UNIVERSITY OF CAMBRIDGE

Intellegens

Probabilistic neural network identification of an alloy for direct laser deposition

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Neural network algorithm to

Train from sparse datasets

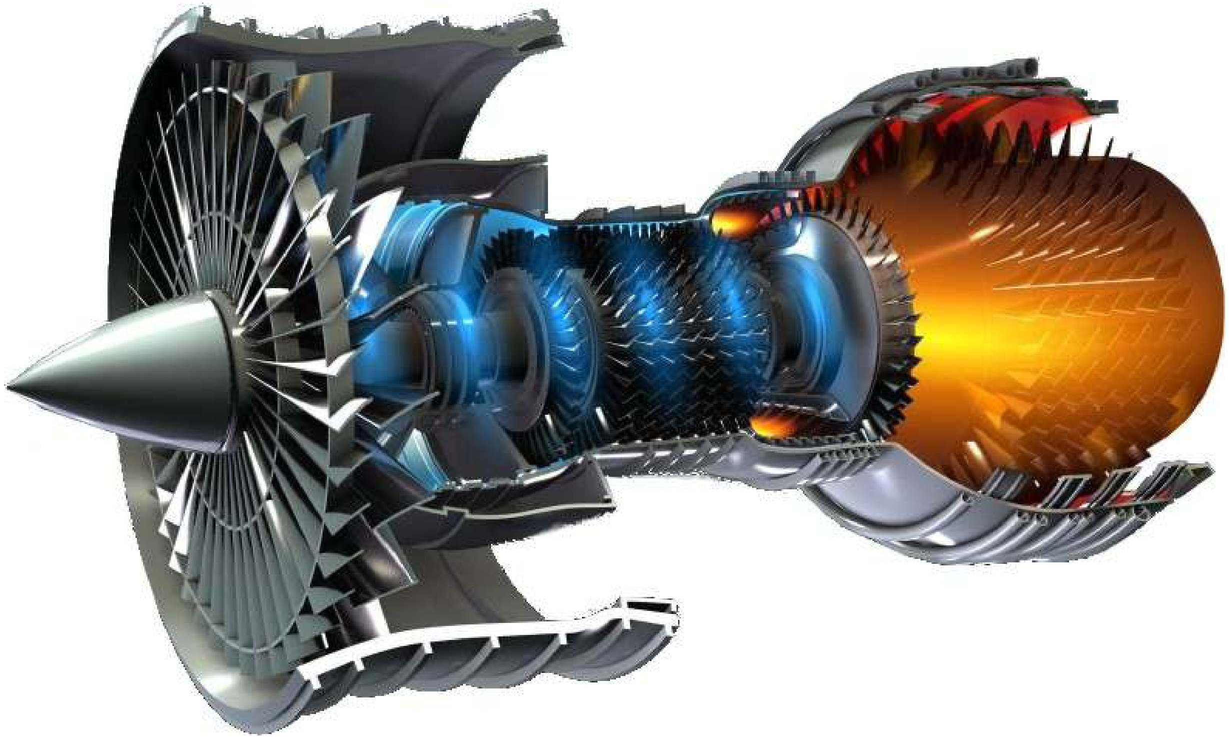
Merge simulations, physical laws, and experimental data

