工业互联网产业联盟
Alliance of Industrial Internet

Artificial Intelligence Apps in IIOT

-By Zhu Weilie， CIO of China Huaneng Group Co.

Self-introduction

工业互联网产业联盟
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- Chief Information Officer of the China Huaneng Group co.
- Receiver the state council special allowance.
- Contributing Vice Chairman of China Information Industry Association
- Executive director of China Computer Society
- Chairman of IIOT and Big Data Application Association

Education Background

- BA in Gas Turbine, School of Thermal Engineering at Tsinghua University
- MS in Thermal turbines, School of Thermal Engineering at Tsinghua University
- MBA, Business School of Tsinghua University

Working Experience

China Huaneng(CHG)：

■ 13-year experience in electricity production, construction, planning and operation management.

■ 15-year experience in IT management

Chinese Academy of Sciences

■3-year experience in technology research

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Development of CHG IIOT program

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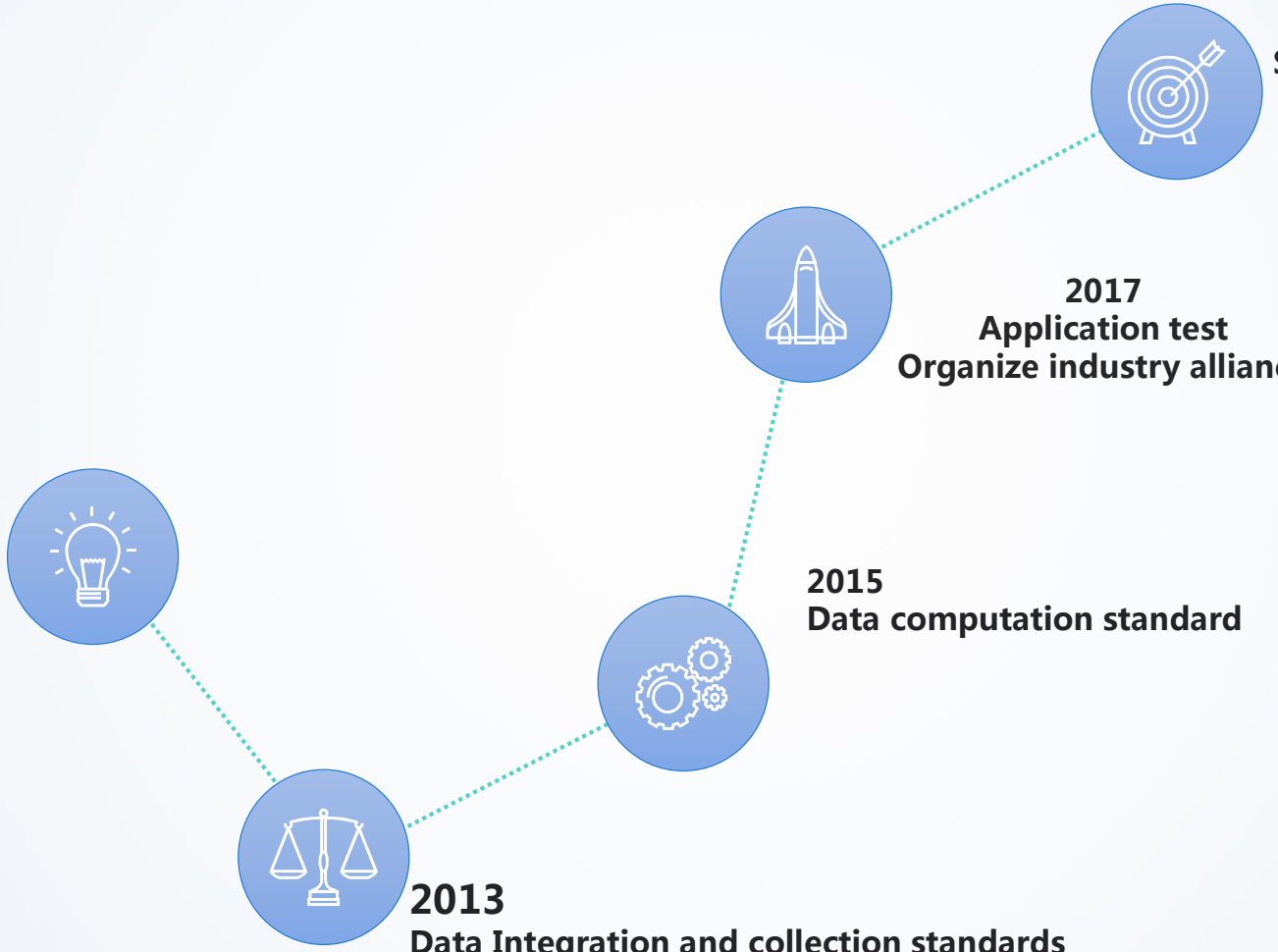


