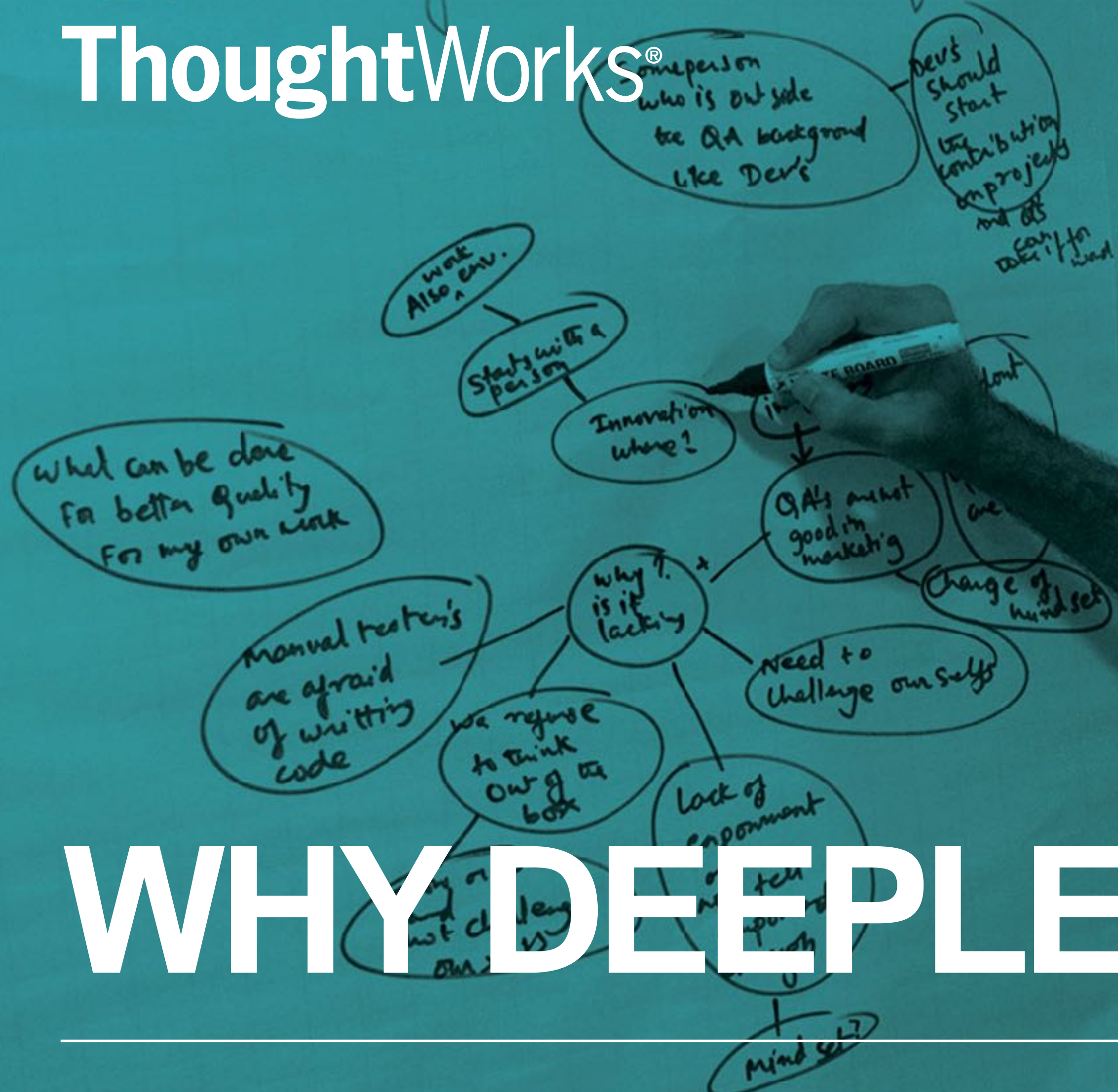
ThoughtWorks  
Consultant





ThoughtWorks®

In testing tools & techniques



# WHY DEEPLY LEARNING.SCALA



---

# WHAT'S GOOD IN BIG DATA ECOSYSTEM?

---





---

# WHAT'S GOOD IN BIG DATA ECOSYSTEM?

---



- **Static Type System**



---

# WHAT'S GOOD IN BIG DATA ECOSYSTEM?

---



- **Static Type System**
- **Functional Programming**



---

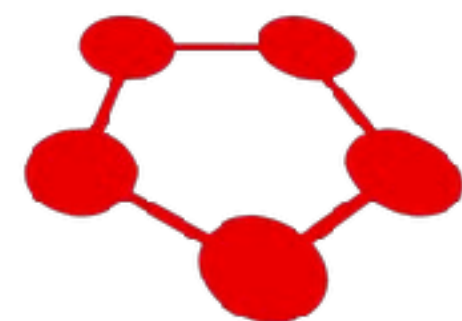
# WHAT'S GOOD IN DEEP LEARNING FRAMEWORKS?

