講者簡介

Dr. Kenneth Tran (USA)
Principal Research Engineer,
Reinforcement Learning Group,
Microsoft Research

Dr. Kenneth Tran 是微軟研究強化學習小組首席研究工程師，研究專長和經驗包括：強化學習、深度學習、最佳化、分散式運算。

在室內農業方面，近期曾帶領微軟研究團隊 Sonoma 參與國際自動化溫室挑戰賽（Autonomous Greenhouses Challenge）並奪得獎項。比賽中，Sonoma 是唯一擊敗人類（來自荷蘭的種植業者）的 AI 團隊，其淨利潤較後者高出了 17%。

Kenneth Tran is a Principal Research Engineer in the Reinforcement Learning Group, Microsoft Research. His research expertise and experience includes Reinforcement Learning, Deep Learning, Optimization, and Distributed Computing.

In the Indoor Ag space, Kenneth recently led a Microsoft Research team – Sonoma – participating and winning the international Autonomous Greenhouses Challenge. In the challenge, Sonoma was the only AI team that beat humans – in this case Dutch growers – with 17% higher net profit

QUALIFICATIONS

- Ph.D. University of Texas, Austin in Computational and Applied Mathematics

PROFESSIONAL EXPERIENCE

- Microsoft Research from 2012 till now

Artificial Intelligence for Indoor Ag

Kenneth Tran
Microsoft Research

About Microsoft Research

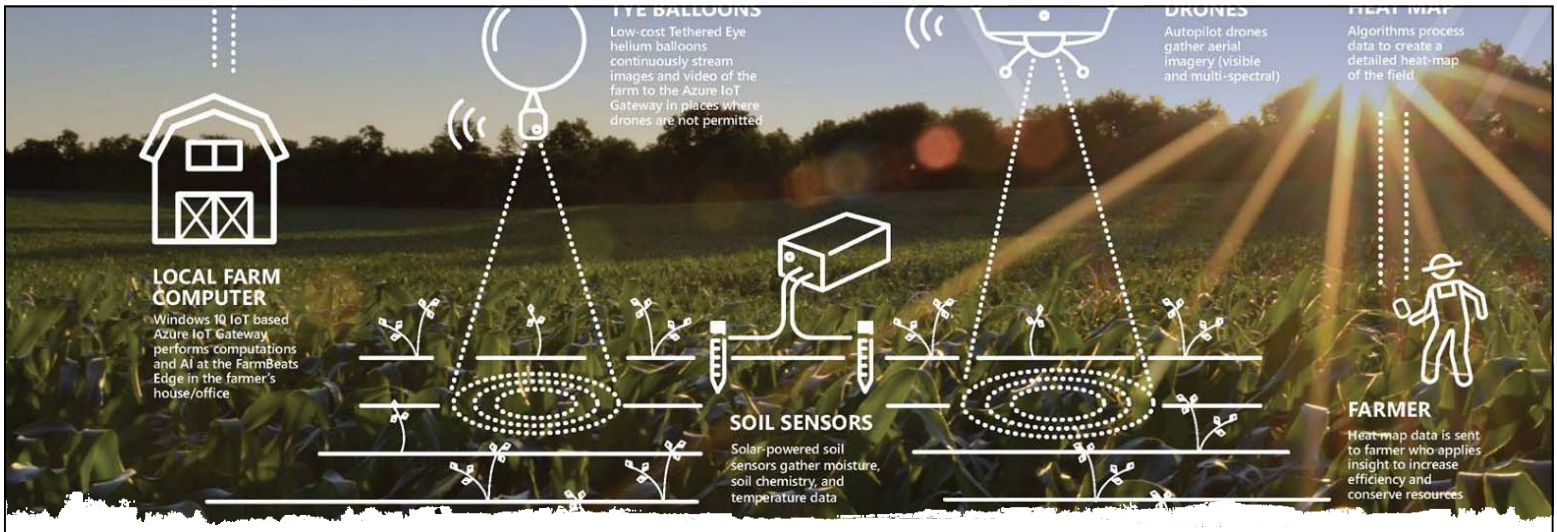
- Mission: advance the state-of-the-art of computing and solve challenging world problems
- MSR did research in ML long before it became phenomenon

人工智慧在室內農業的應用

Kenneth Tran
微軟研究院

關於微軟研究所

- 使命：推進最先進的計算技術並解決具有挑戰性的世界性問題
- 微軟研究所早在機器學習成為熱門研究之前就開始機器學習的研究

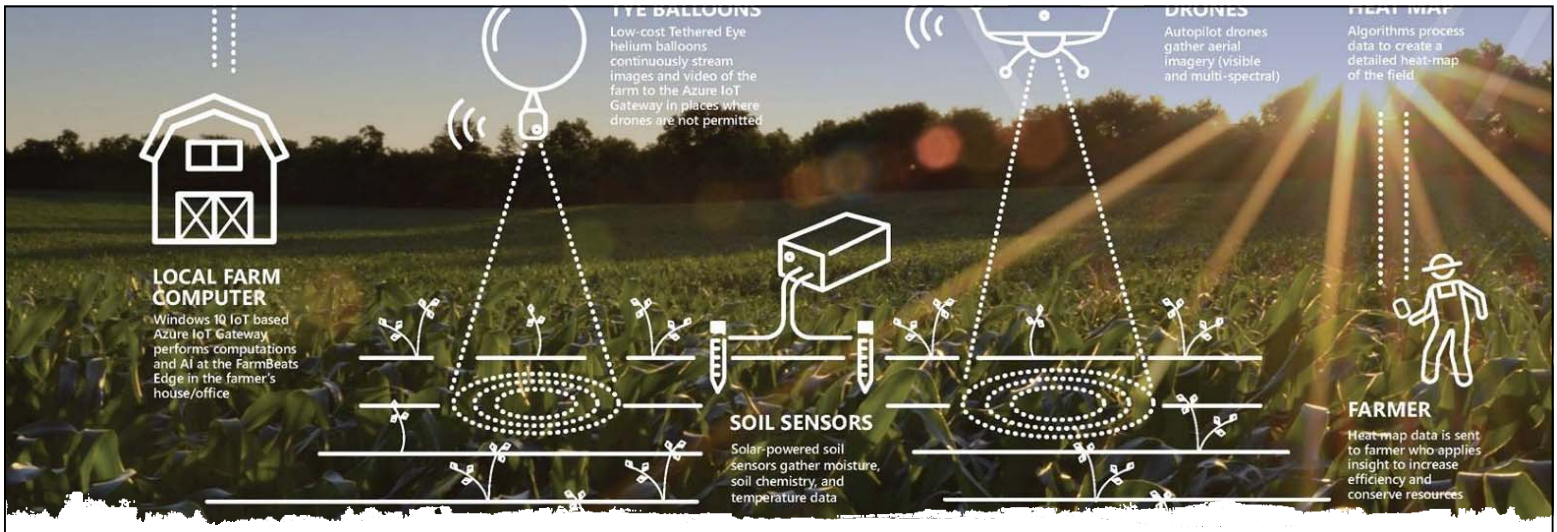


MSR & Ag Research

- Project FarmBeats: assist open-field farmers
  - Wireless communication
  - Cloud & Edge
  - AI: micro-climate prediction, smart pest control, etc.

MSR & Ag Research

- Project FarmBeats: assist open-field farmers
- Project **Sonoma**: ML and RL for Indoor Ag
  - Autonomous
  - Higher quality, higher yield, lower resources usage



微軟研究院與農業研究

- FarmBeats 專案：協助露天耕作的農民
  - 無線通訊
  - 雲端與邊緣運算
  - 人工智慧：微氣候預測、智能害蟲防治

微軟研究院與農業研究

- FarmBeats 專案：協助露天耕作的農民
- Sonoma 專案： 機器學習(ML)及強化學習(RL)應用於室內農業
  - 自動化
  - 質量更高，產量更高，資源利用率更低