2012
Early exploration in Big Data Application

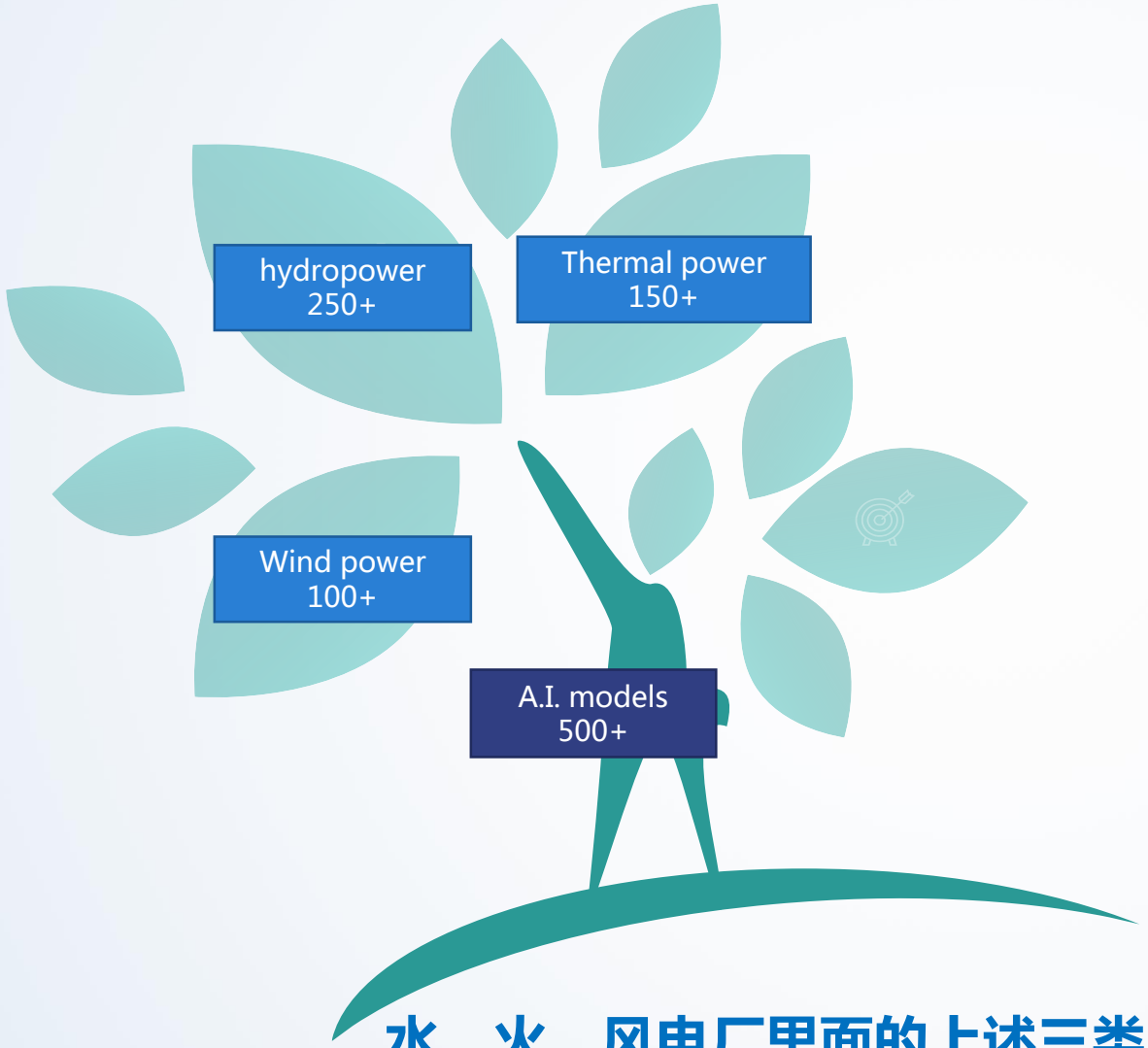
2013
Data Integration and collection standards

2015
Data computation standard

2017
Application test
Organize industry alliance

2018年
Smart industry +Eco system construction

Developed Apps



reliability
(anomaly detection，root cause)

Economic operation
(optimization)

Challenge from factory
(base on demend)

水、火、风电厂里面的上述三类问题，我们均用AI加以解决
We solve all problems which above by using A.I.

Traditional

VS

A.I.

Low efficiency
High cost

1. Regular inspection
2. Regular maintenance
3. Manually examination

1. Use features
2. Precise maintenance
3. Reduce regular inspection

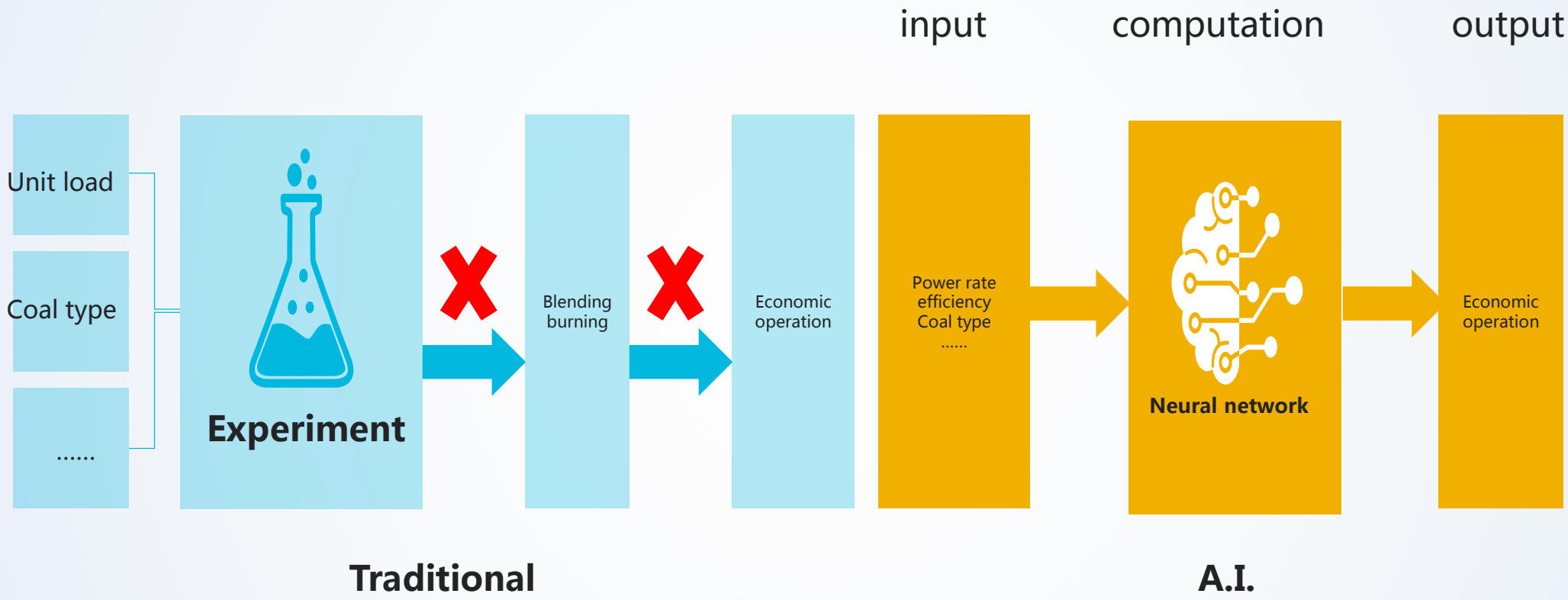
High efficiency
Low cost

Condition-based maintenance is always our goal. We make it true!

