Software for a better world

UNIVERSITY OF LIMERICK
OLLSCOIL LUIMNIGH

A World Leading SFI Research Centre

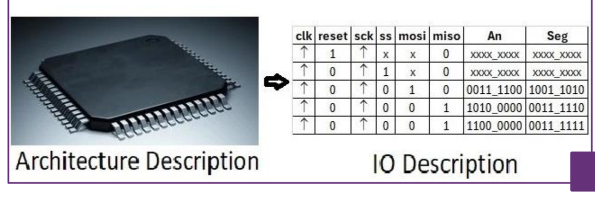
Science Foundation Ireland — For what's next

Biocomputing and Developmental Systems (BDS) Group

1 AUTOMATIC DESIGN OF DIGITAL CIRCUITS

AD/DC

Design Specification

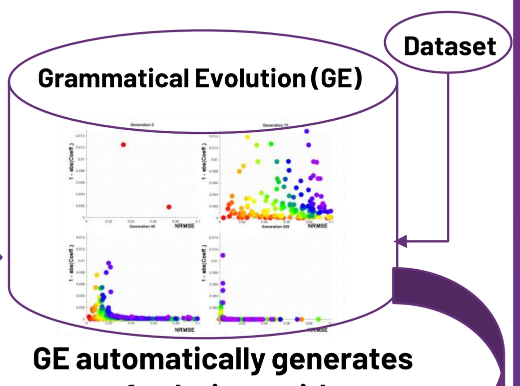


Use Machine Learning to automatically design digital circuits from high level descriptions.

Grammar

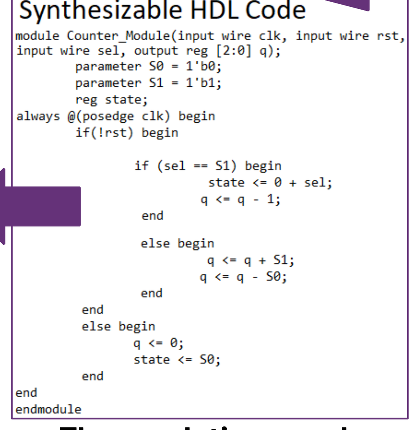
⟨assign⟩ ::= assign output = ⟨expression⟩;
⟨expression⟩ ::= ⟨expression⟩ * ⟨expression⟩
| ⟨expression⟩ + ⟨expression⟩
| input | ⟨c⟩ | ⟨x⟩
⟨c⟩ ::= c0 | c1 | c2 | c3
⟨x⟩ ::= x1 | x2 | x3

A grammar specifies the subset of a Hardware Description Language



GE automatically generates a set of solutions with different trade-offs

Synthesizable HDL Code



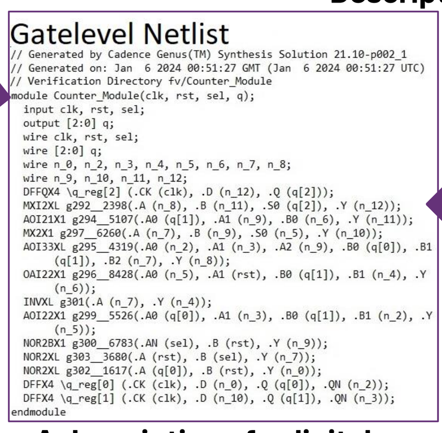
These solutions can be automatically converted into hardware

Logic Synthesis

	BC	TC	WC
Temperature (Celsius)	0°	25°	125°
Core Voltage (Volts)	1.32	1.2	1.08
IO Voltage (Volts)	2.75	2.5	2.25
Area (Cell count)	6562	6568	6513
Total Power (in Milliwatt)	21.30	17.60	14.40
Datapath Delay (in Pico Second)	1691	5180	7986

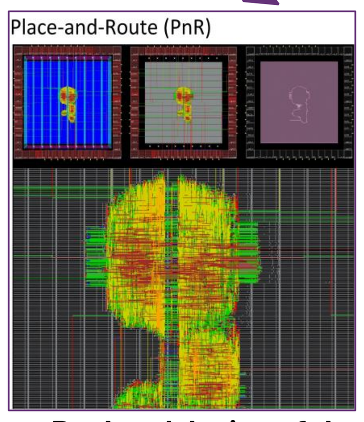
Transform the high-level hardware description into a gate-level netlist for efficient implementation in hardware.

