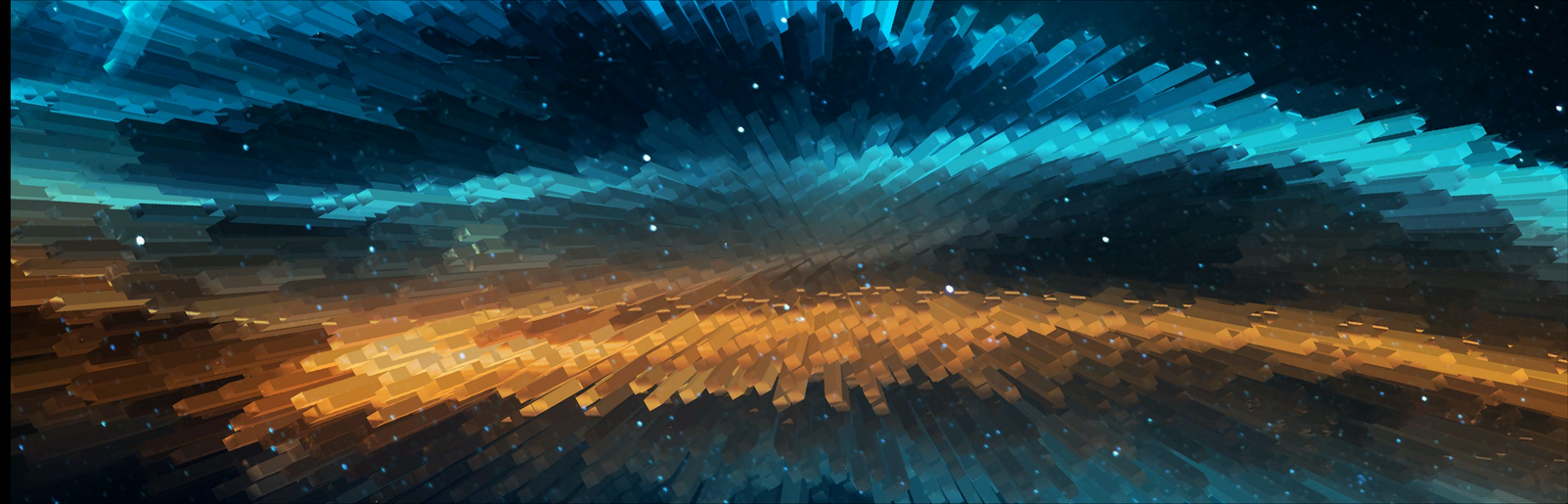
技术联想
驱动行业智能化变革

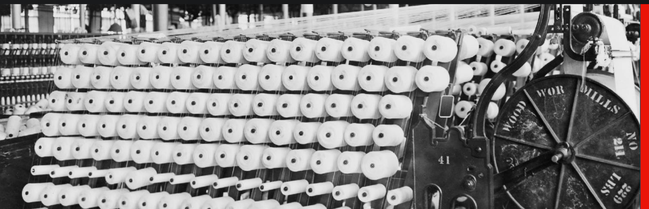
Tech-Powered Lenovo Drives
Intelligent Transformation



机械化时代
Age of Steam Engine
1760s-1840s

信息化时代
Age of Information
1950s-2000s

技术驱动行业变革的历史 Tech-Powered Industrial Revolution



1870s – 1910s
电气化时代
Age of Electricity

2010s-?
智能化时代
Age of Intelligence

智能物联网
Smart IoT


智能物联网：AR与计算机视觉技术
Smart IoT : AR & Computer Vision Technology

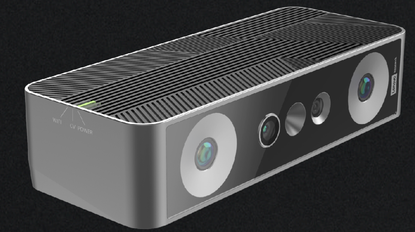
智能物联网：
AR与计算机视觉技术

Smart IoT:
AR & Computer
Vision Technology

晨星AR眼镜G2
daystAR G2

- 双目SLAM 6自由度定位与姿态估计
  Stereo SLAM and 6DoF Position Estimation
- 实时3D Mesh 建模
  Realtime 3D Mesh Reconstruction
- 三维弱纹理物体识别
  3D Feature-less Object Recognition