Reduce the need for expensive experimental development

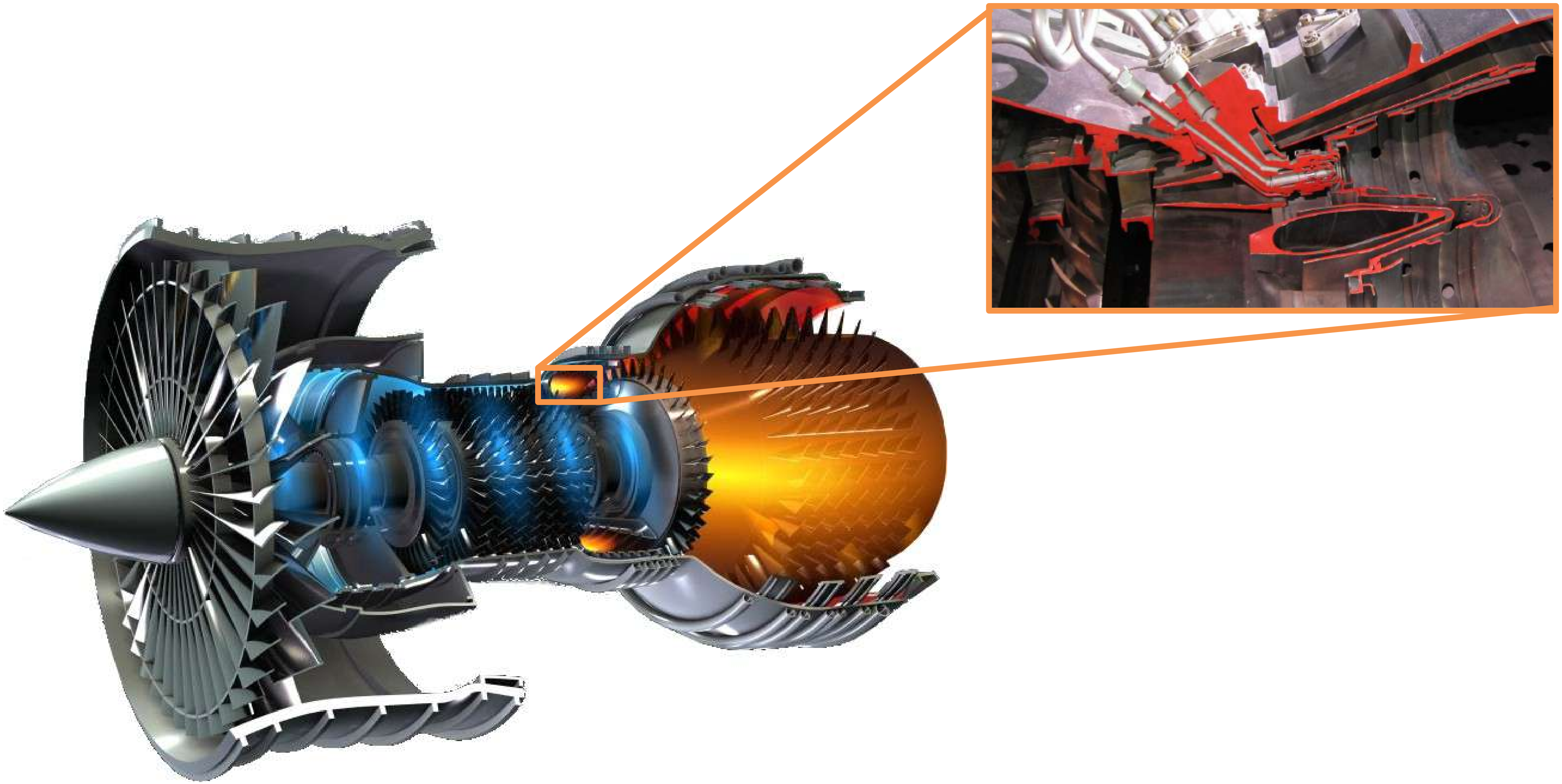
Accelerate materials and drugs discovery