Project Sonoma

Develop an algorithm that can operate indoor farms autonomously and efficiently

Microsoft Research AI

- Rules based: set of rules based on experience and domain knowledge

Traditional Methods

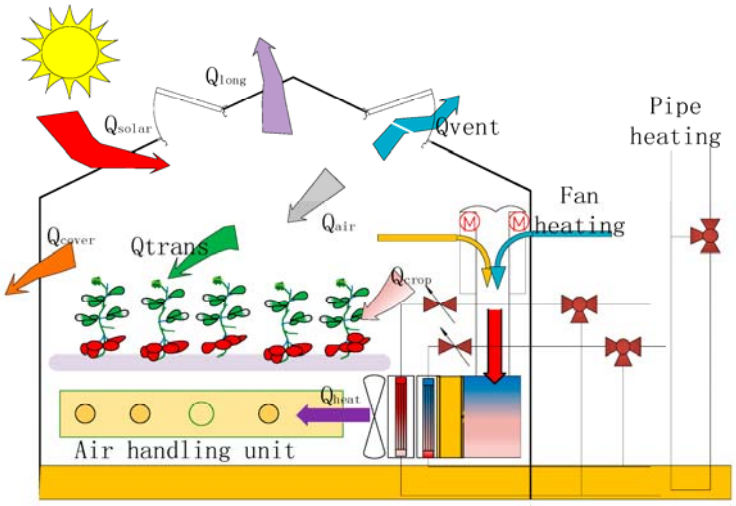
Microsoft Research AI

Sonoma專案

開發一種可以自動化且高效率運營室內農場的演算法

- 規範基準：基於經驗和領域知識的規則

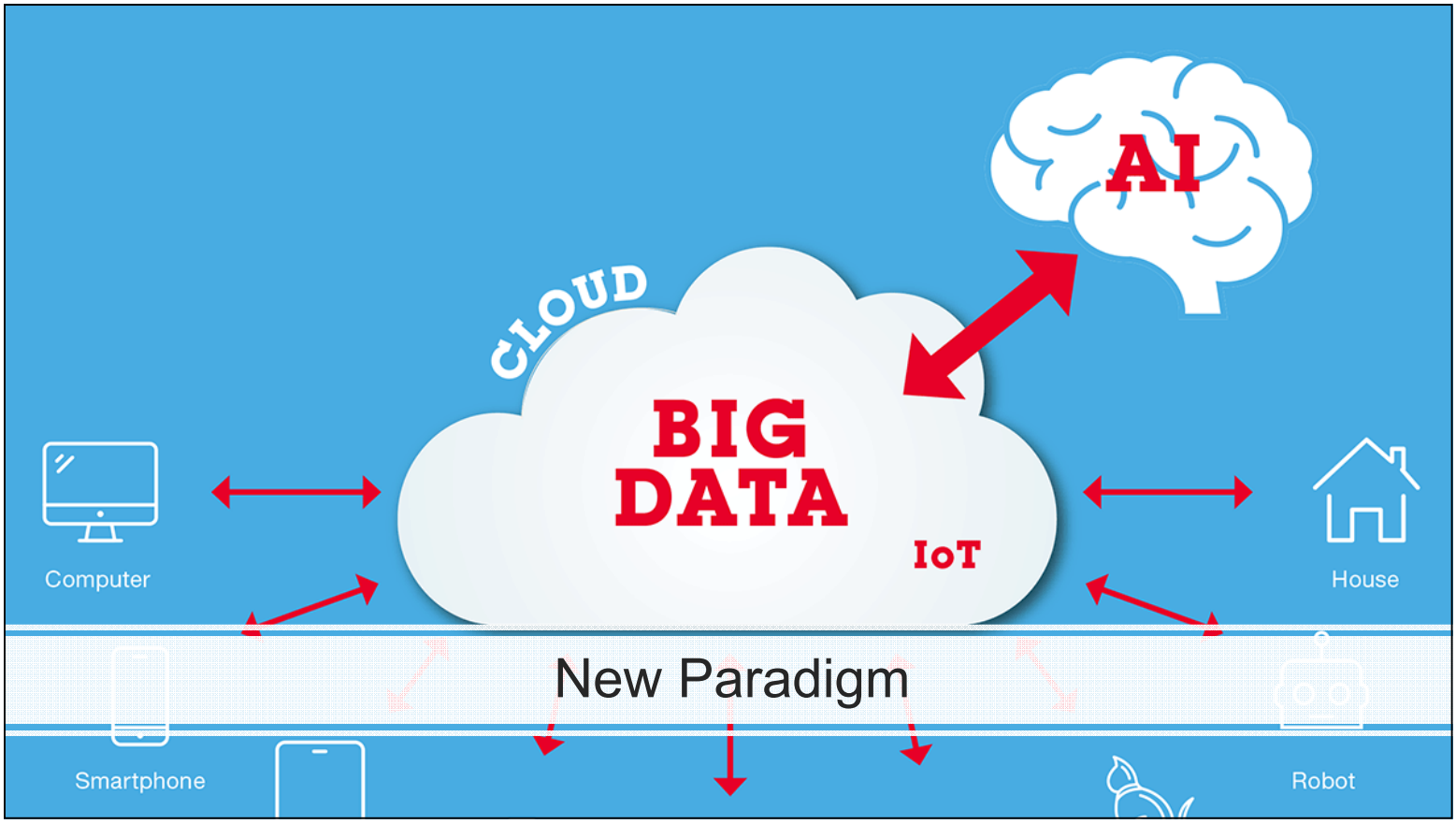
傳統方法

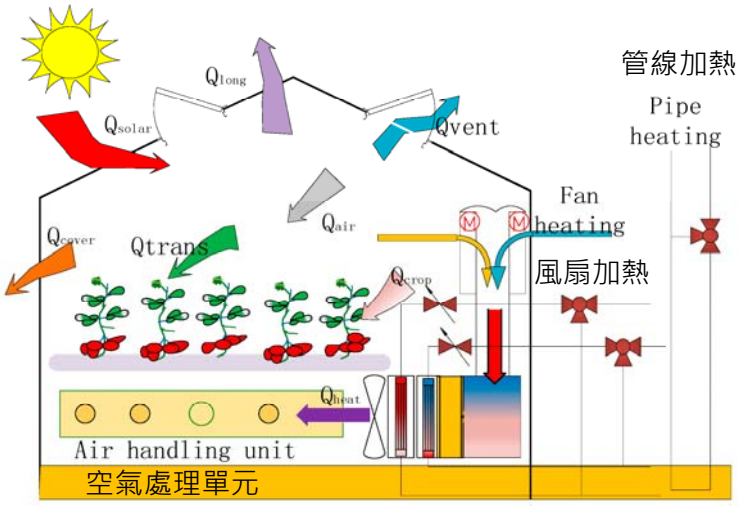


- Rules based
- Use control theory based on differential equations
  - Many systems are not well described by DEs
  - Costly and not scalable
  - Not practical