晨星3D视觉相机
daystAR 3D CV Camera



智能物联网：
AR与计算机视觉技术
Smart IoT: AR & Computer Vision Technology

- 双目SLAM 6自由度定位与姿态估计
  Stereo SLAM and 6DoF Position Estimation
- 实时3D Mesh 建模
  Realtime 3D Mesh Reconstruction
- 三维弱纹理物体识别
  3D Feature-less Object Recognition

智能基础架构
Smart Infrastructure

智能基础架构： AIOps智能运维技术

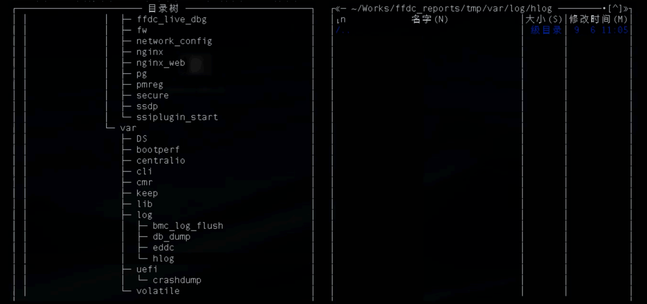
Smart Infrastructure : AIOps (Artificial Intelligence for IT Operations)

智能运维技术

Artificial Intelligence for IT Operations (AIOps)

数据中心AI赋能异常检测及故障定位

AI-driven Anomaly Detection & Fault Location in Data Center



百万行日志

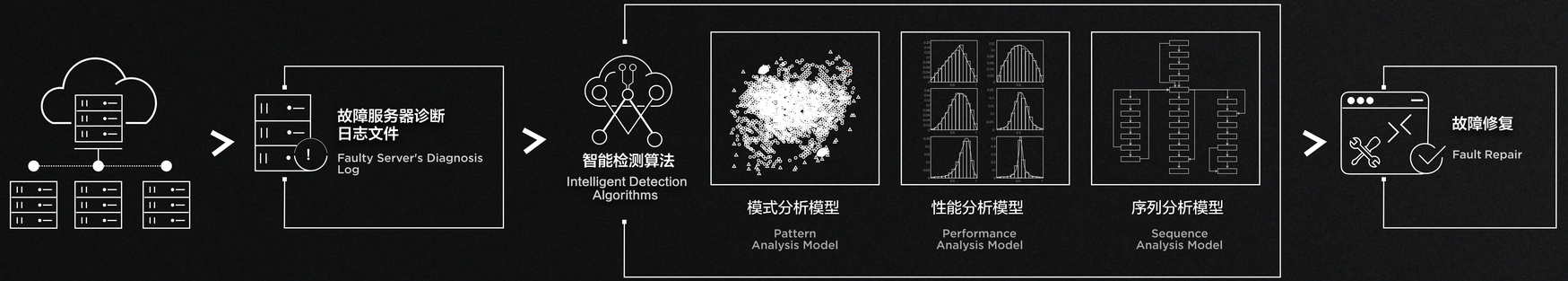
Millions of Log Lines

1个资深工程师X2天

1 Senior Engineer x 2 Days

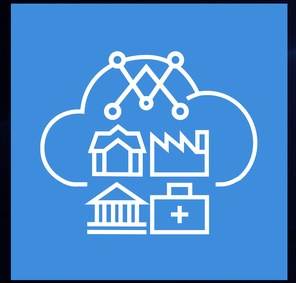
数据中心AI赋能异常检测及故障定位

AI-driven Anomaly Detection & Fault Location in Data Center



1个资深工程师X2天
1 Senior Engineer x 2 Days

1个普通工程师X2小时
1 Engineer x 2 Hour



行业智能

Smart Verticals

行业智能：基于增强学习的智能排产优化算法

Smart Verticals： SPS (Smart Production Scheduling) based on Deep Reinforcement Learning

基于增强学习的智能排产优化算法

SPS (Smart Production Scheduling) based on Deep Reinforcement Learning

人机大战 Human vs. A.I.