Generic with proven applications in materials discovery and drug design

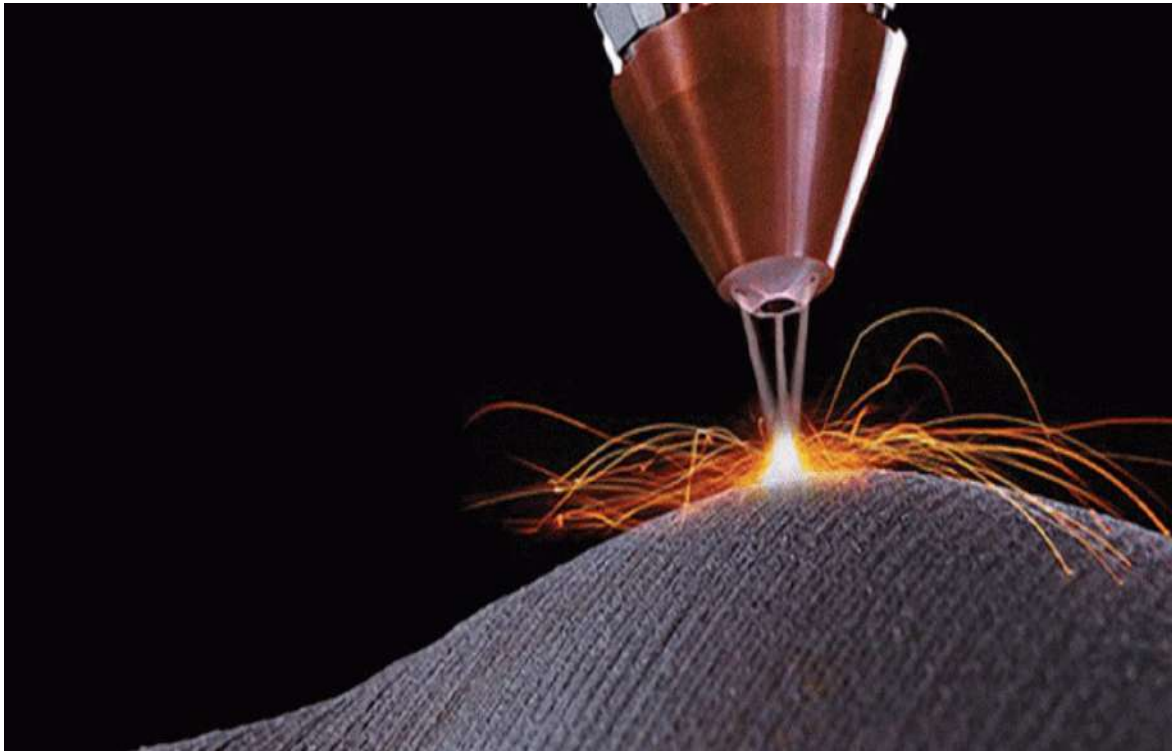
Schematic of a jet engine



Combustor in a jet engine



Direct laser deposition requires new alloys



Neural networks for materials design

Composition