Traditional Methods

Microsoft Research AI





管線加熱

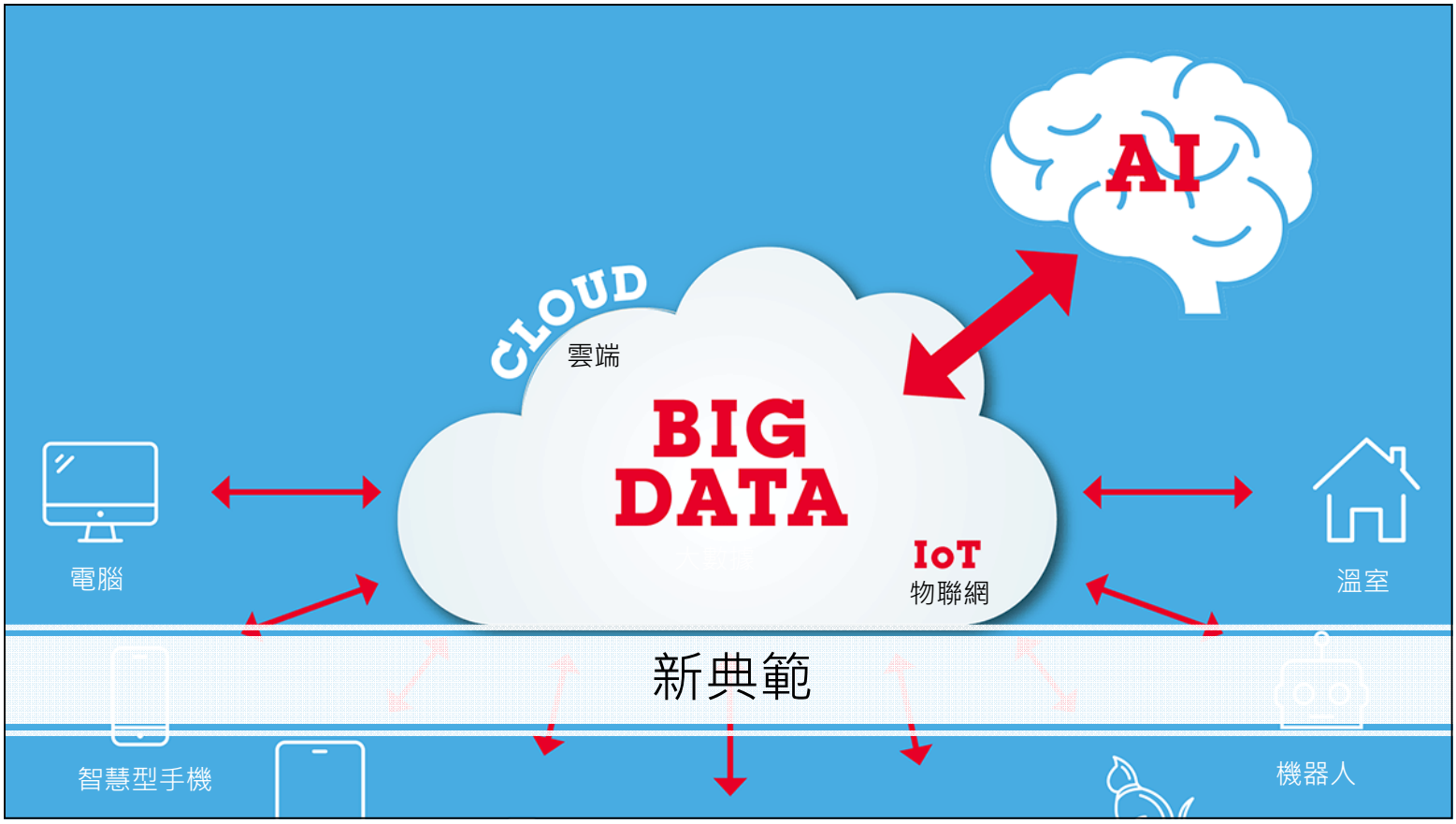
Pipe
heating

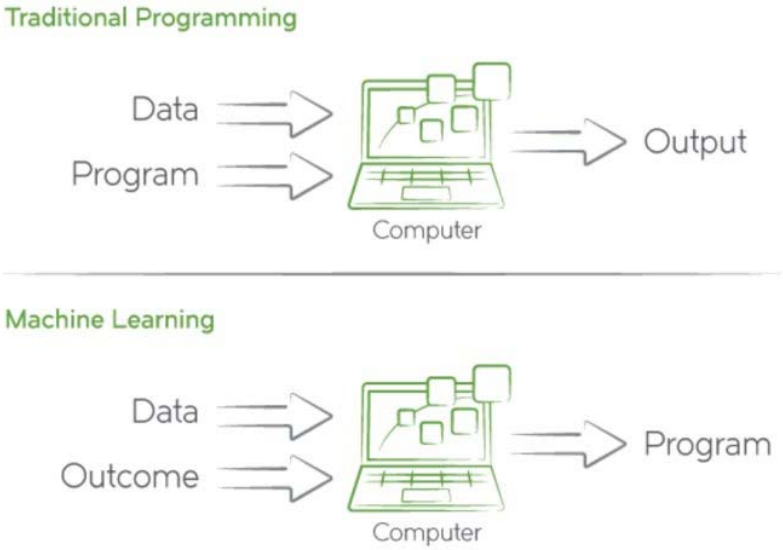
風扇加熱

- 規範基準
- 基於微分方程的控制理論
  - 對於很多系統，微分方程式都未能好好描述
  - 成本高且不可擴展
  - 不實用

傳統方法

Microsoft Research AI

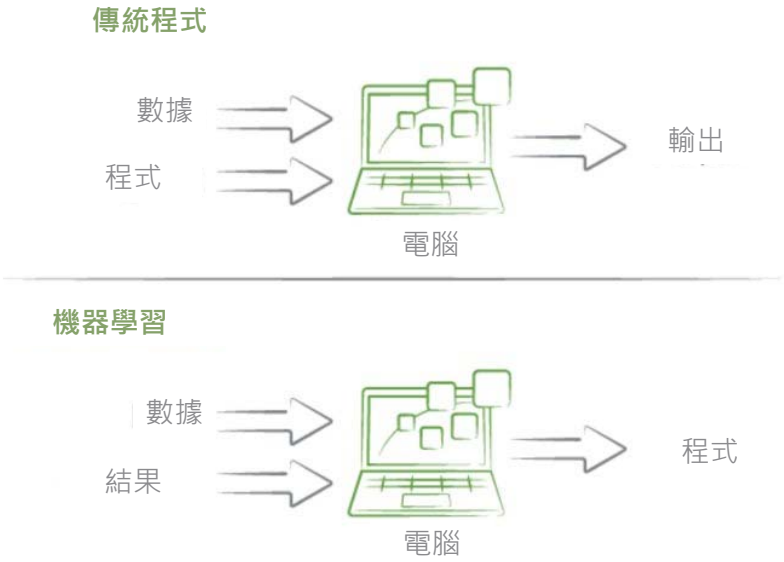




Traditional Programming vs Machine Learning

Autonomous Greenhouse Challenge

- Produce a cucumber crop within 4 months, remotely using AI
- Optimize for crop yield and resource usage efficiency

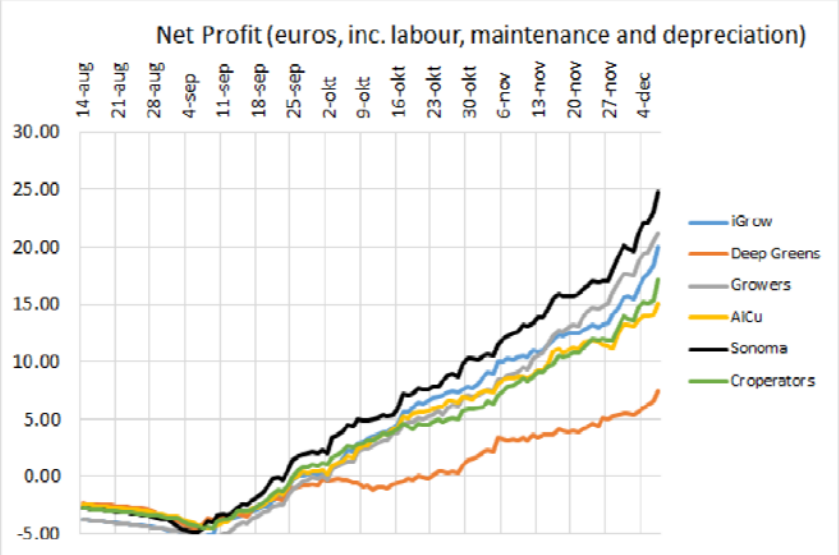


傳統程式與機器學習

無人溫室挑戰

- 四個月內利用人工智慧遠端生產小黃瓜
- 優化作物產量和資源利用效率

Results



Results

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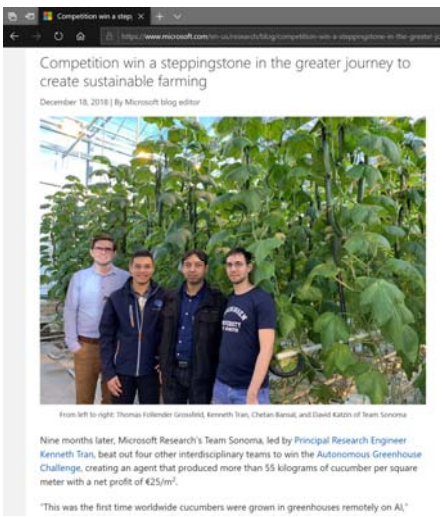

Competition win a stepping stone in the greater journey to create sustainable farming

December 18, 2018 | By Microsoft blog editor

From left to right: Thomas Follender Grosshild, Kenneth Tran, Chetan Bansal, and David Katzin of Team Sonoma

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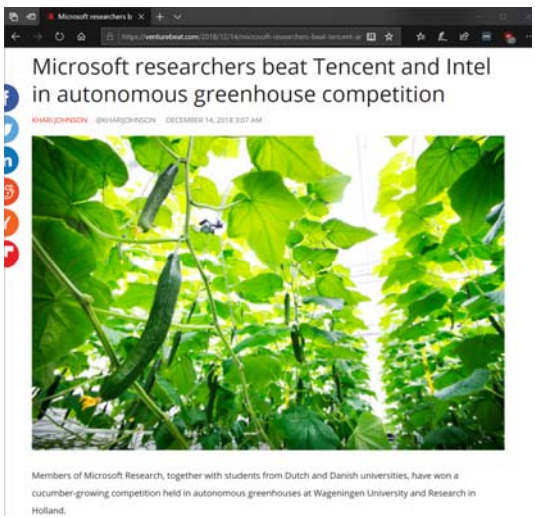

Microsoft researchers beat Tencent and Intel in autonomous greenhouse competition