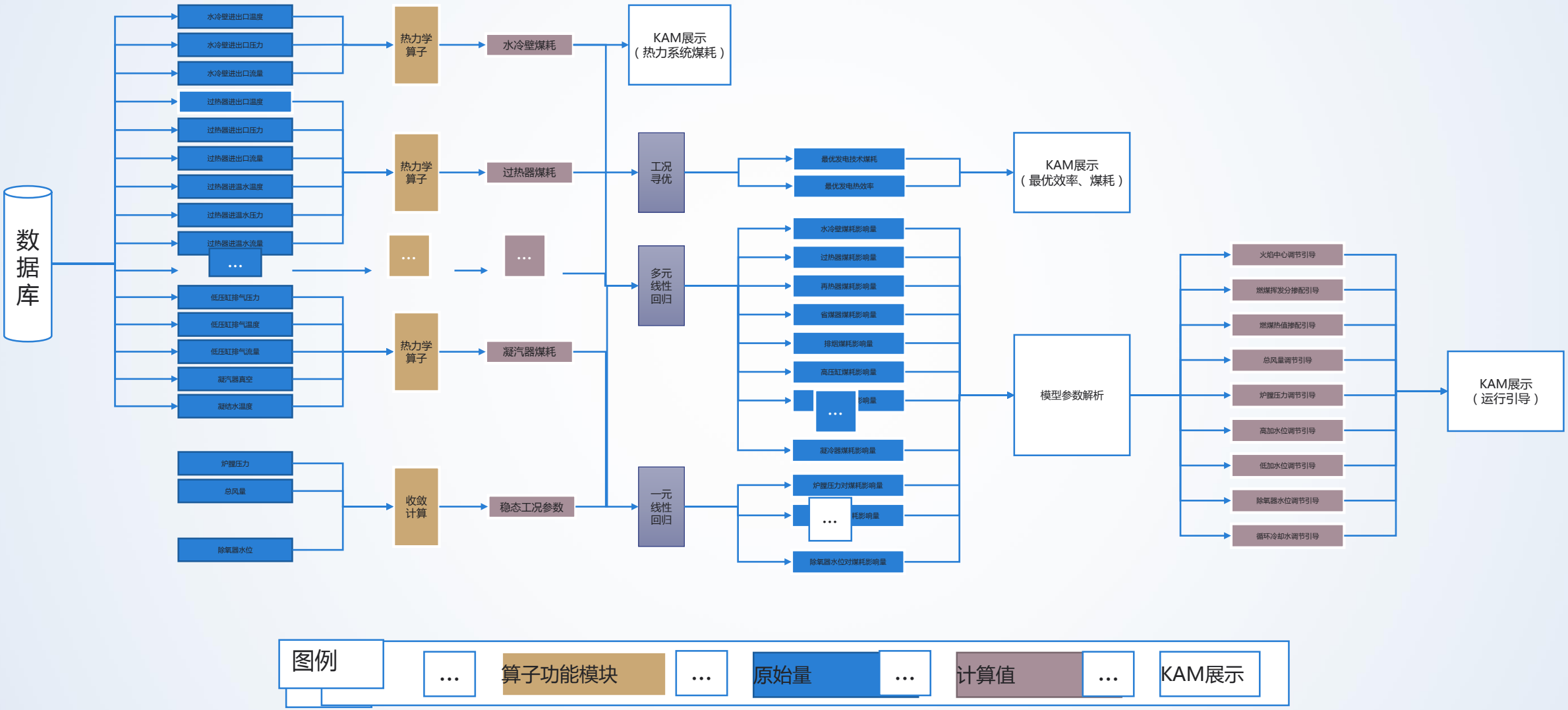
Hydropower unit lower frame vibration ramp rate

Hydropower unit health index evaluation system launched

- The features of top cover horizontal vibration and centrifugal force ramped up since Jun 6 2017, at the end of Sep the ramp rates were continuously rising.
- System sent out anomaly signal and failure warning


input
computation
output
Unit load
Coal type
.....
Experiment
Blending burning
Economic operation
Power rate efficiency Coal type .....
Neural network
Economic operation
Traditional
A.I.

Case —Using A.I. to guiding blending burning



Optimal operation algorithm flow chart

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Input parameters

发电技术煤耗
发电热效率
锅炉效率
汽机效率
煤热系数
省煤器煤耗
过热器煤耗
...
凝汽器煤耗
总风量
炉膛压力
高加水位
...
除氧器水位

Multivariate regression model

$$y = k_1x_1 + k_2x_2 + \ldots + k_{18}x_{18} + \varepsilon$$

Tuning parameters

模型参数解析

形成引导项

Guide chart

调整参数	引导方式
火焰中心（左右）	给出火焰水平位置调整方向
火焰中心（上下）	给出火焰高度调整方向及对整体煤耗的调节影响量
均热系数	给出煤种整体挥发分含量的调整方向及对整体煤耗的调节影响量
煤热系数	给出煤种整体热值的调整方向及对整体煤耗的调节影响量
总风量	给出炉膛总风量的调整方向及对整体煤耗的调节影响量
炉膛压力	给出炉膛压力的调整方向及对整体煤耗的调节影响量
高加水位	给出高加水位的调整方向及对整体煤耗的调节影响量
除氧器水位	给出除氧器水位的调整方向及对整体煤耗的调节影响量
低加水位	给出低加水位的调整方向及对整体煤耗的调节影响量
凝汽器循环冷却	给出循环冷却水的调整方向及对整体煤耗的调节影响量

Optimal operation system interface

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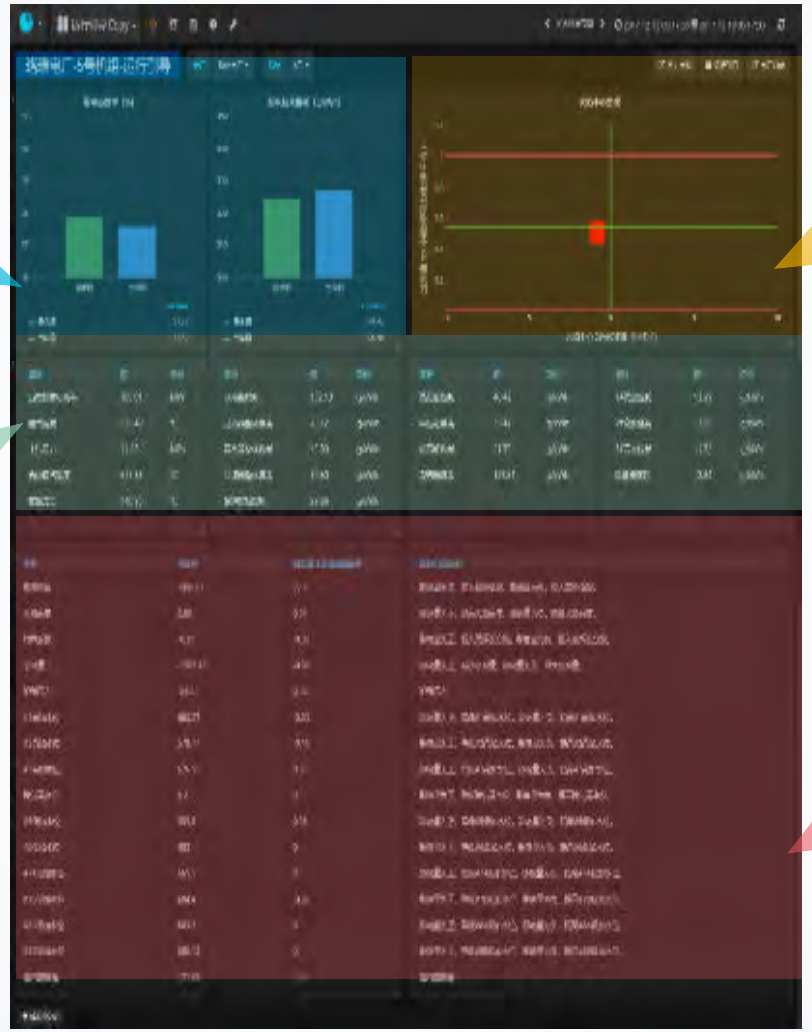
Coal consumption optimization