Properties

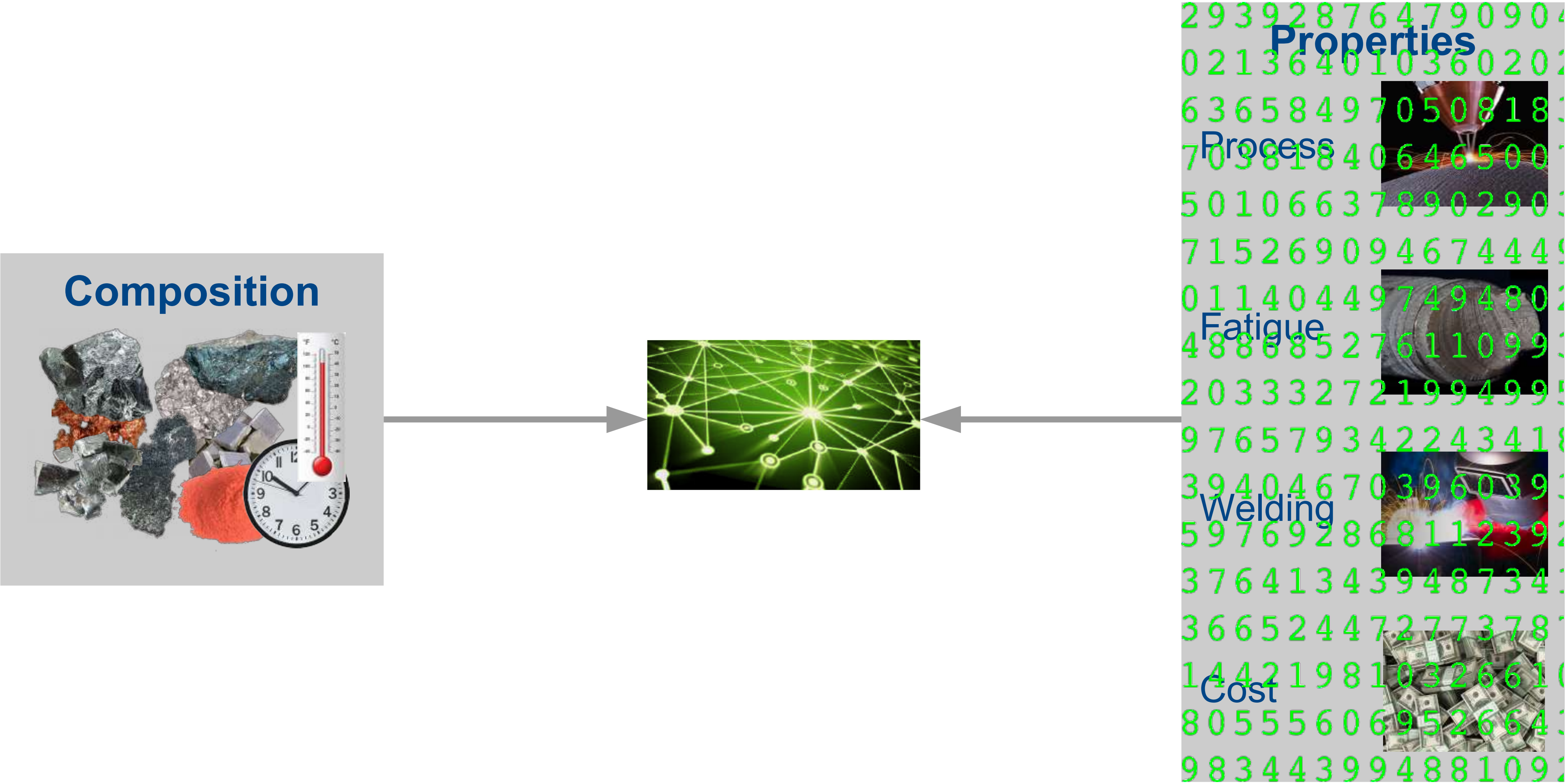
Process

Fatigue

Welding

Cost

Neural networks for materials design



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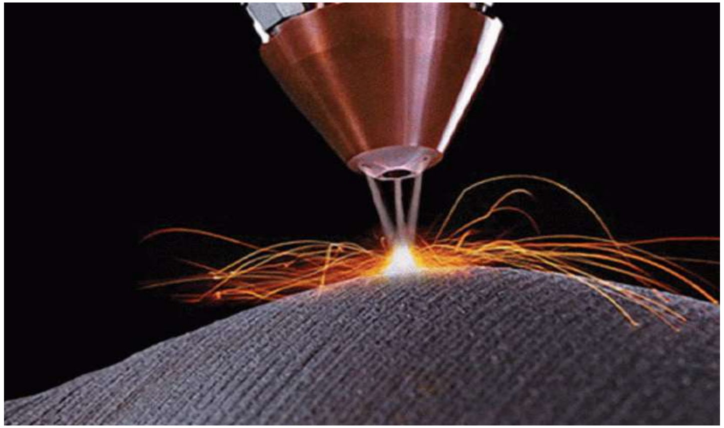
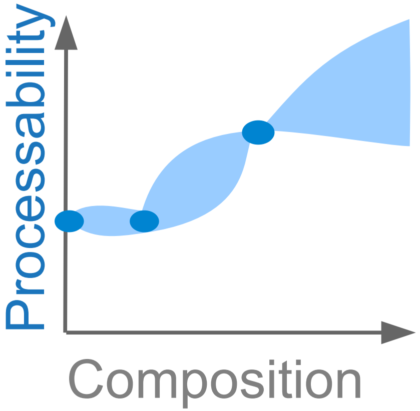