KHARI JOHNSON @KHARIJOHNSON DECEMBER 14, 2018 3:07 AM

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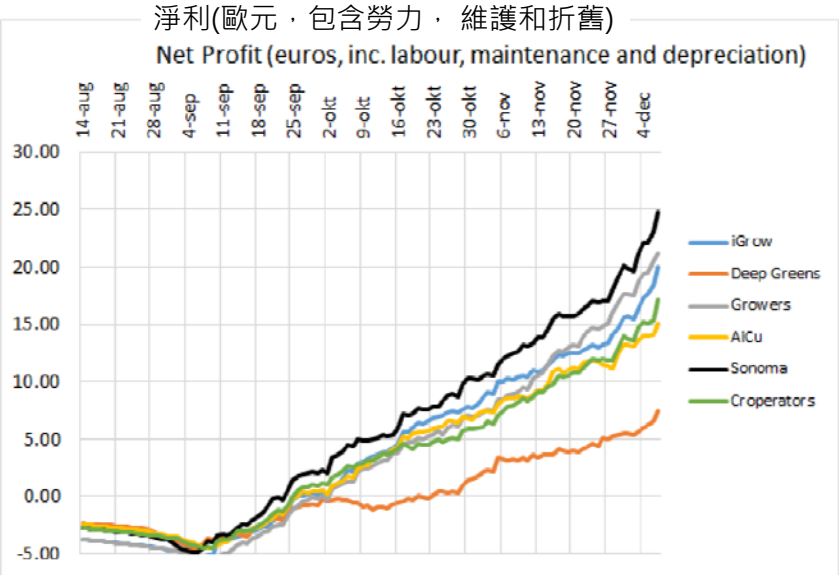
結果

淨利(歐元，包含勞力， 維護和折舊)



結果

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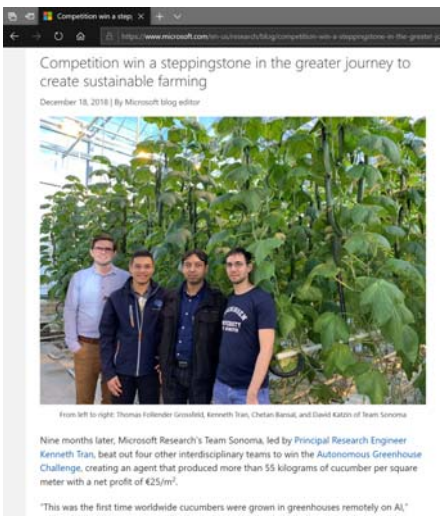

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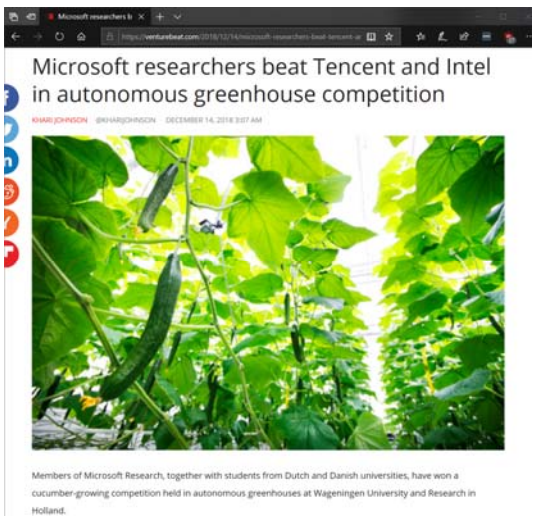

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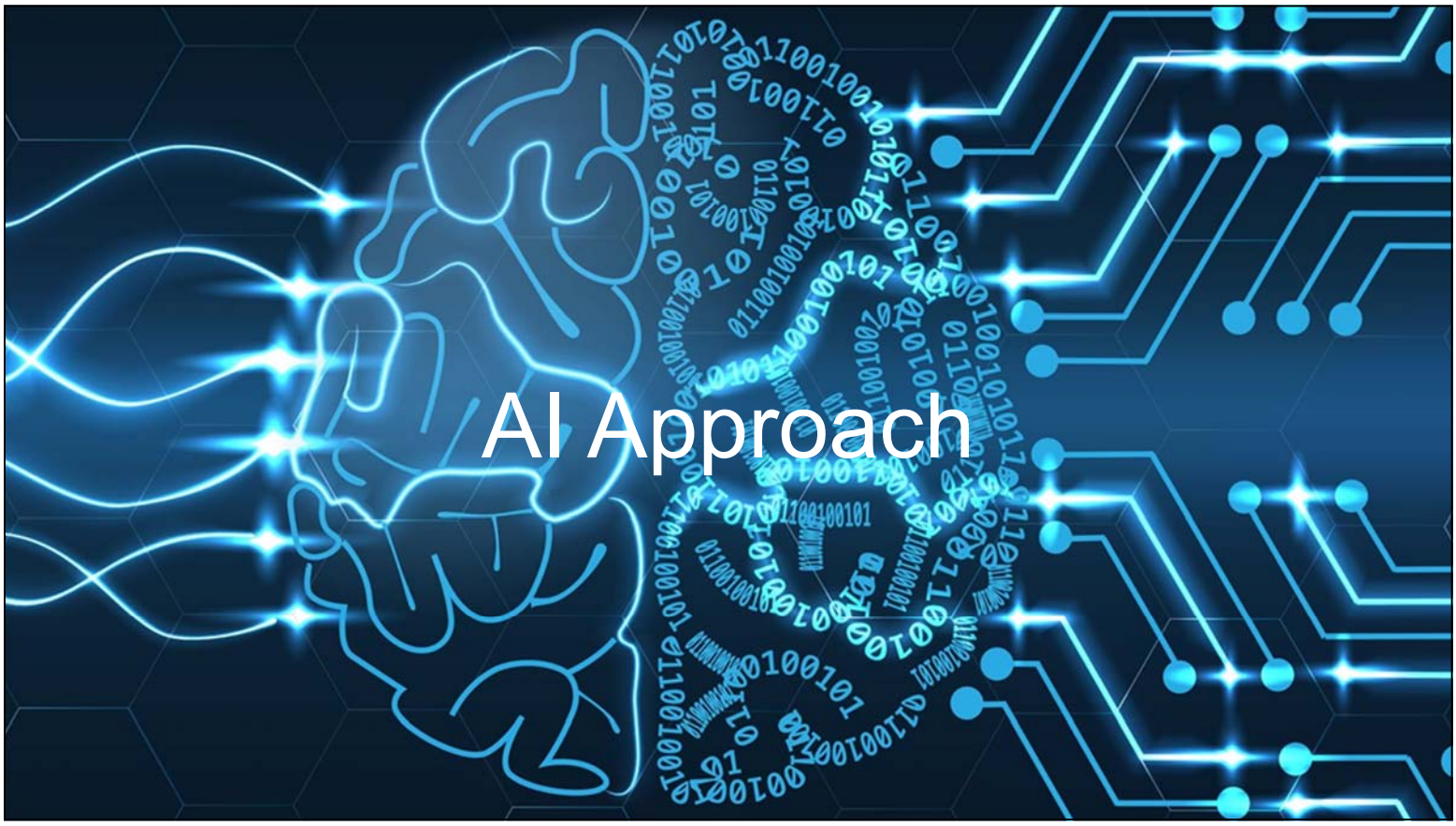
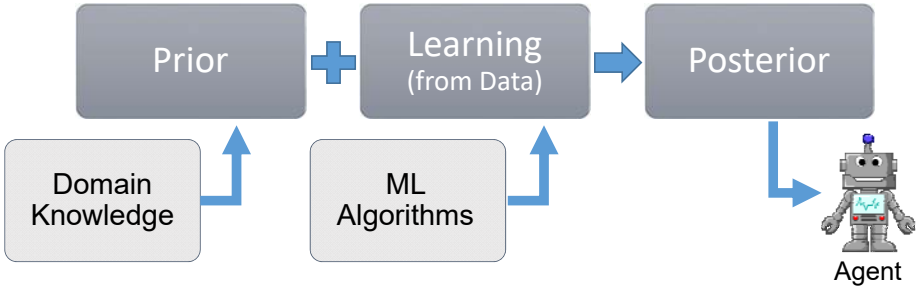
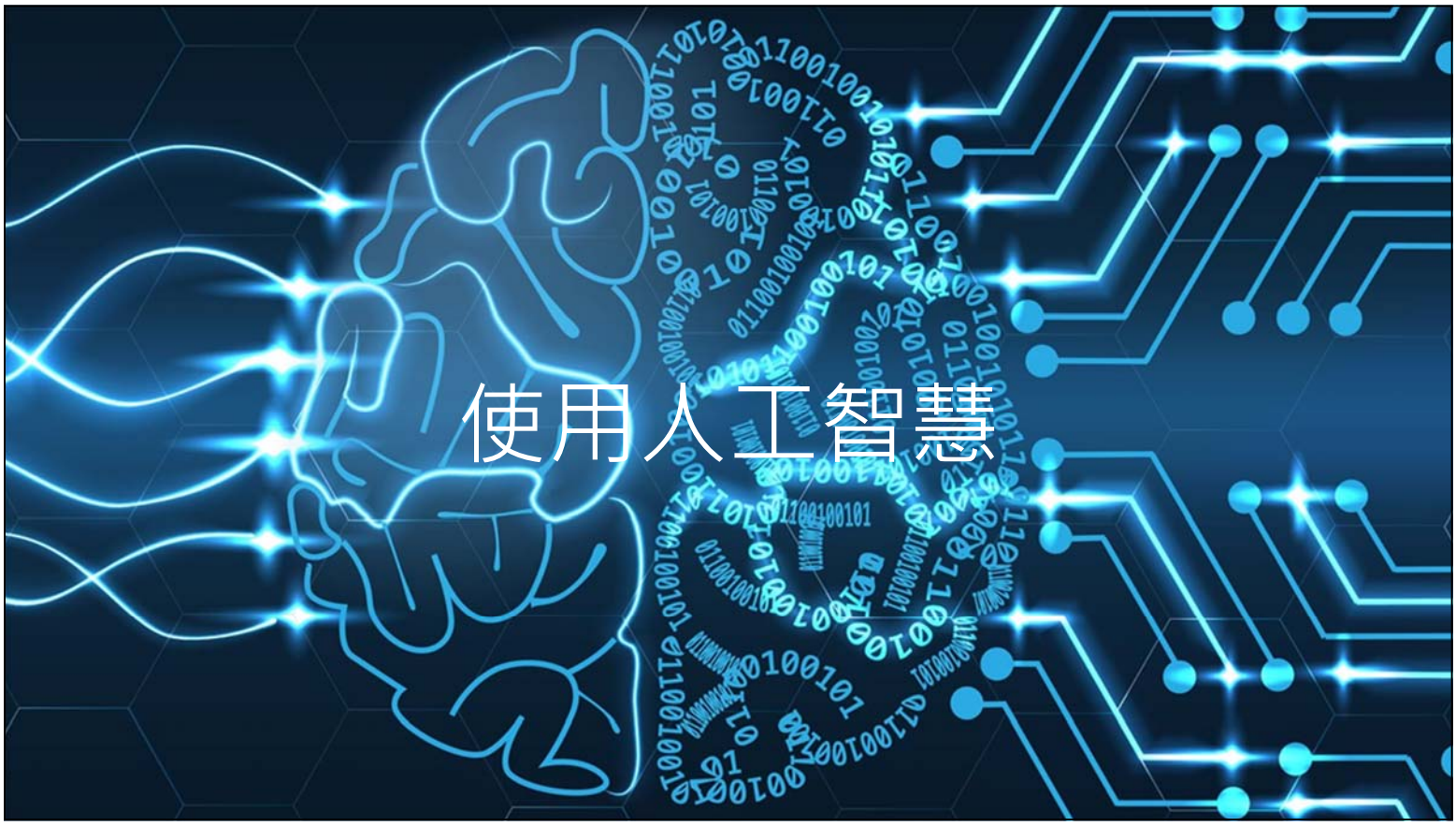