Flame center monitoring



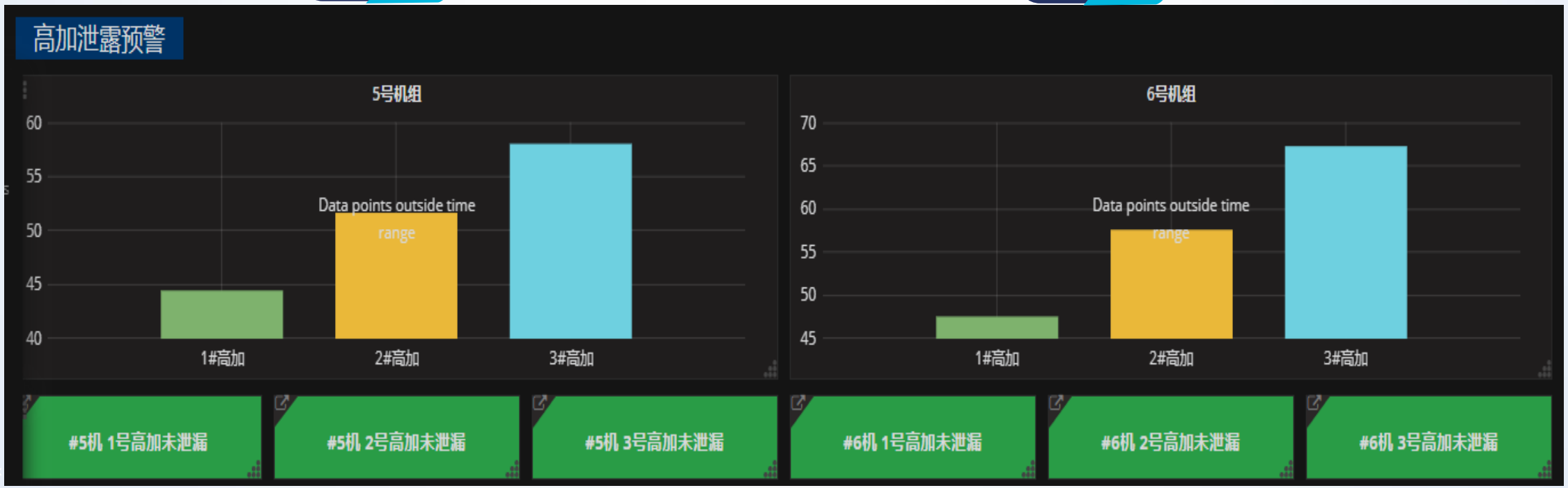
Operation monitoring

Operation guiding

Only notice when leaking above certain level

Model design：water level、water temperature、valve opening level

We can detect the deflect much early



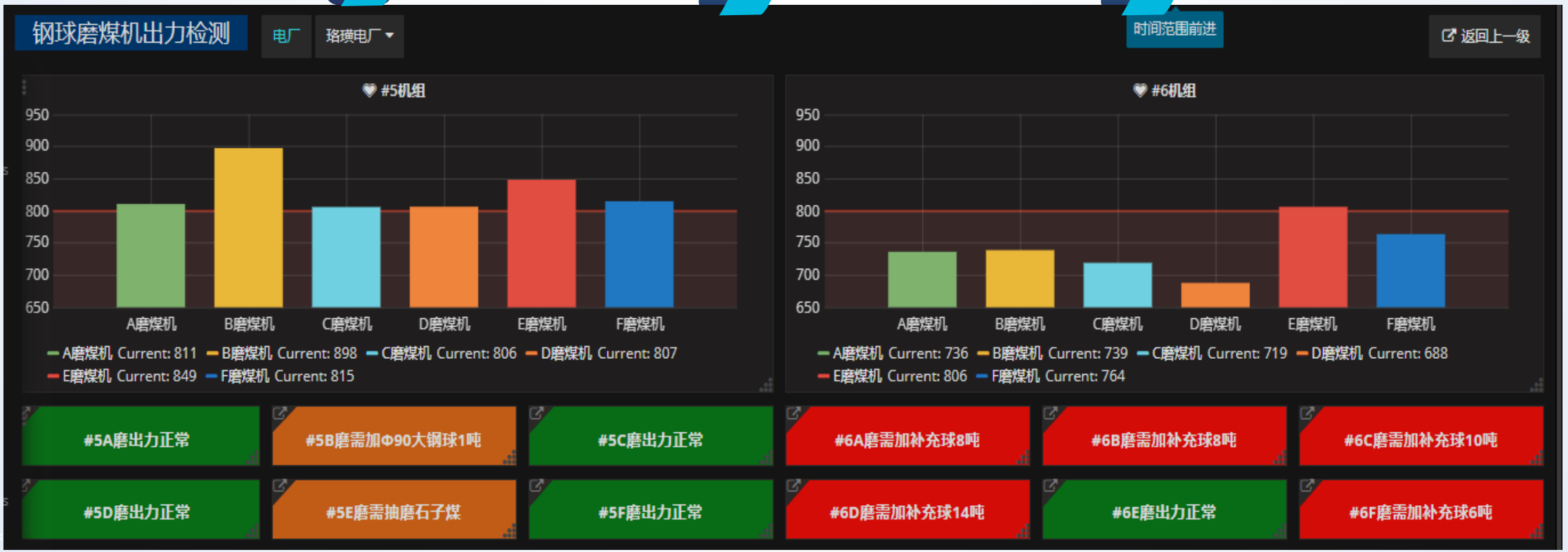
Case-Coal mill

If the coal mill output decrease, the coal fineness decrease, the unit load is too low for running