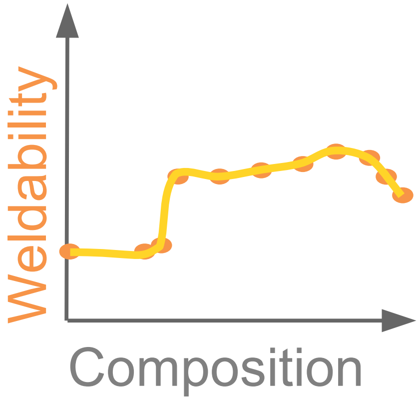
Laser

Electricity

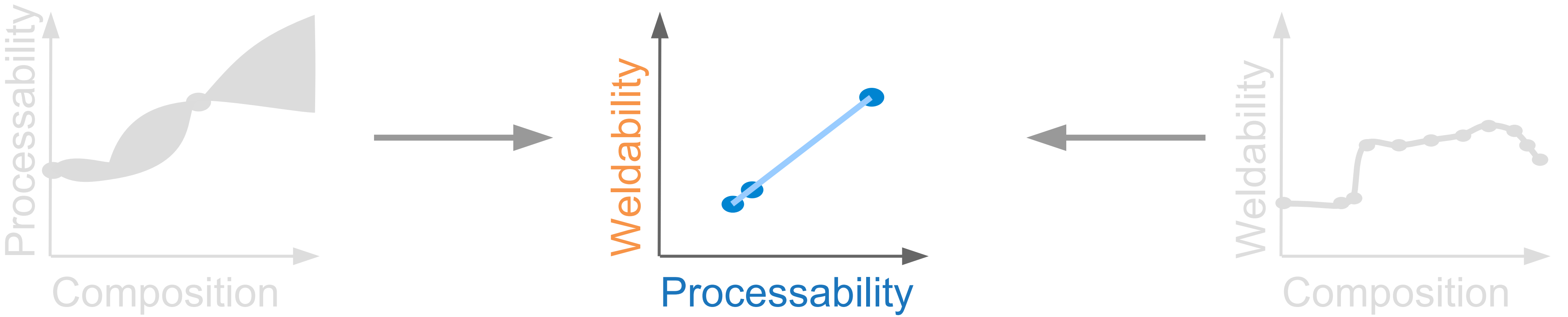
Insufficient data for processability



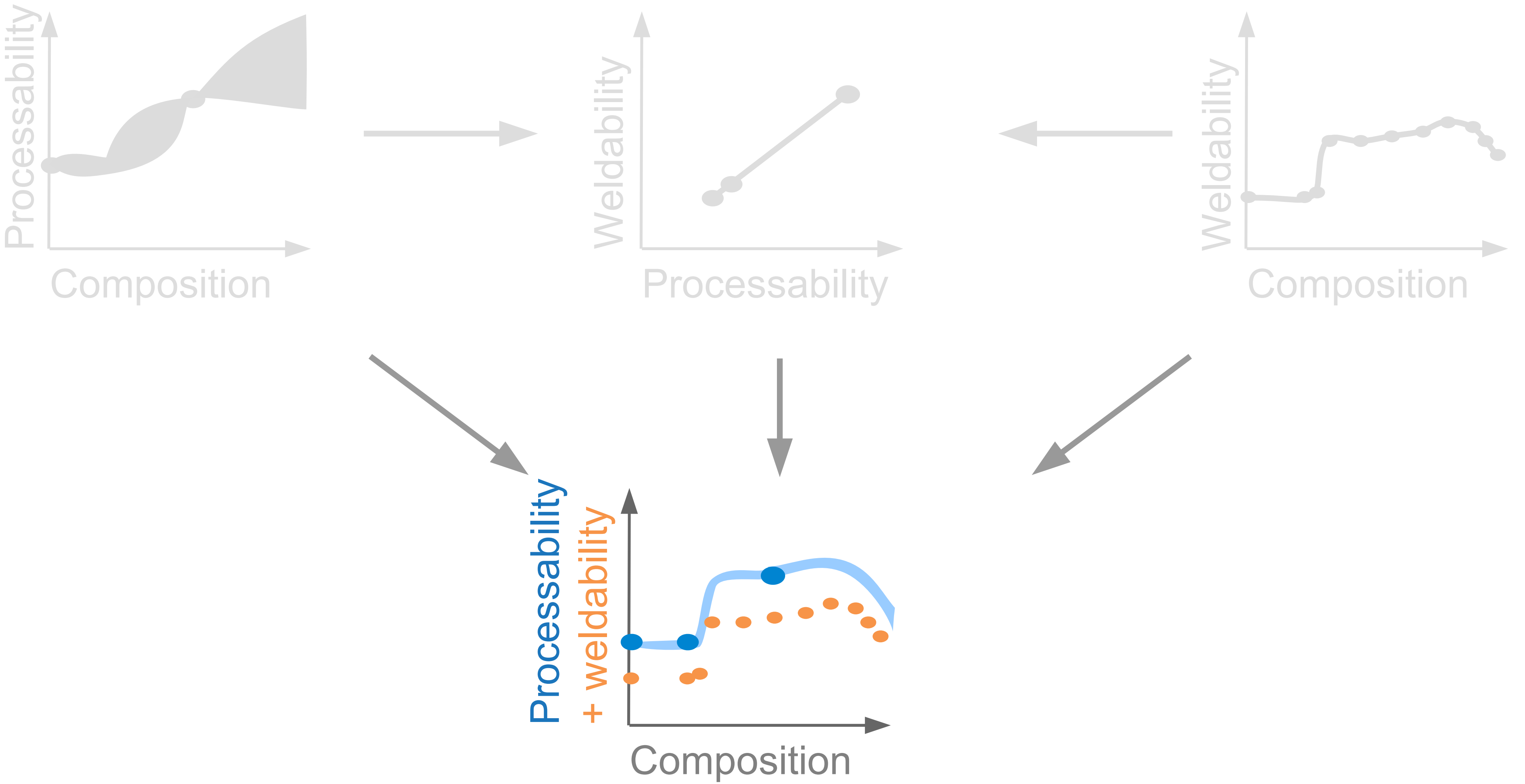
Welding is analogous to direct laser deposition



Simple processability-welding relationship



Merging properties with the neural network



Target properties

Elemental cost	<	25 $\$kg^{-1}$
Density	<	8500 kgm^{-3}
γ’ content	<	25 wt%
Oxidation resistance	<	0.3 $mgcm^{-2}$
Processability	<	0.15% defects
Phase stability	>	99.0 wt%
γ’ solvus	>	1000˚C
Thermal resistance	>	0.04 $K\Omega^{-1}m^{-3}$
Yield stress at 900˚C	>	200 MPa
Tensile strength at 900˚C	>	300 MPa
Tensile elongation at 700˚C	>	8%
1000hr stress rupture at 800˚C	>	100 MPa
Fatigue life at 500 MPa, 700˚C	>	10^5 cycles