---



theano

**PYTORCH**



Chainer



---

# WHAT'S GOOD IN DEEP LEARNING FRAMEWORKS?

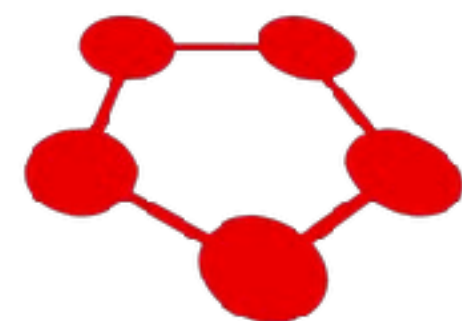
---



theano

- **Internal DSL**

PYTORCH



Chainer



---

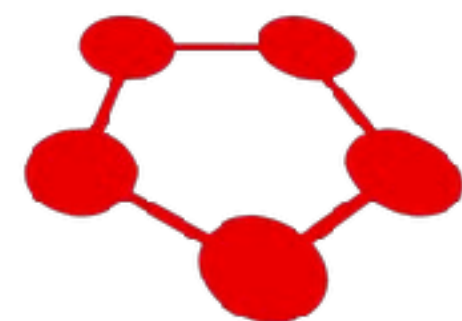
# WHAT'S GOOD IN DEEP LEARNING FRAMEWORKS?

---



theano

PYTORCH



Chainer

- **Internal DSL**
- **Automatic Differentiation**



---

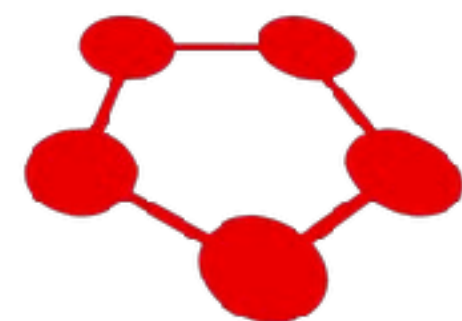
# WHAT'S GOOD IN DEEP LEARNING FRAMEWORKS?

---



theano

PYTORCH



Chainer

- **Internal DSL**
- **Automatic Differentiation**
- **Dynamic Neural Network**



---

# WHAT'S GOOD IN DEEP LEARNING FRAMEWORKS?

---



---

# WHAT'S GOOD IN DEEP LEARNING FRAMEWORKS?

---

- **Static Type System**
- **Functional Programming**

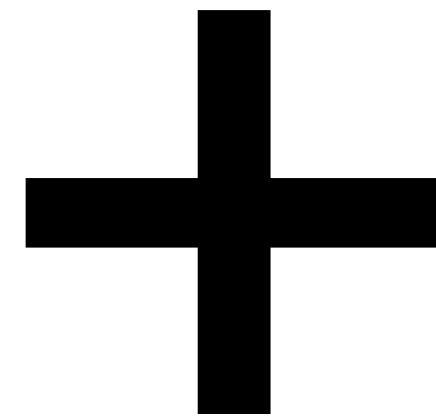


---

# WHAT'S GOOD IN DEEP LEARNING FRAMEWORKS?

---

- **Static Type System**
- **Functional Programming**



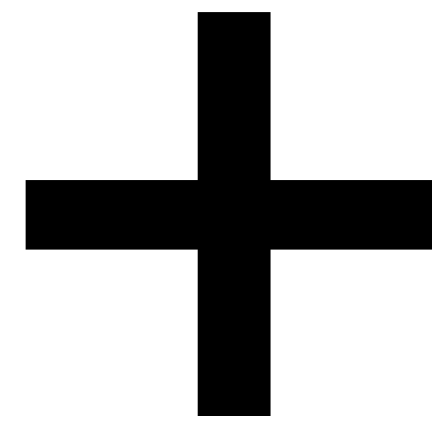


---

# WHAT'S GOOD IN DEEP LEARNING FRAMEWORKS?

---

- **Static Type System**
- **Functional Programming**



- **Internal DSL**
- **Automatic Differentiation**
- **Dynamic Neural Network**

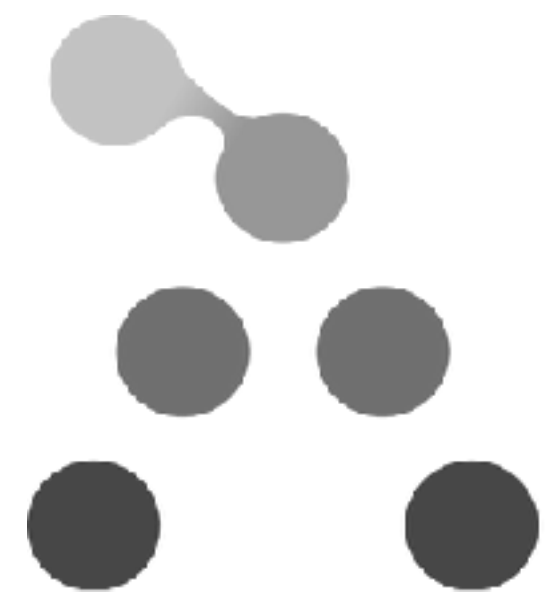


---

# WHAT'S GOOD IN DEEP LEARNING FRAMEWORKS?

---

- **Static Type System**
  - **Functional Programming**
- +**
- **Internal DSL**
  - **Automatic Differentiation**
  - **Dynamic Neural Network**