1997

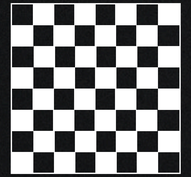
深蓝 Deep Blue

2016

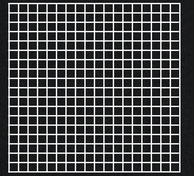
阿尔法围棋 AlphaGO

博弈树复杂度
Game Tree Complexity

井字棋
TIC-TAC-TOE

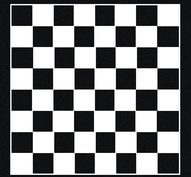


国际象棋
CHESS

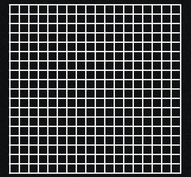


围棋
GO

井字棋
TIC-TAC-TOE



国际象棋
CHESS



围棋
GO

博弈树复杂度
Game Tree Complexity(GTC)

$GTC \geq \lg(b^p)$

b=分支因子
b=branching factor

p=手
p=plies

以围棋为例
Taking Go for example

平均每局
For a Go game on average

$b \approx 250$ $p \approx 150$

$GTC \geq \lg(250^{150}) \approx 360$

井字棋
– 博弈树复杂度
TIC-TAC-TOE
- Game Tree Complexity

5

宇宙中原子数
Atoms in Universe

80

国际象棋
– 博弈树复杂度
Chess
- Game Tree Complexity

123

围棋
– 博弈树复杂度
GO
- Game Tree Complexity

360

8
产线数
No. of production lines

4300+
订单数
No. of orders

33000+
机器数量
No. of machines

1-30
承诺交期/天
Promised deliver day

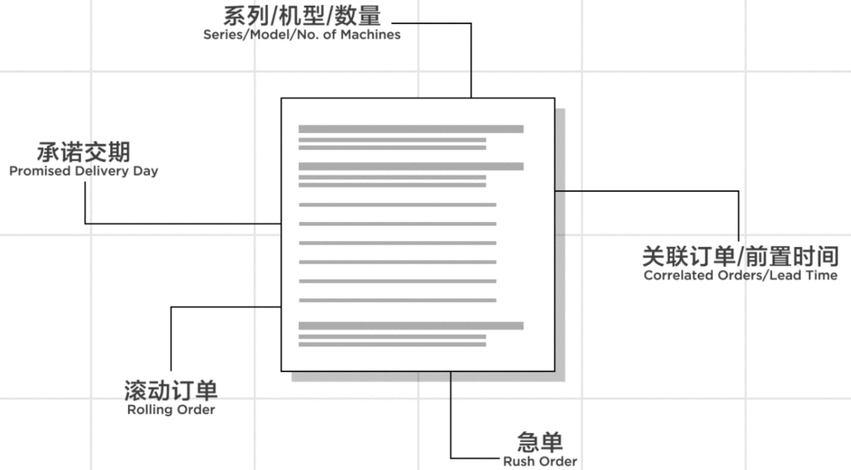
9
系列
Series

92
机型
Model

≤3
每条产线可生产系列
No. of supported series per line

COC 92x92
换线成本
Changeover cost

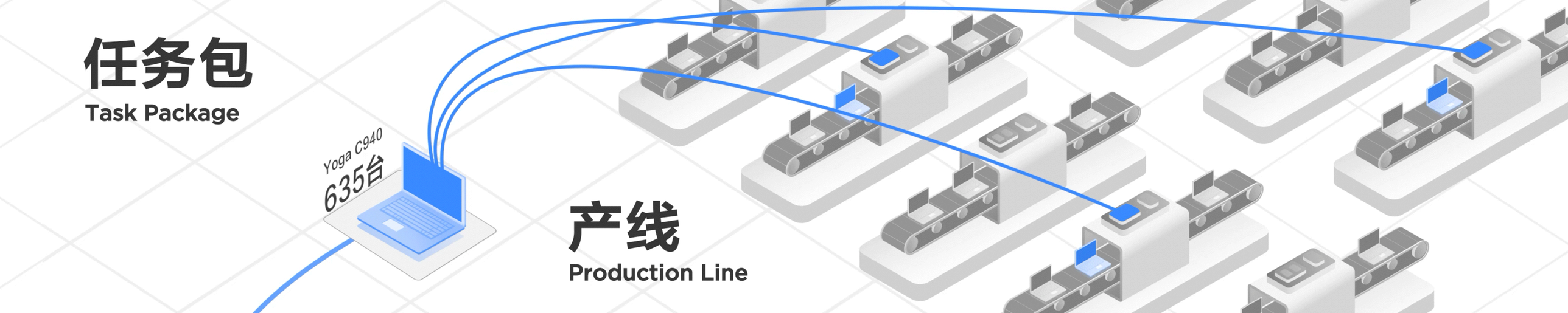
订单
Order


系列/机型/数量
Series/Model/No. of Machines
承诺交期
Promised Delivery Day
关联订单/前置时间
Correlated Orders/Lead Time
滚动订单
Rolling Order
急单
Rush Order

任务包

Task Package

任务包
Task Package



产线
Production Line

井字棋
– 博弈树复杂度
TIC-TAC-TOE
- Game Tree Complexity

5

宇宙中原子数
Atoms in Universe

80

国际象棋
– 博弈树复杂度
Chess
- Game Tree Complexity

123

围棋
– 博弈树复杂度
GO
- Game Tree Complexity

360

井字棋
– 博弈树复杂度
TIC-TAC-TOE
- Game Tree Complexity

5

宇宙中原子数
Atoms in Universe

80

国际象棋
– 博弈树复杂度
Chess
- Game Tree Complexity

123

智能排产
– 博弈树复杂度
SPS
-Game Tree Complexity

162

围棋
– 博弈树复杂度
GO
- Game Tree Complexity

360

人机大战 Human vs. A.I.