Gatelevel Netlist

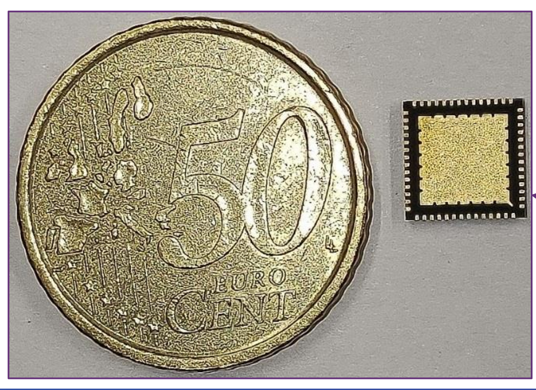


A description of a digital circuit at the level of individual logic gates and their interconnections.

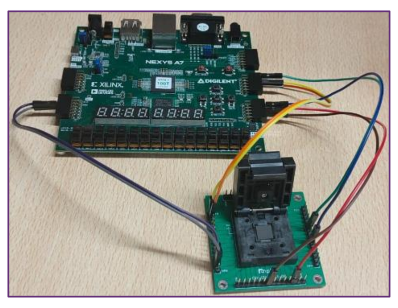
Place-and-Route (PnR)



Backend design of the IC.



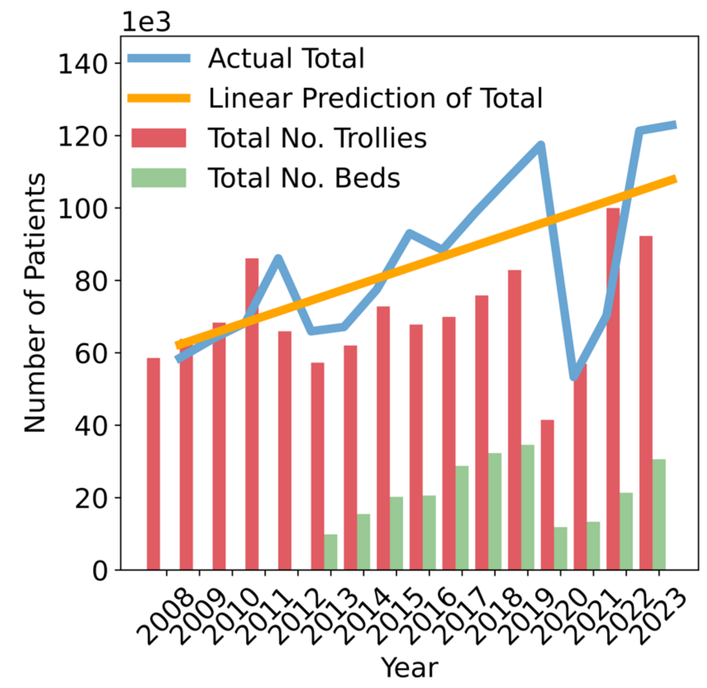
Fabricated IC using TSMC 65nm technology.