**DeepLearning**.scala



---

# WHY DEEPLARNING.SCALA

---

**Static Type  
System**

**Functional  
Programming**

**Internal DSL**

**Automatic  
Differentiation**

**Dynamic Neural  
Network**



---

# WHY DEEPLARNING.SCALA

---

	Static Type System	Functional Programming	Internal DSL	Automatic Differentiation	Dynamic Neural Network
Theano	No	No	Yes	symbolic differentiation	No

---

# WHY DEEPLARNING.SCALA

---

	Static Type System	Functional Programming	Internal DSL	Automatic Differentiation	Dynamic Neural Network
Theano	No	No	Yes	symbolic differentiation	No
TensorFlow	No	No	No	No	No



---

# WHY DEEPLARNING.SCALA

---

	Static Type System	Functional Programming	Internal DSL	Automatic Differentiation	Dynamic Neural Network
Theano	No	No	Yes	symbolic differentiation	No
TensorFlow	No	No	No	No	No
TensorFlow Fold	No	No	No	No	Yes

---

# WHY DEEPLARNING.SCALA

---

	Static Type System	Functional Programming	Internal DSL	Automatic Differentiation	Dynamic Neural Network
Theano	No	No	Yes	symbolic differentiation	No
TensorFlow	No	No	No	No	No
TensorFlow Fold	No	No	No	No	Yes
TensorFlow Eager Execution	No	No	Yes	Yes	Yes



---

# WHY DEEPLARNING.SCALA

---

	Static Type System	Functional Programming	Internal DSL	Automatic Differentiation	Dynamic Neural Network
Theano	No	No	Yes	symbolic differentiation	No
TensorFlow	No	No	No	No	No
TensorFlow Fold	No	No	No	No	Yes
TensorFlow Eager Execution	No	No	Yes	Yes	Yes
Chainer	No	No	Yes	Yes	Yes

---

# WHY DEEPLARNING.SCALA

---

	Static Type System	Functional Programming	Internal DSL	Automatic Differentiation	Dynamic Neural Network
Theano	No	No	Yes	symbolic differentiation	No
TensorFlow	No	No	No	No	No
TensorFlow Fold	No	No	No	No	Yes
TensorFlow Eager Execution	No	No	Yes	Yes	Yes
Chainer	No	No	Yes	Yes	Yes
Torch & PyTorch	No	No	Yes	Yes	Yes



---

# WHY DEEPLARNING.SCALA

---

	Static Type System	Functional Programming	Internal DSL	Automatic Differentiation	Dynamic Neural Network
Theano	No	No	Yes	symbolic differentiation	No
TensorFlow	No	No	No	No	No
TensorFlow Fold	No	No	No	No	Yes
TensorFlow Eager Execution	No	No	Yes	Yes	Yes
Chainer	No	No	Yes	Yes	Yes
Torch & PyTorch	No	No	Yes	Yes	Yes
DeepLearning4j	Yes	No	No	No	No

---

# WHY DEEPLARNING.SCALA

---

	Static Type System	Functional Programming	Internal DSL	Automatic Differentiation	Dynamic Neural Network
Theano	No	No	Yes	symbolic differentiation	No
TensorFlow	No	No	No	No	No
TensorFlow Fold	No	No	No	No	Yes
TensorFlow Eager Execution	No	No	Yes	Yes	Yes
Chainer	No	No	Yes	Yes	Yes
Torch & PyTorch	No	No	Yes	Yes	Yes
DeepLearning4j	Yes	No	No	No	No
BigDL	Yes	No	No	No	No



---

# WHY DEEPLARNING.SCALA

---

	Static Type System	Functional Programming	Internal DSL	Automatic Differentiation	Dynamic Neural Network
Theano	No	No	Yes	symbolic differentiation	No
TensorFlow	No	No	No	No	No
TensorFlow Fold	No	No	No	No	Yes
TensorFlow Eager Execution	No	No	Yes	Yes	Yes
Chainer	No	No	Yes	Yes	Yes
Torch & PyTorch	No	No	Yes	Yes	Yes
DeepLearning4j	Yes	No	No	No	No
BigDL	Yes	No	No	No	No
DeepLearning.scala	Yes	Yes	Yes	Yes	Yes

# ARCHITECTURE OF DEEPLARNING.SCALA 2.0