Overall Approach

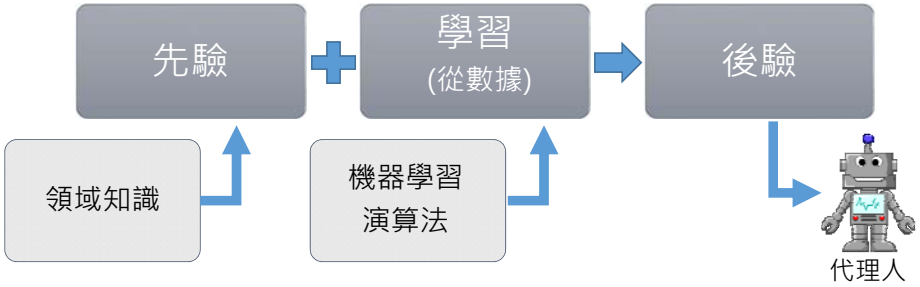
- Combine domain knowledge, classical model-predictive control, and Reinforcement Learning (RL)
- "Model-based" RL



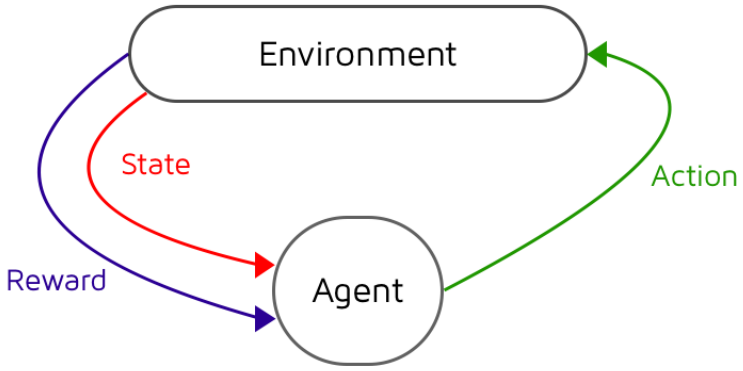


整體方法

- 結合領域知識，經典模型預測控制和強化學習(RL)
- 以模型為基礎的強化學習 (RL)

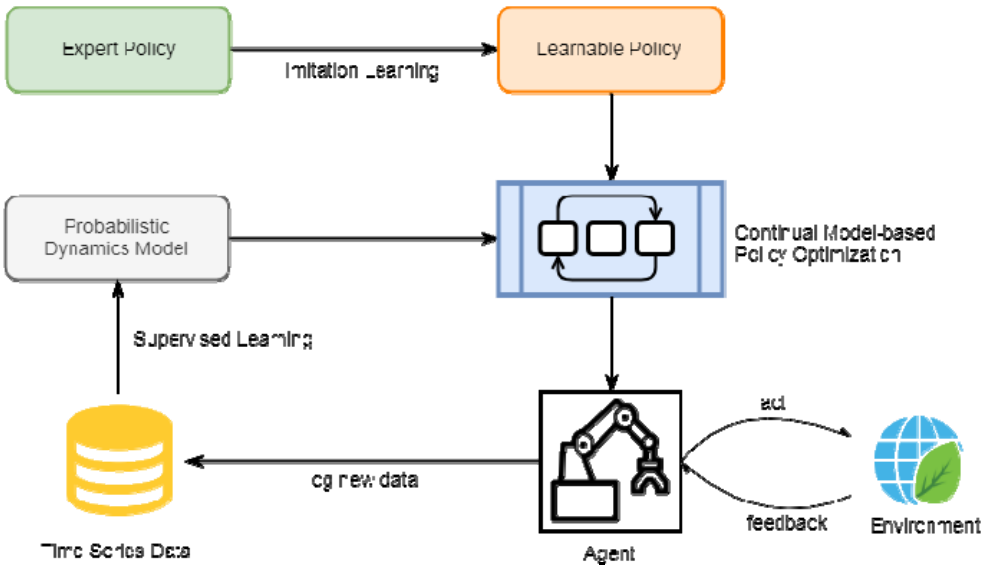


Reinforcement Learning

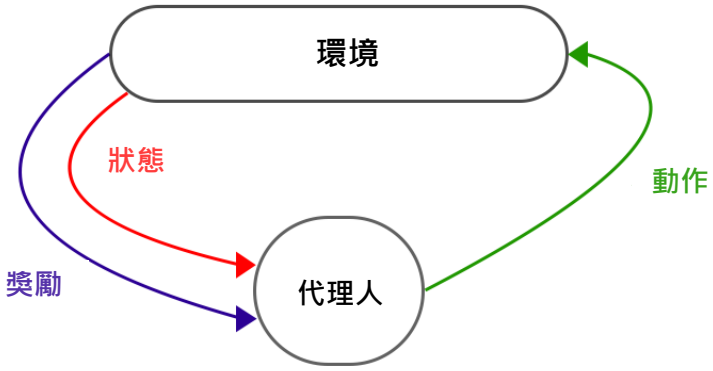


- Observations
  - Plant state, environment state, etc.
- Action
  - Light, climate control, nutrients, etc.
- Reward
  - e.g. plant weight