Composition

Cr: 19%

Co: 4%

Mo: 4.9%

W: 1.2%

Zr: 0.05%

Nb: 3%

Al: 2.9%

C: 0.04%

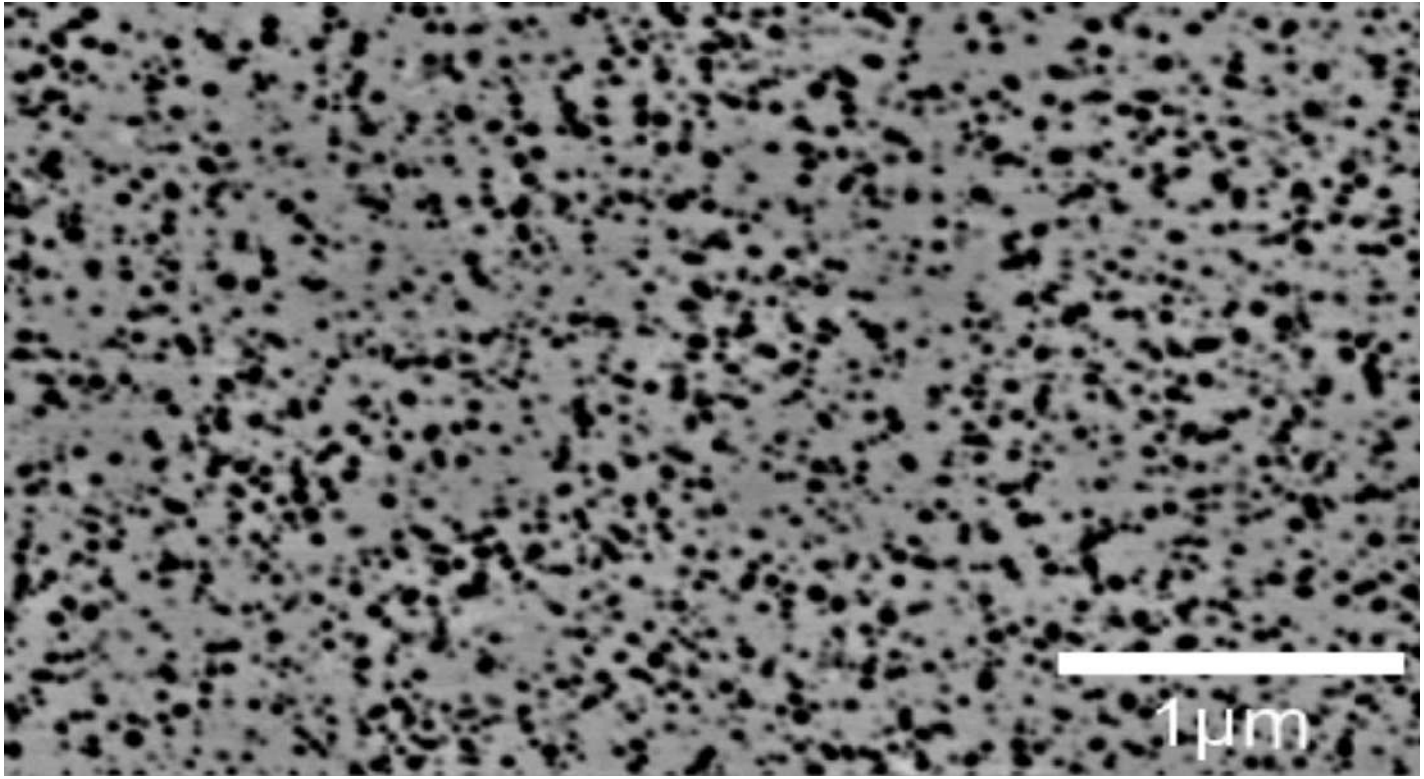
B: 0.01%

Ni

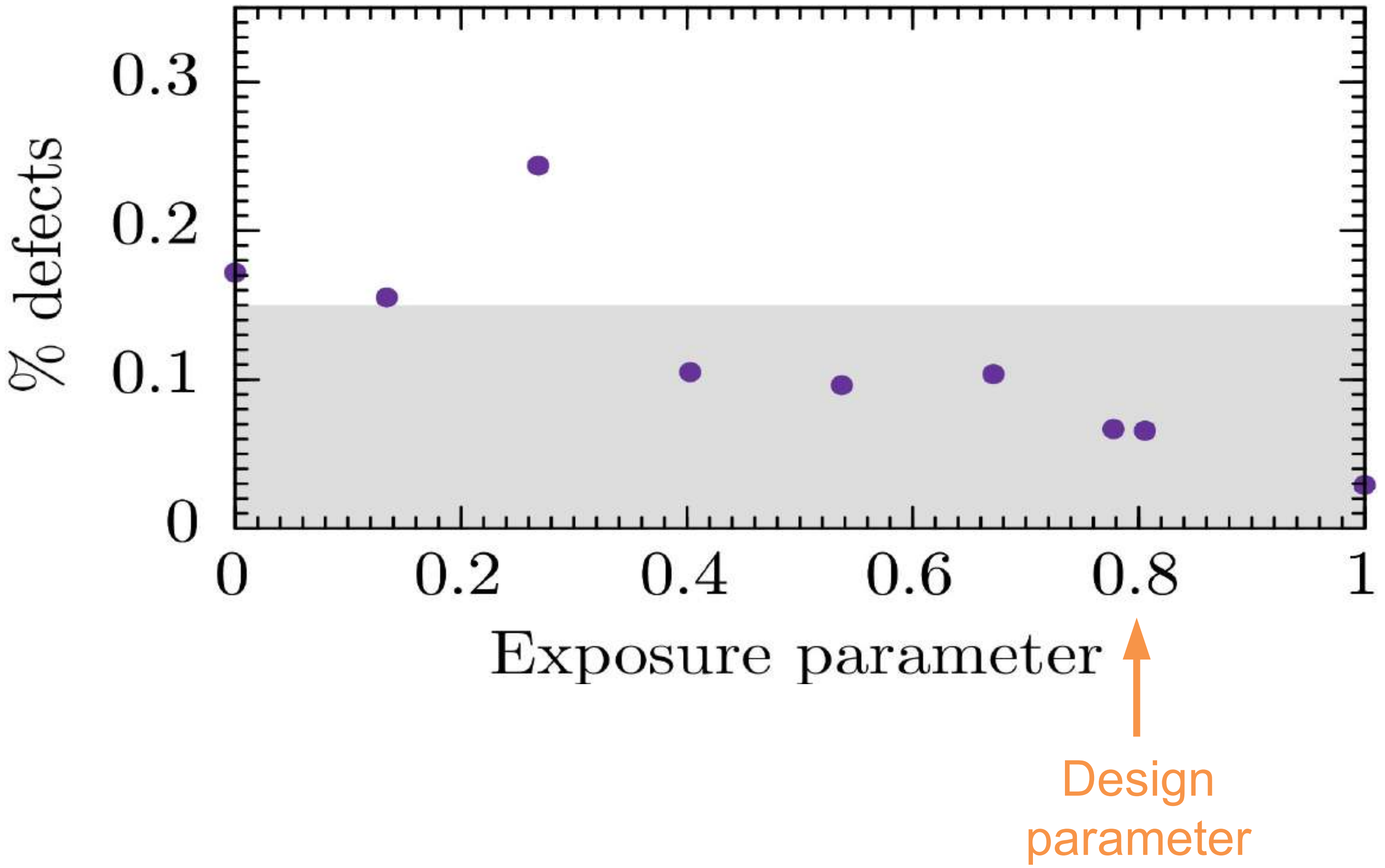
Expose 0.8