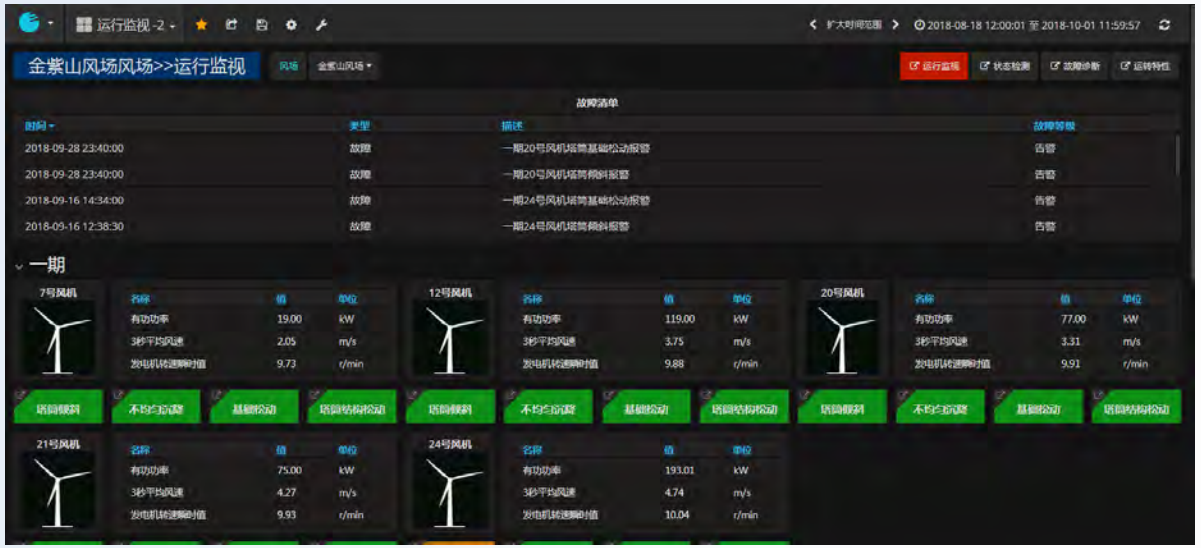
Model design :
Coal mill power rate, Coal mill output

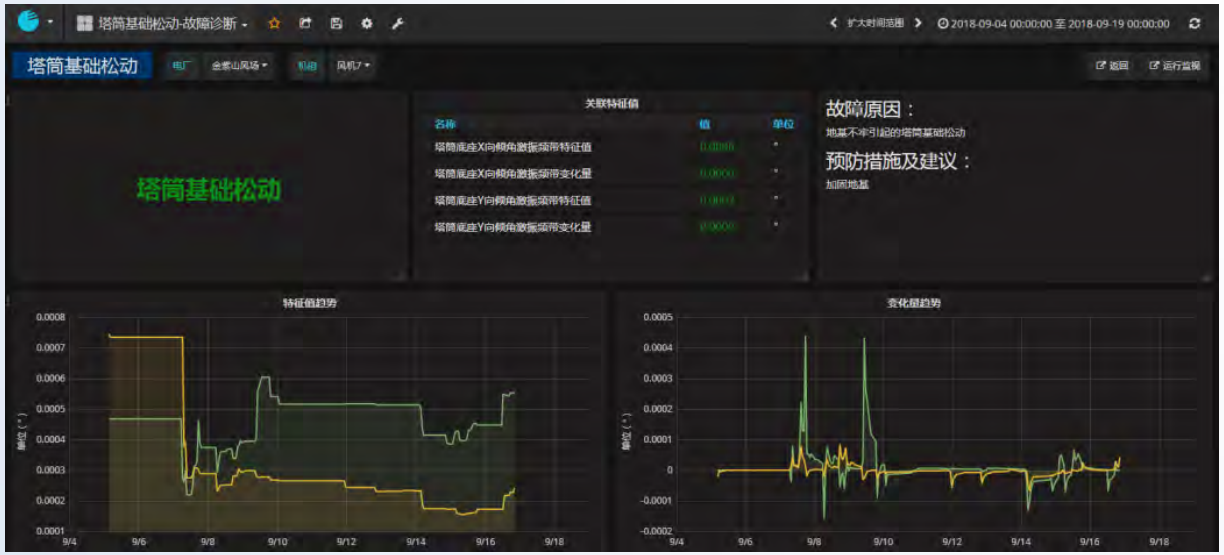
Optimizing:
Find the optimize point between coal mill output rate and steel ball adding rate

Make sure the unit load is above the minimum rate and the cost of adding steel ball is minimum



The new developed wind power Apps





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We have leading technology from the characteristic value of language and picture to the characteristic value of industry.