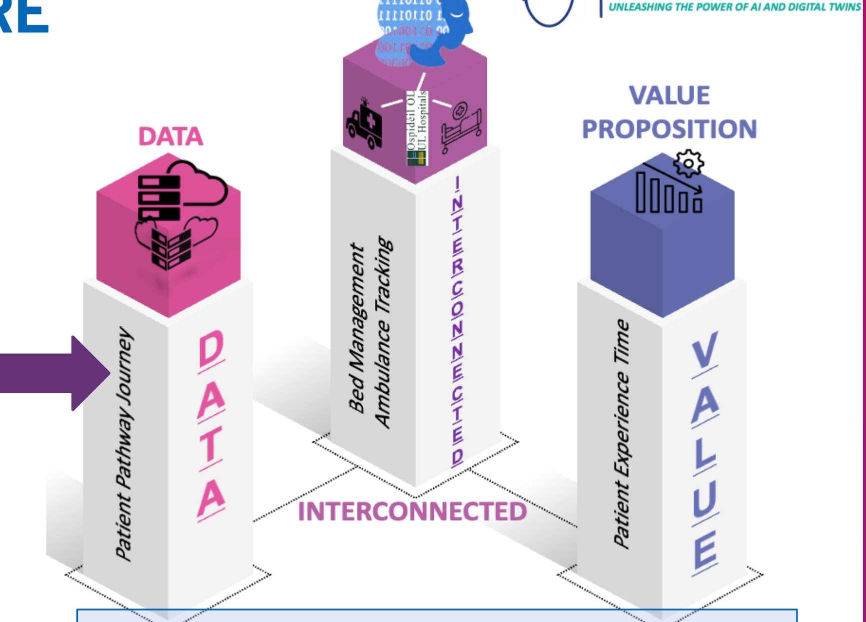


Functional Verification of the IC using FPGA (Field Programmable Gate Array).

2 UNLEASHING THE POWER OF AI AND DIGITAL TWINS FOR EMERGENCY CARE

ALTER

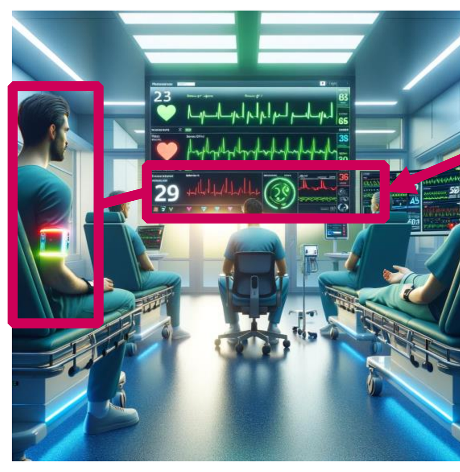




A dynamic and interconnected Digital Twin (DT) to streamline patient flow

ASSISTANT TECHNOLOGIES – EFFECTIVE USE OF 'WAIT' TIME

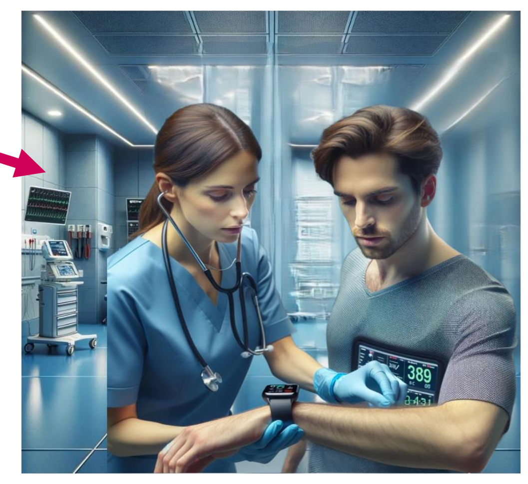
Waiting patients monitored by AI



Patient vital signs deteriorate. AI notifies the appropriate staff for intervention.

Reduced burden on staff. Efficient use of patient wait time. Valuable patient information tracked.