T_{HT} 1300ºC

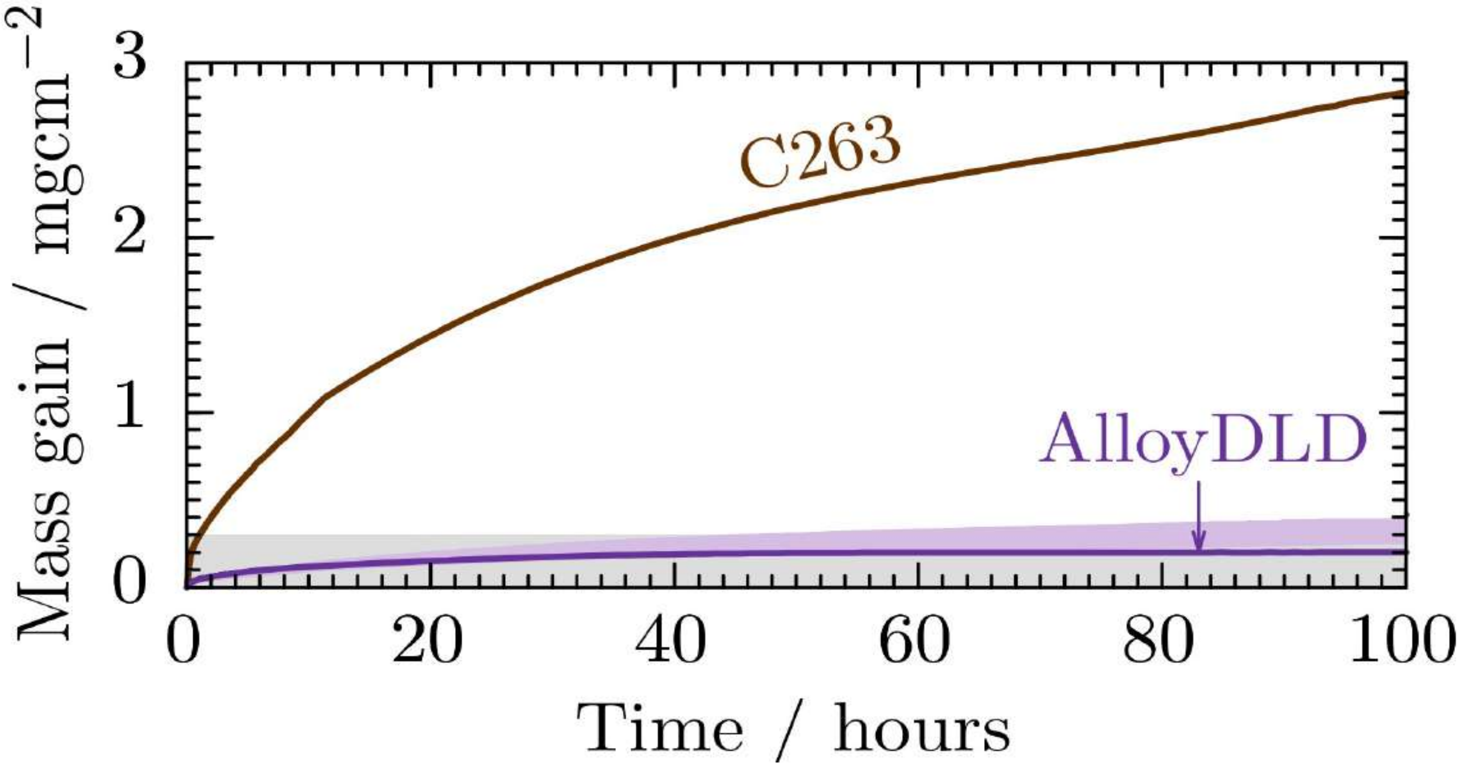
Microstructure



Testing the processability



Testing the oxidation resistance



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