From measured value to the characteristic value

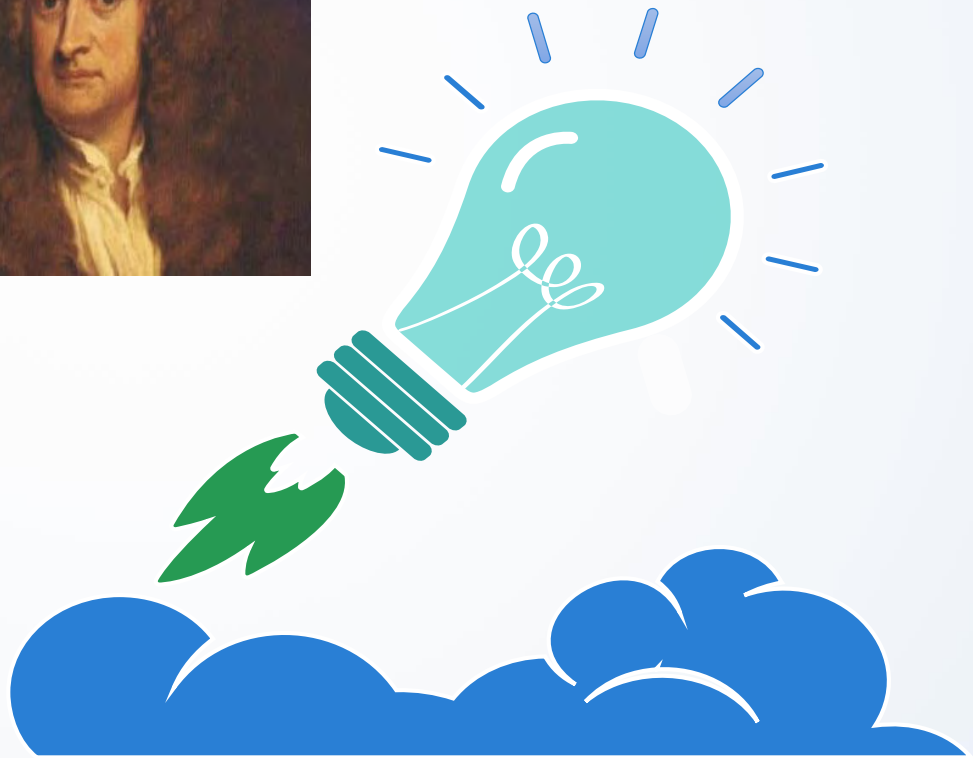
from phenomenon to essence

F=**M**a

R=U/I

Vehicle fuel consumption

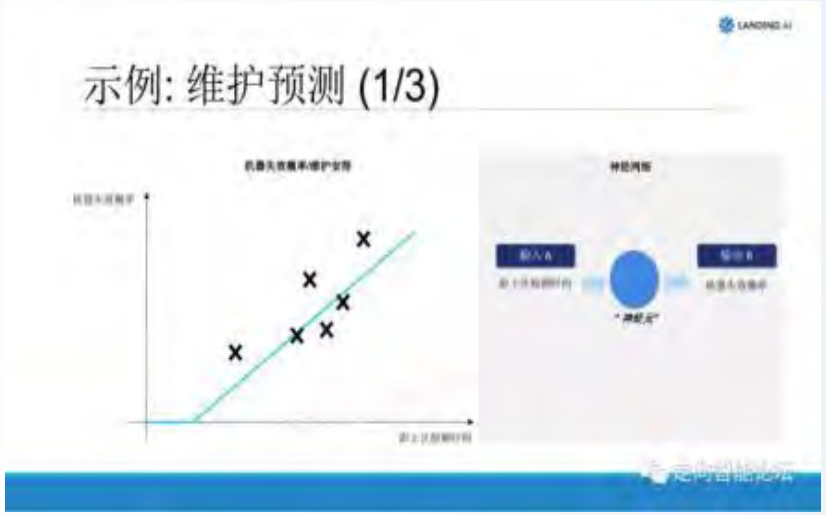
A.I. is not only can be us in identifying of voice and picture.



Detection of malfunction is personalized.

The detection rate of malfunctions shall be over 95%

The value of statistic can only solve the problems regarding re-designing and re-manufacture.



The ex-chief scientist of Baidu, Andrew NG, used machine learning to solve the problem regarding the maintenance of equipment, but his method can’ t solve the personalization problem.

We can diagnose malfunction on a personalized basis.

The traditional method and algorithm stays in the level of common questions, which can not detect malfunctions in reality.

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Location
Digital twin

Weather
Digital twin

Car assemble
Digital twin

transmission
Digital twin

Engine
Digital twin

Brake
Digital twin

Car body
Digital twin

Out source data

Smart transportation

Equipment data

(4) The high level A.I. app gain huge benefit

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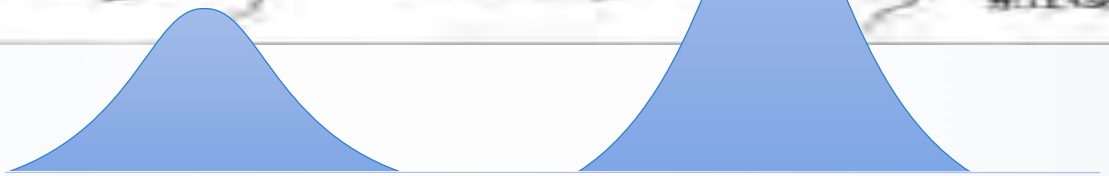
The cost of surplus water in Sichuan Province

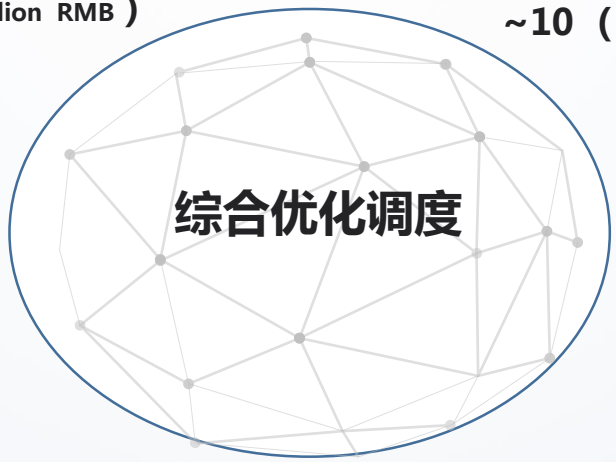


2014
9.68 (billion KWH)
~3 (billion RMB)

2020
35 (billion KWH)
~10 (billion RMB)

Carbon emission

electrovalence



Meteorological information

Control information

注：数据来源国家能源局《水电基地弃水问题驻点四川监管告》

Intelligence: the understanding to neural breaks up into 3 processes

1.Perception: picture, voice, sense, collect

Dragonfly, snake

2. Understanding: calculate, modeling, compare, judge

collect information: picture, temperature, odour

Perception: collect date through sensor, edge computing

3. Output: action, execute

dangerous ?
Run away?
food ?
eat?

predation

Understanding of AI: data modelling

Decision-making optimization

We break up the above process into 3 products

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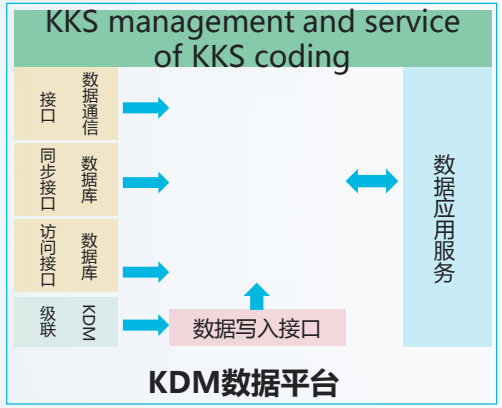
KDM
KKS Dynamic Data Management