排产周期长
Long scheduling cycle

只能顾及单个目标
Single target

学习时间长
Long learning curve

快速响应
Rapid response

数据驱动
Data-driven

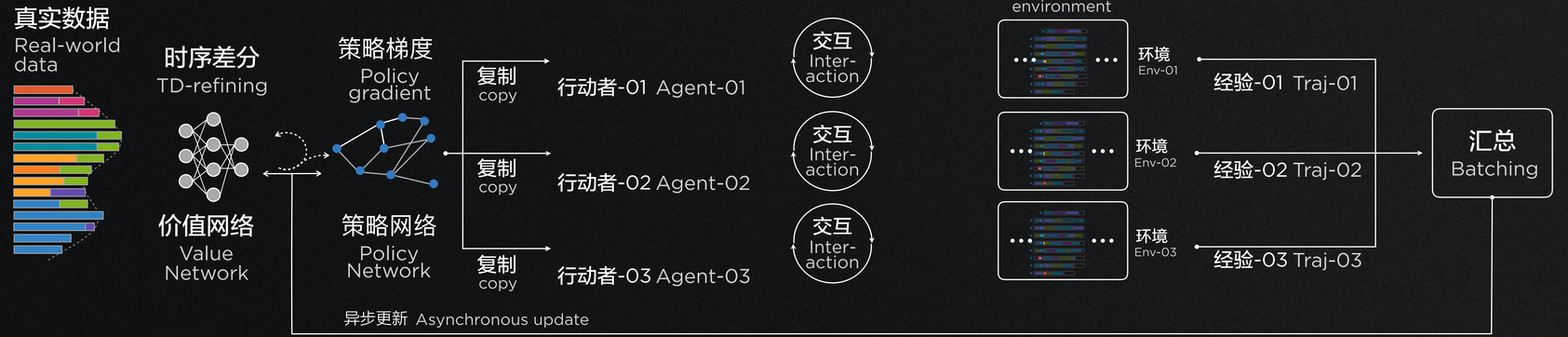
无人员变动带来的风险
Stable scheduling

智能排产核心技术一

–多交互增强学习优化网络

Core technology of SPS

- Multi-Interface Reinforcement Learning Optimization Network



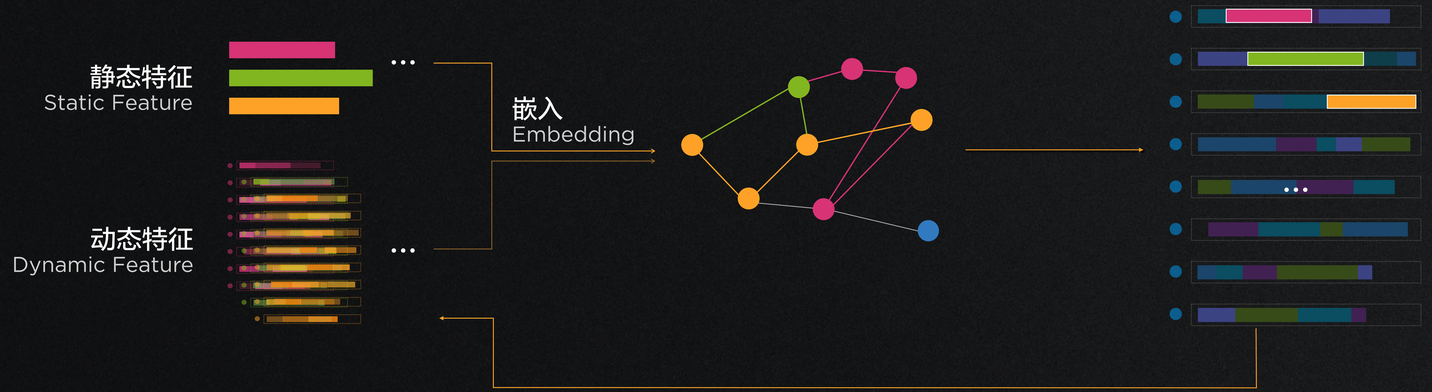
异步的优势行动者–评论家方法 Asynchronous Advantage Actor-Critic(A3C)

智能排产核心技术二

-基于注意力机制的最优化网络