Model-based RL Framework

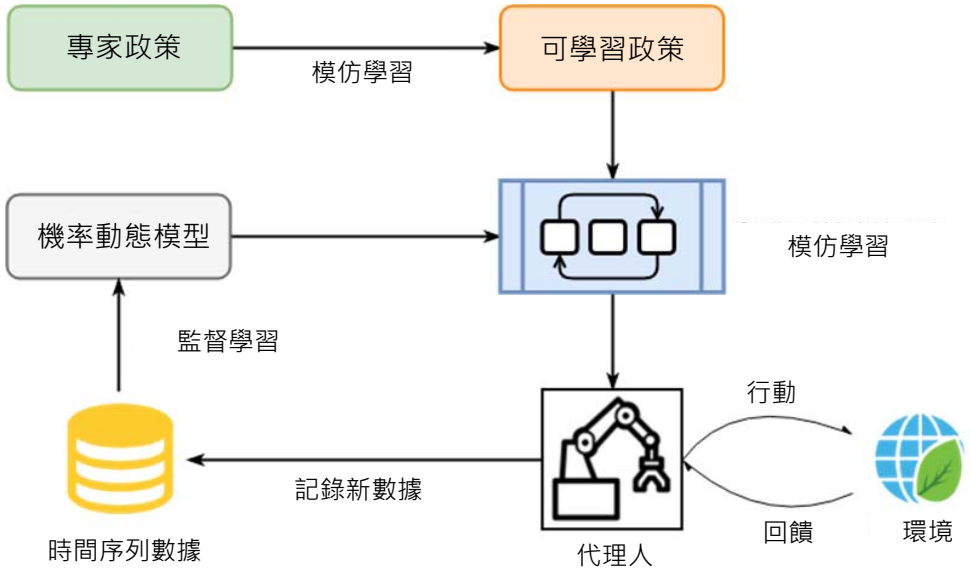


強化學習



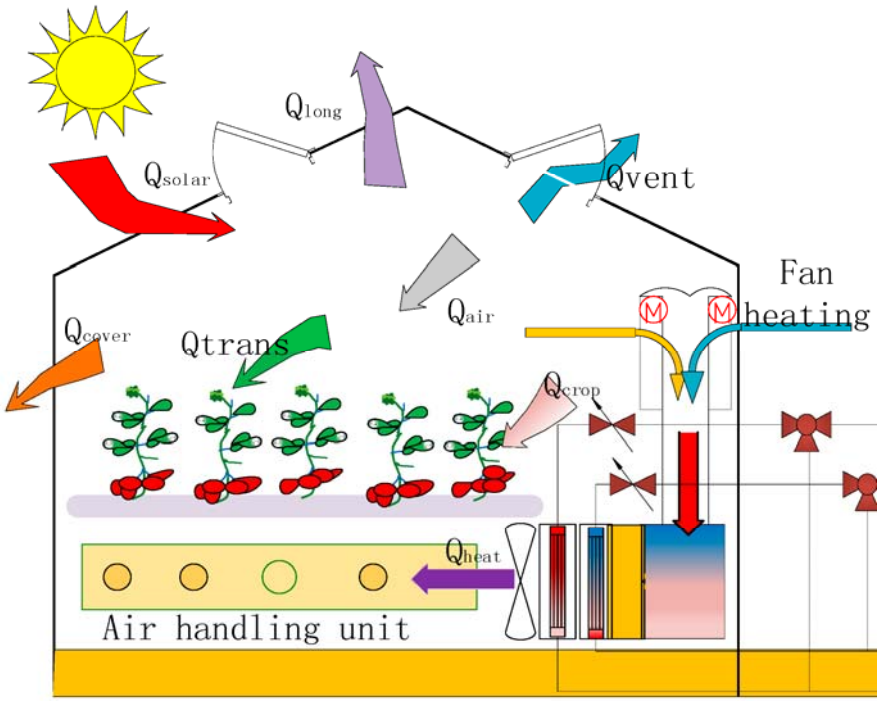
- 觀察
  - 植物狀態，環境狀態等
- 行動
  - 光，氣候控制，營養素等
- 獎勵
  - 例如 植物重量

基於模型的強化學習框架

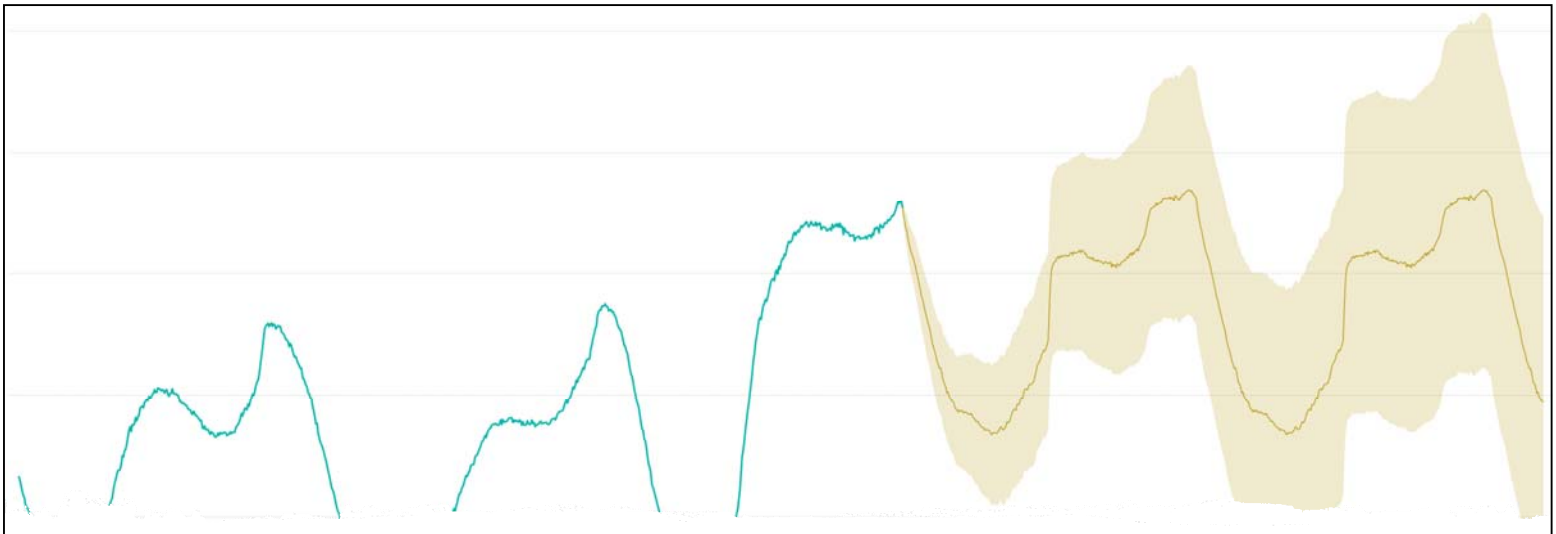


Greenhouse Temperature Prediction

- Coefficients are not given
- Estimated from data, via simple regression



Microsoft Research AI

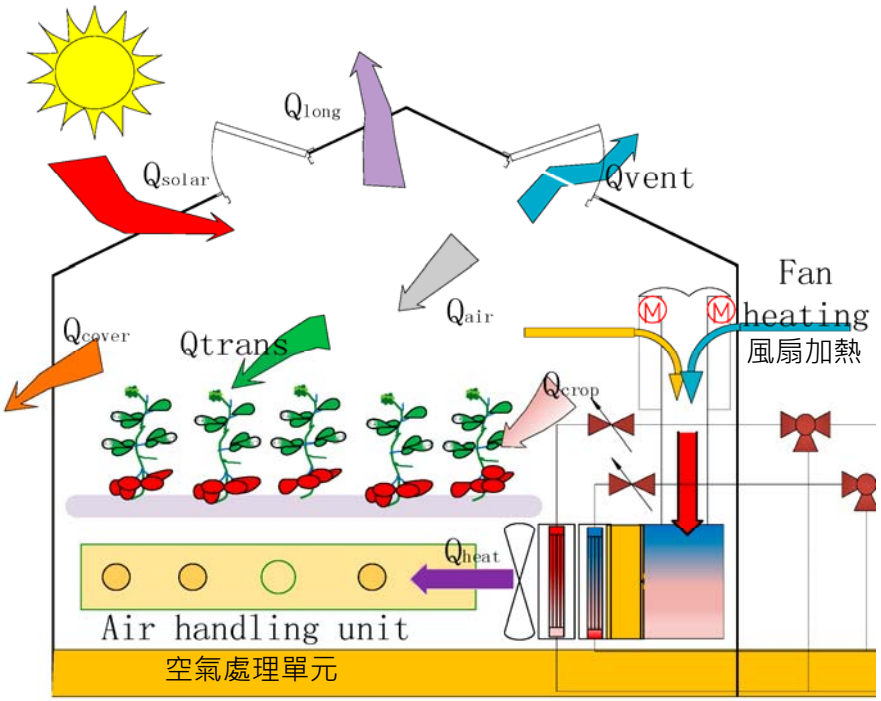


Microclimate Forecast

- Powered by Deep4Cast
- Predict the difference between the truth and Letsgrow's forecast