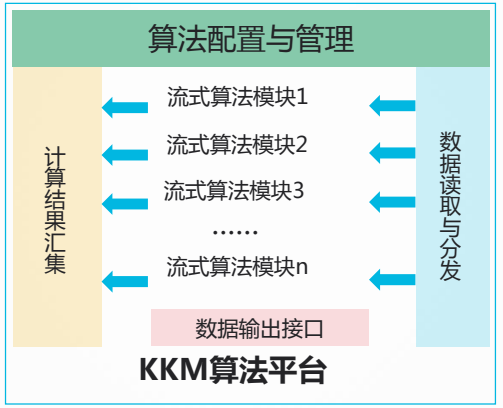
Perception



- 全息KKS数据编码体系
- 丰富的工业通信规约和数据库接口
- 内嵌增强型时序数据库
- 数据预处理和边缘计算
- WebServive数据服务接口

KKM
Key Knowledge Management

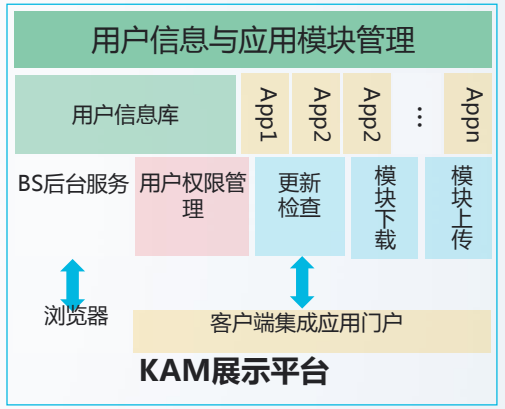
Understanding



- 模型构建与应用的开发和运行平台
- 流式计算引擎，在线实时运行
- 多种统计学习算法和计算模块
- 计算流程组态开发和运行环境
- WebService数据服务接口

KAM
Key Application Management

Decision-making



- HTML5展示页面的开发和运行平台
- 交互和展示KDM，KKM数据
- 基于图形控件的页面组态开发工具
- 多种规约的数据输出接口

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The future architecture of IIOT should be like galaxy

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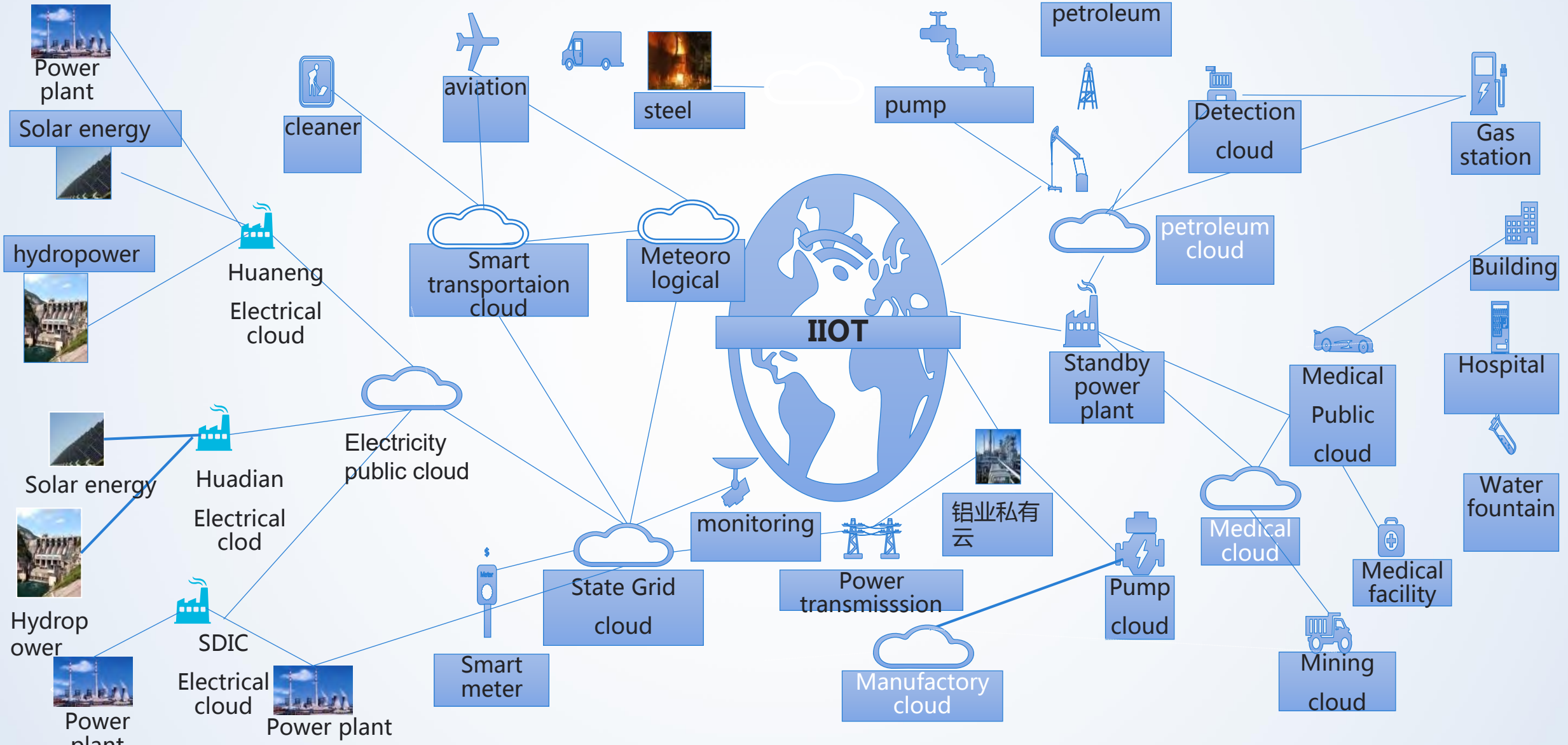
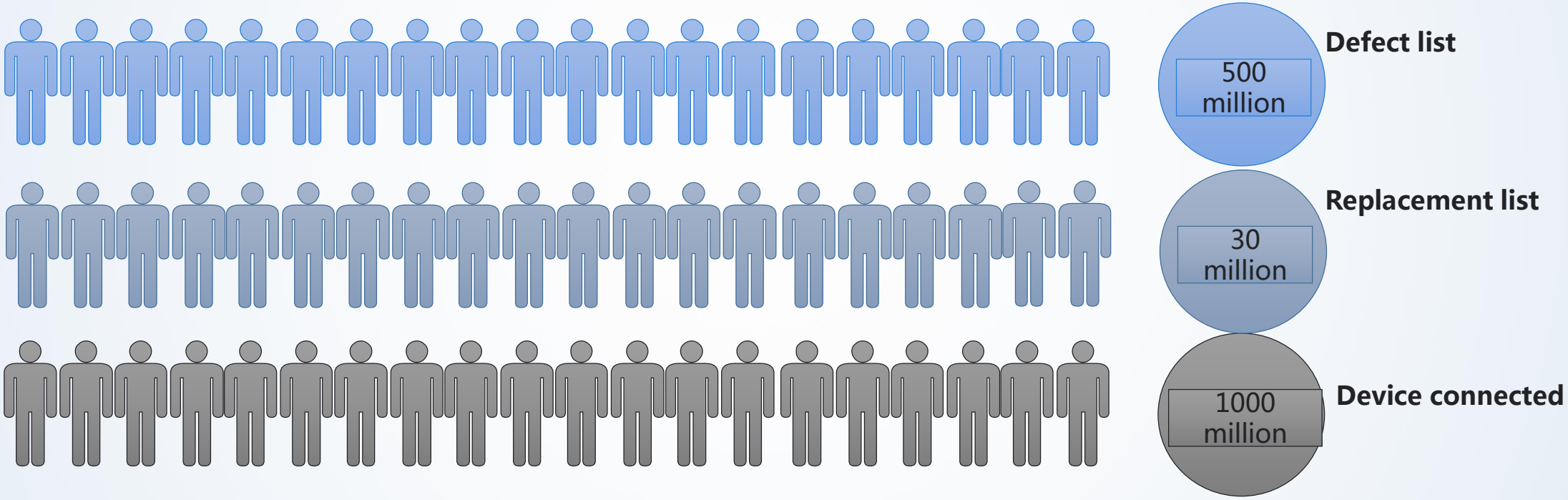