Core technology of SPS

Attention Mechanism based
Optimization Network



人机大战结果

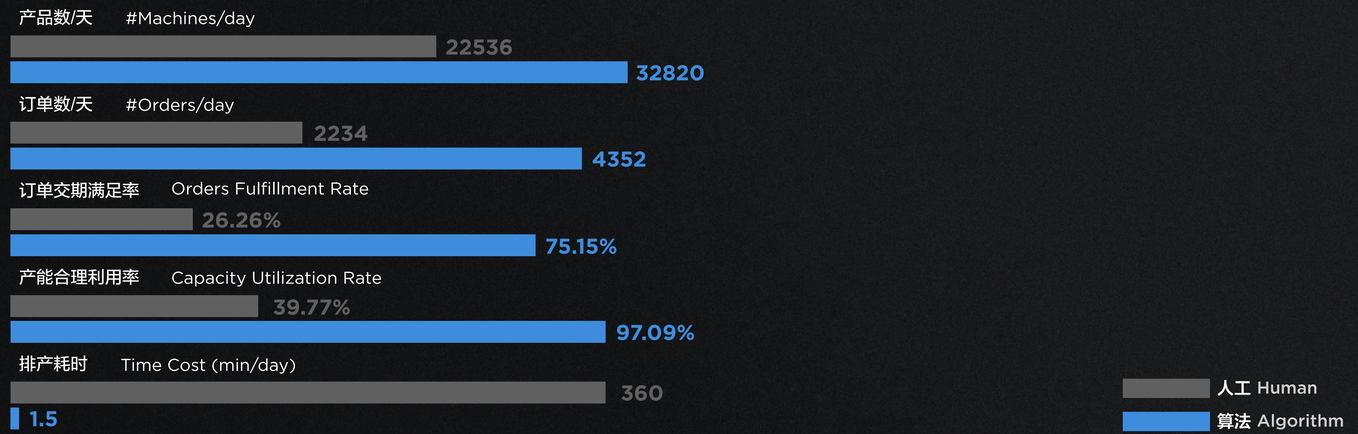
Human vs. A.I. Results

对比:

- 某生产车间人工和算法排产KPI对比
- AI排产在各指标上均优于人工

Comparison:

- Between human planner and SPS
- The schedule generated by AI algorithm is superior in terms of every KPI



打造技术联想，释放效率红利，驱动智能变革

Building Tech-Powered Lenovo, Enjoying Efficiency Dividend, & Driving Intelligent Transformation