溫室溫度預測

- 未給相關系數
- 透過簡單回歸從數據估算



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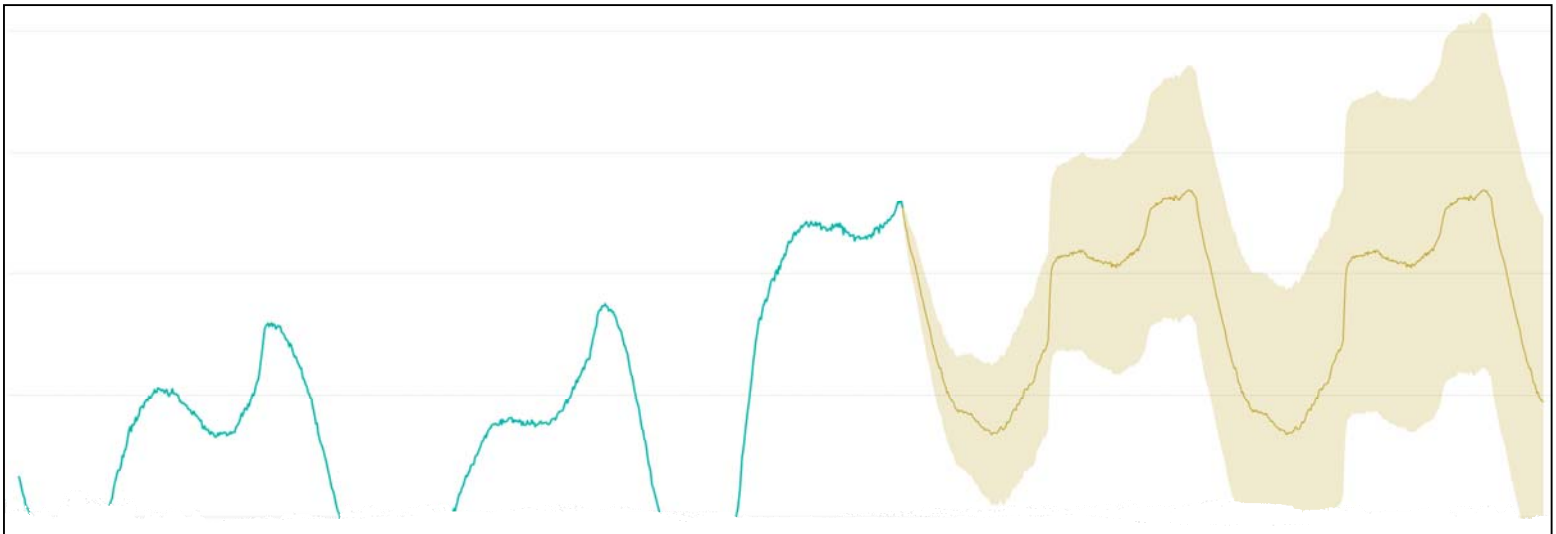
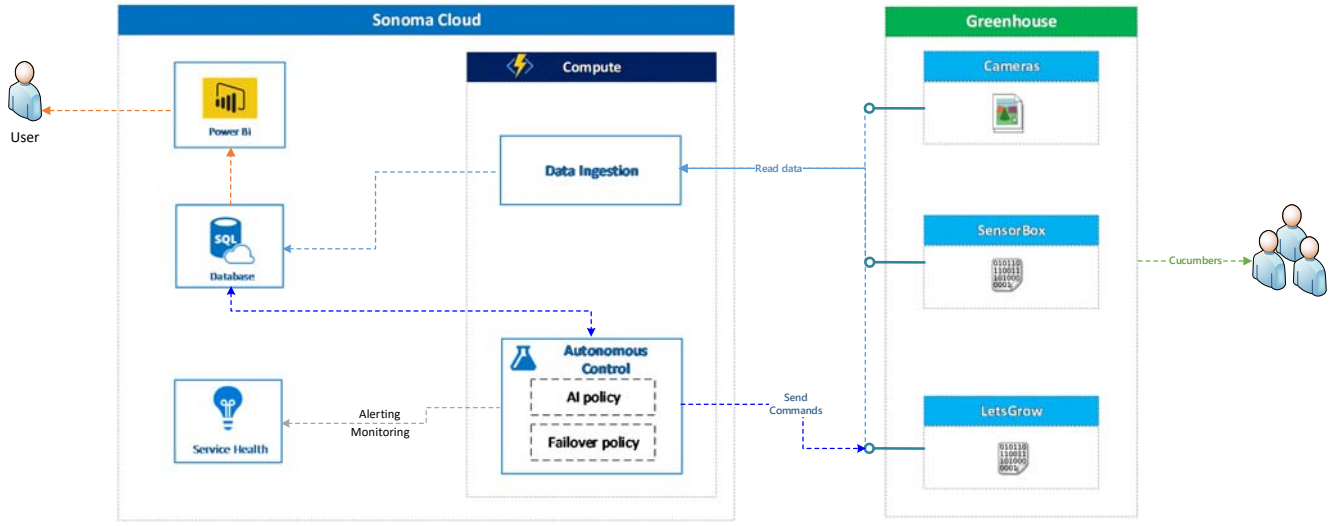


微氣候預測

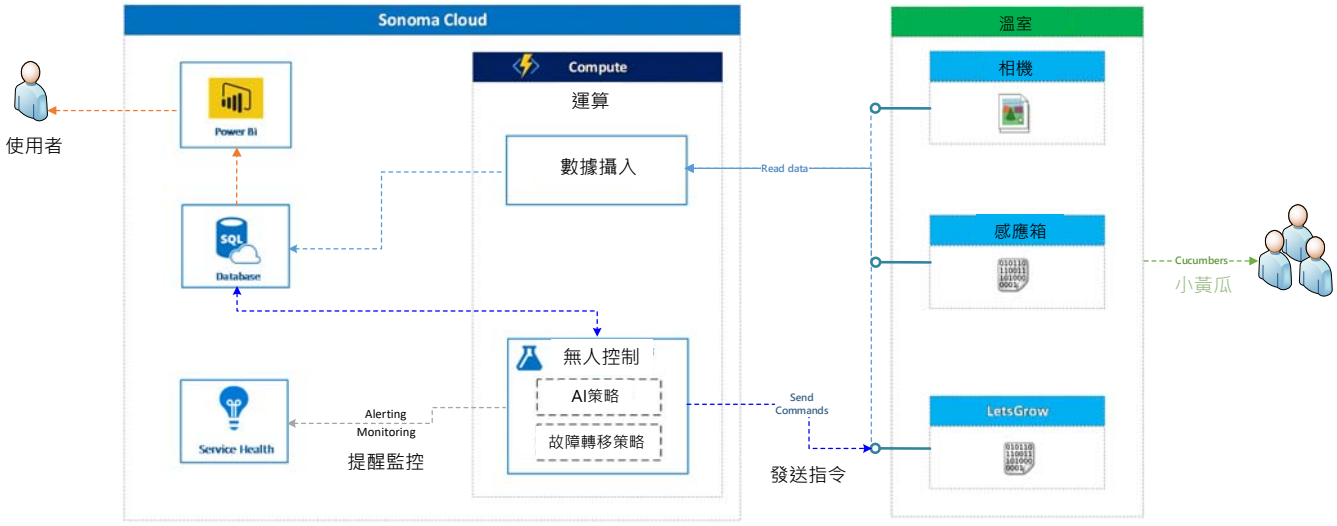
- 由 Deep4Cast 提供支持
- 預測事實與Letsgrow預報之間的差異

Software architecture




系統設計

軟體架構


Sonoma Cloud
Compute
運算
數據攝入
無人控制
AI策略
故障轉移策略
Power Bi
Database
Service Health
Alerting
Monitoring
提醒監控
使用者
Read data
Send
Commands
發送指令
溫室
相機
感應箱
LetsGrow
Cucumbers
小黃瓜

Power BI

Robustness

Murphy's law: *"whatever can go wrong, will go wrong".*

- **Data**: We validate all data for anomalies and staleness.
- **Failover Policy:** Based on time, if data cannot be retrieved for an extended period.
- **Infrastructure**: Geo-redundancy incase of infrastructure failure. Monitoring & alerting in place.
- **Instrumentation**: For any issues which slips through the gaps, sophisticated telemetry instrumentation in place for RCA.

Power BI

穩健性

莫非定律：「凡是可能出錯的事就一定會出錯」

- **數據**：我們驗證所有數據是否異常和過時。
- **故障轉移策略**：基於時間，如果數據無法長時間檢索。
- **基礎設施**：基礎設施故障時的地理容錯備份，有監控和警報。
- **儀器儀表**：對於任何沒注意到的問題，有先進的遙測儀器進行相關組件分析(RCA)。

Scalability

- **Stateless & Serverless**: We use Azure functions for running our models and data pipelines. Helps avoid managing servers or virtual machines.
- **Cost effective**: pay per run, don't need an always-on server.
- We can deploy the system to **multiple greenhouses** with minimal effort.
- Horizontally & vertically scalable.
- **Continuous** code/model **deployment**.