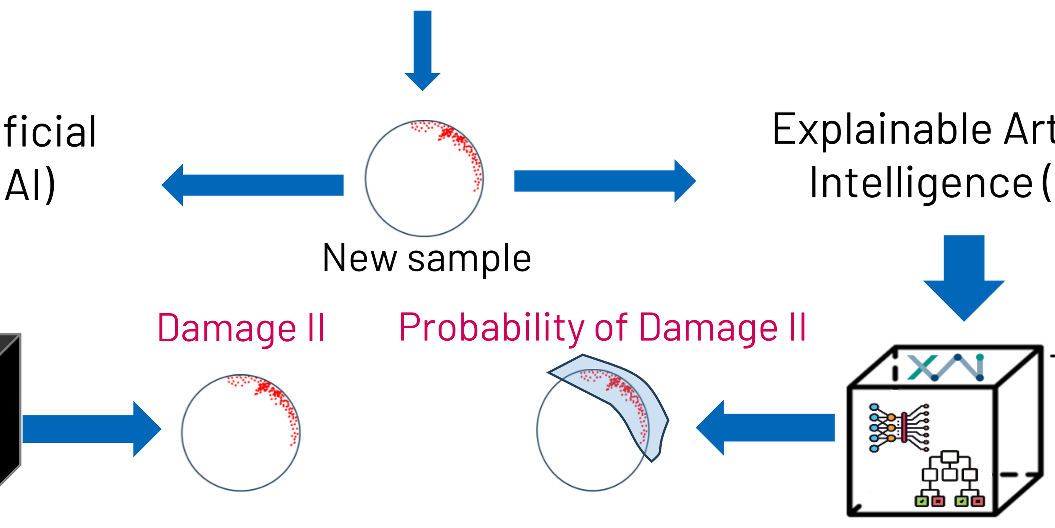
Intervention when most appropriate



Ospidéil OL / UL Hospitals — ICHEC Irish Centre for High-end Computing — HSE Feidhmeannacht na Seirbhíse Sláinte Health Service Executive — Digital for Resilience Challenge

3 Explainable Safety and Security

Use Machine Learning to identify critical safety issues



Traditional AI only gives prediction.

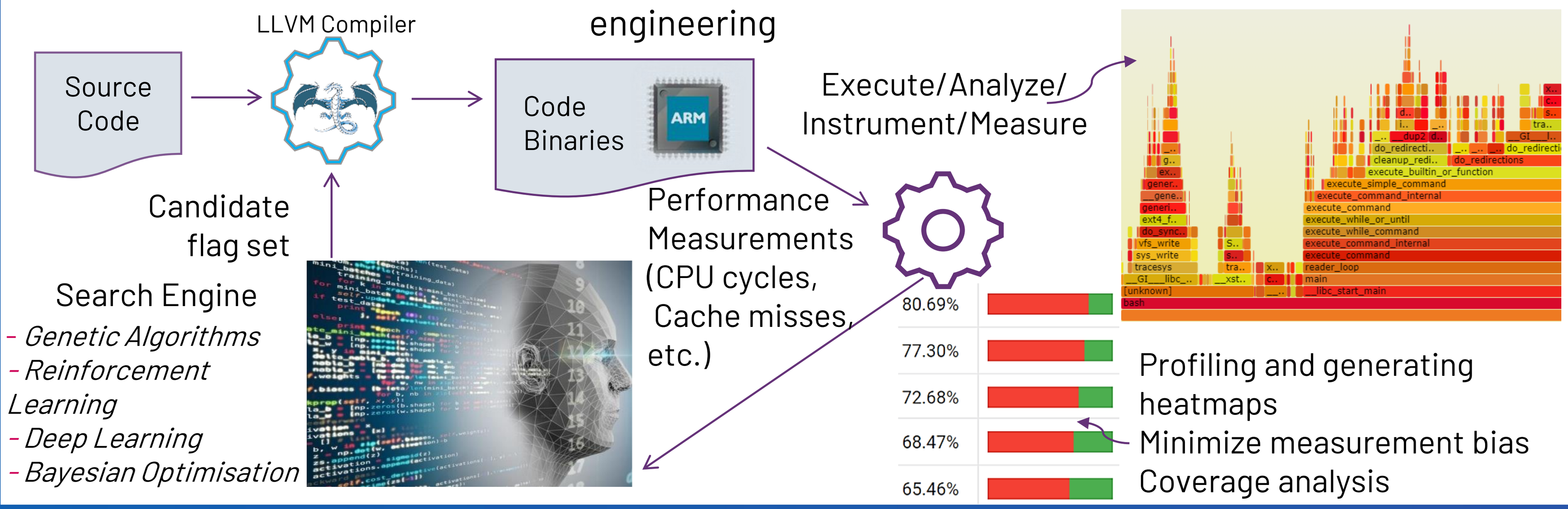
XAI explains **why** a decision was made.