Huge volume data is not using



Unstructured data mining

Defect list、replacement list、 maintenance record

Model

Model verification

Using data from defect list, replacement list and maintenance record to verify model

structuralization

Text mining (Natural language processing)

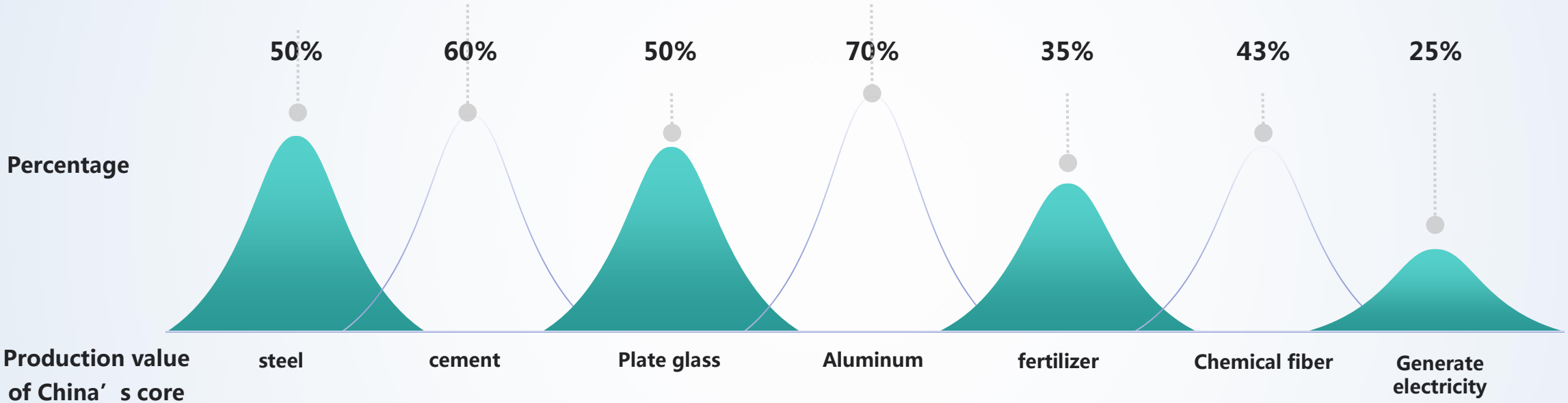
Model input

Defect library

Parameter tuning

Keep feeding operation data to tuning model parameter

Model library



The percentage of China’s flow enterprises compared with global production

AI starts in the flow enterprises, which is important in China

Intellectualization will optimize and restructure the ecology of industry

optimize design and maintenance

optimize the maintenance organization

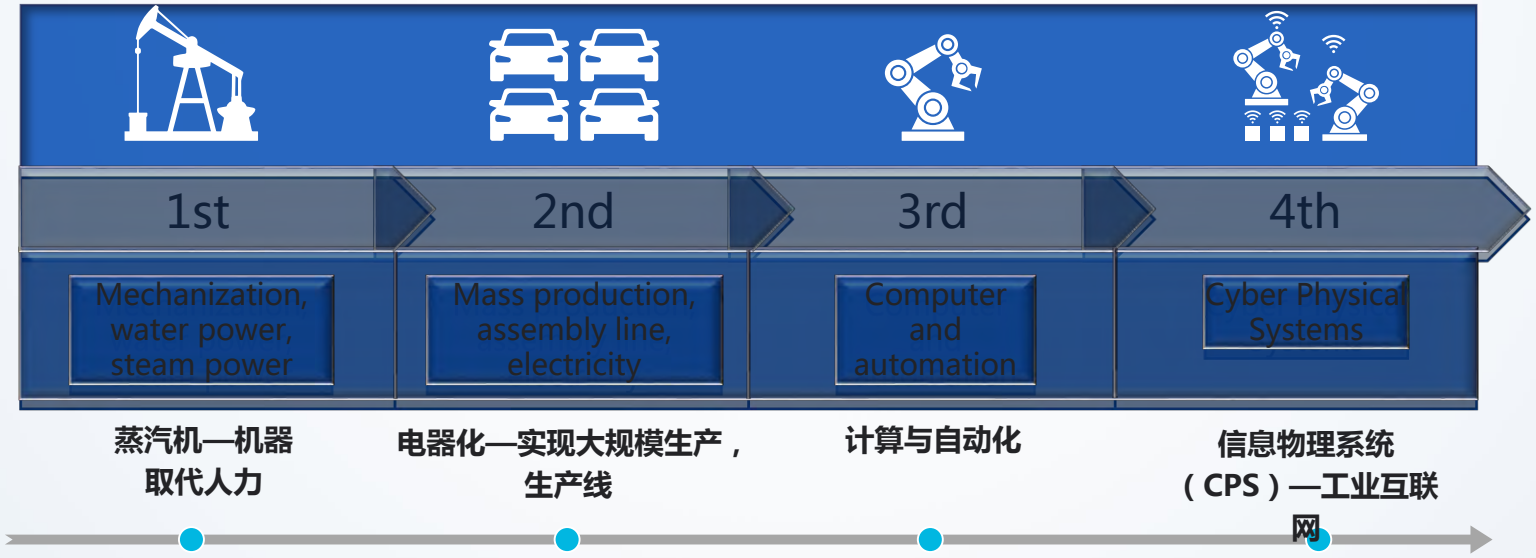
optimize supplement of materials and accessories, reduce inventory

optimize the insurance industry

restructure the ecology of manufacture

AI has passed the age of 1-3, which is the most different but most importance period, such period shall be completed by the industry.

The new generation of industrial internet shall extensively adopt the technology of AI



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共同把握工业互联网的历史机遇

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