Results

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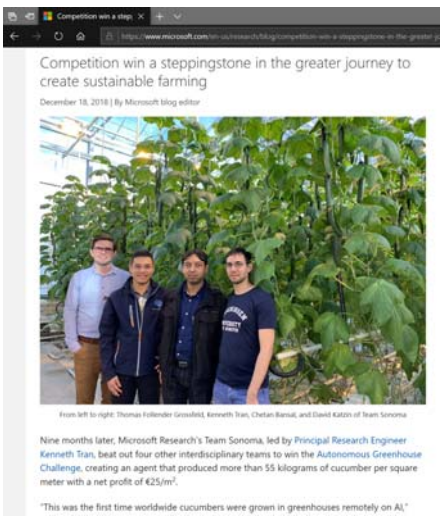
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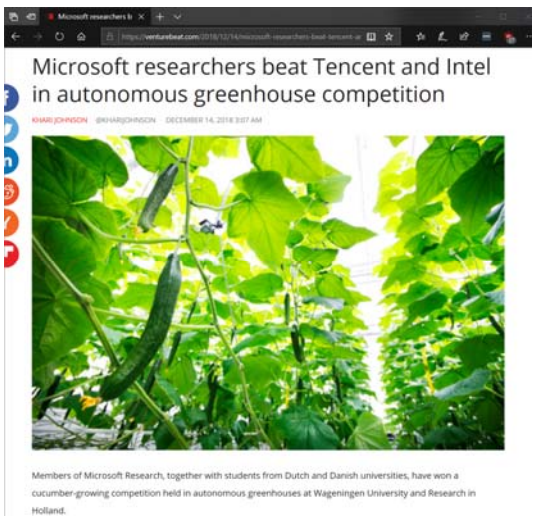
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可擴展性

- **無狀態和無伺服器**：我們使用Azure功能來跑我們的模型和數據工作流，避免管理伺服器或虛擬機。
- **具成本效益**：論次計酬，不需要always-on server。
- 我們可以輕鬆地將系統部署到**多個溫室**。
- 水平和垂直皆可擴展。
- **連續程**式碼/模型**部署**。

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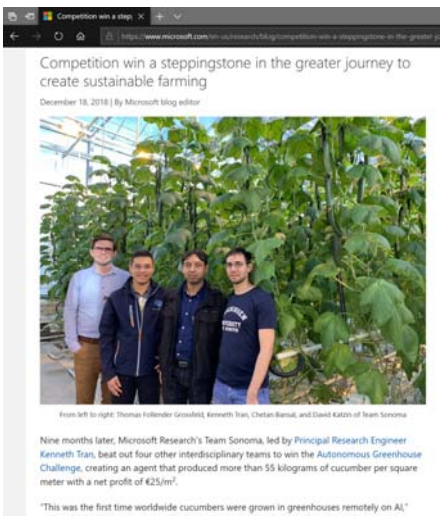
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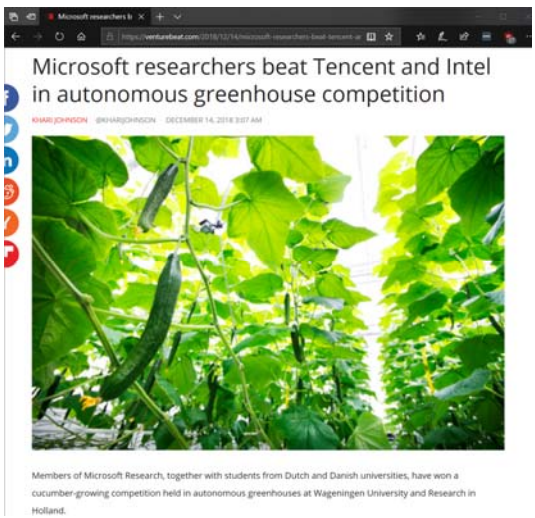
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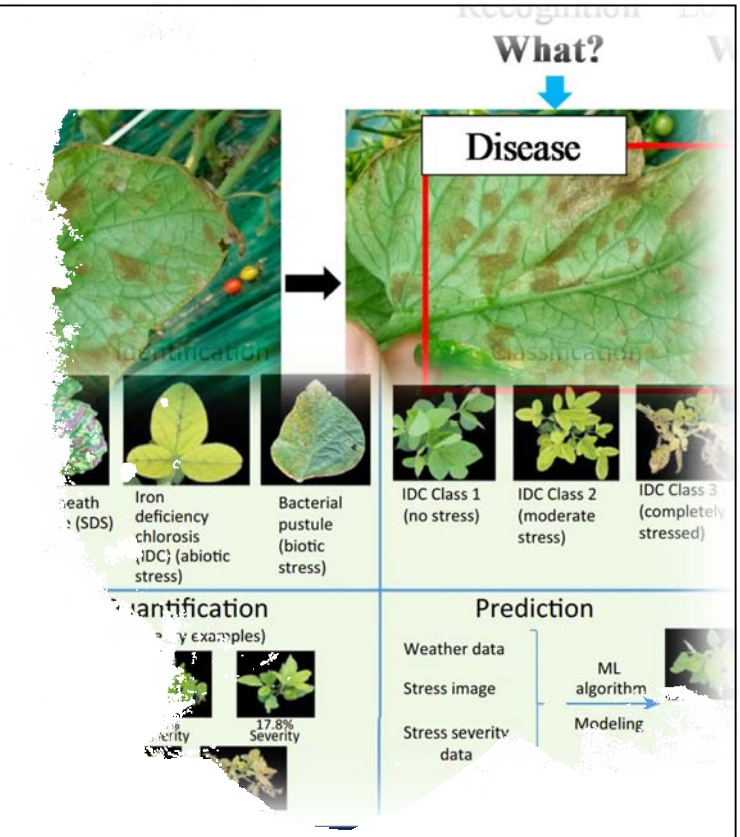
Other applications of ML in Indoor Ag

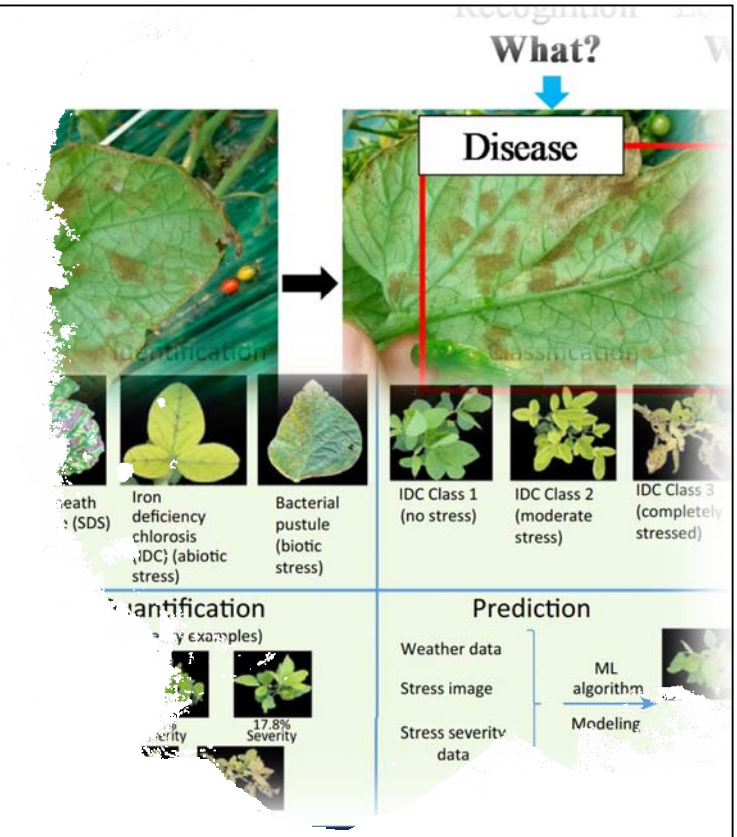
- Phenotype classification
- Pest/Disease detection and prediction
- Anomaly detection
- Automated harvesting and sorting



Challenges ahead

機器學習在室內農業中的其他應用

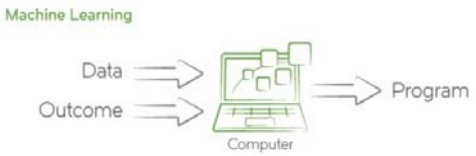
- 表型分類
- 害蟲/疾病檢測和預測
- 異常檢測
- 自動收割和分類



未來的挑戰

Data Issues

- Lack of IoT and data infrastructure
- Lack of diverse data
- Need novel methods to measure or estimate yield and quality autonomously



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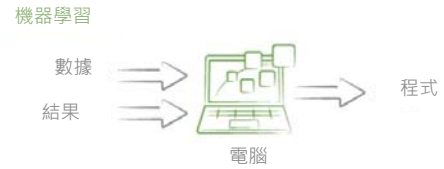
Final thoughts

- Indoor Ag needs disruptive tech to be commercially viable
- Game changers
  - More cost-efficient and flexible LED
  - Intelligent Automation

數據問題

- 缺乏物聯網和數據基礎設施
- 缺乏多樣化的數據
- 需要新穎的方法來自主地測量或估計產量和質量



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最後想法

- 室內農業需要有破壞性的技術才有商業可行性
- 改變遊戲規則者
  - 更具成本效益和靈活性的LED
  - 智能自動化

Thank You!

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Thank You!

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