WACT

Improve Wireless software performance by identifying optimal compilation options

Treat compiler flag optimisation as a machine-learning problem in software engineering

HUAWEI

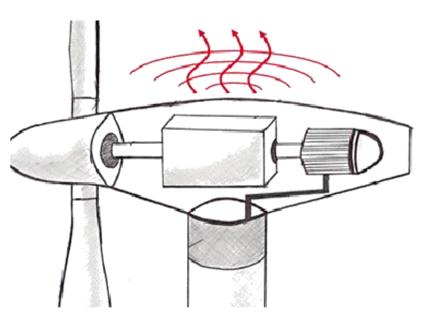


Profiling and generating heatmaps

Minimize measurement bias

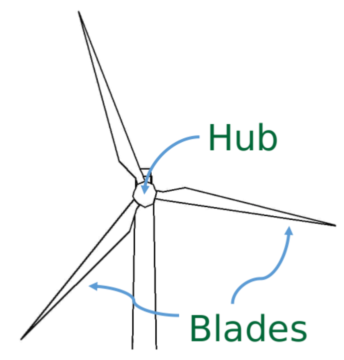
Coverage analysis

4 WIND TURBINE ROTOR SIDE UNDERPERFORMANCE THROUGH POWER CURVE ANALYSIS

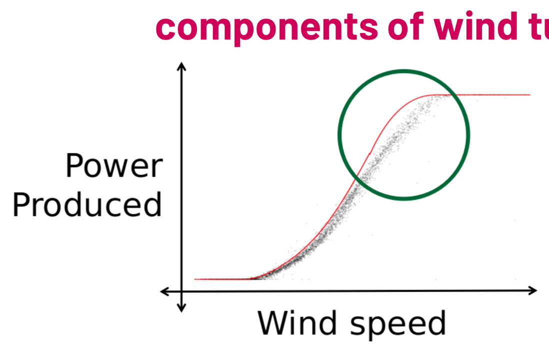


Diagnosing poor turbine performance from gear box failures is simple, as energy lost is measured as heat dissipation.

Rotor issues are trickier; there's no direct way to spot problems in the alarm logs.

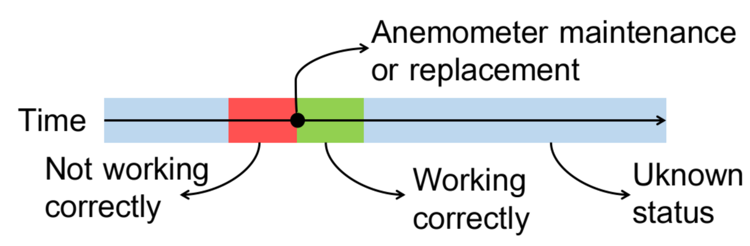


This research will develop a data-driven AI model to identify failures in rotor-side components of wind turbines after diagnosing underperformance.

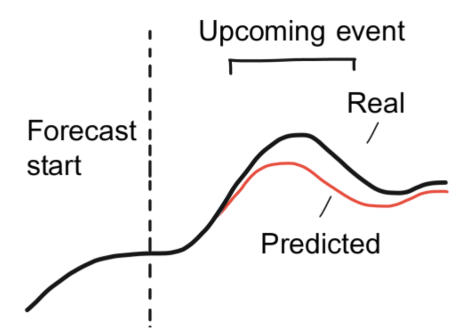


A power curve (red) show the expected power at a certain wind speeds. If actual energy (black dots) falls below, it signals turbine underperformance. This approach reliably detects turbine efficiency.

The main hurdle in this diagnosis is inaccuracies in wind speed measurements, leading to false underperformance signs. Given anemometers' long lifespan, it's difficult to identify when they need replacing or maintenance.



When the power curve indicates normal performance, we can gauge the uncertainty level, hinting at the anemometer's accuracy. Normal Behaviour Models (NBM), a type of anomaly detection, learn from data representing typical operation. Anomalies are flagged when predictions deviate from actual outcomes.



ENERGYPRO

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