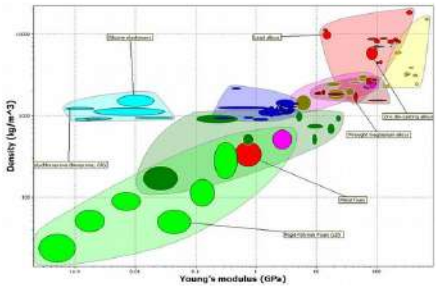
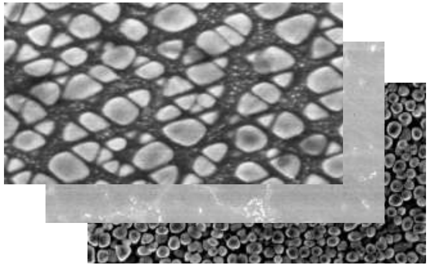
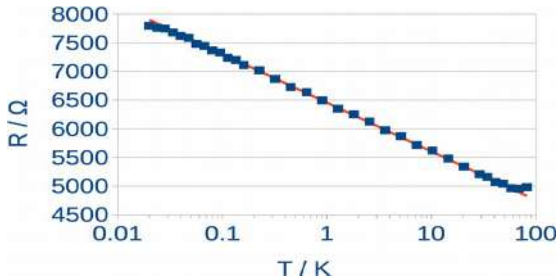
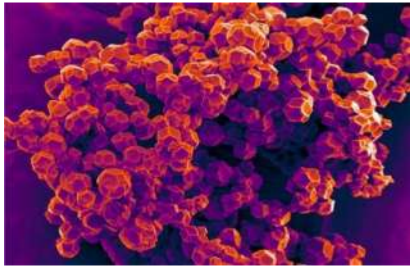
Materials designed









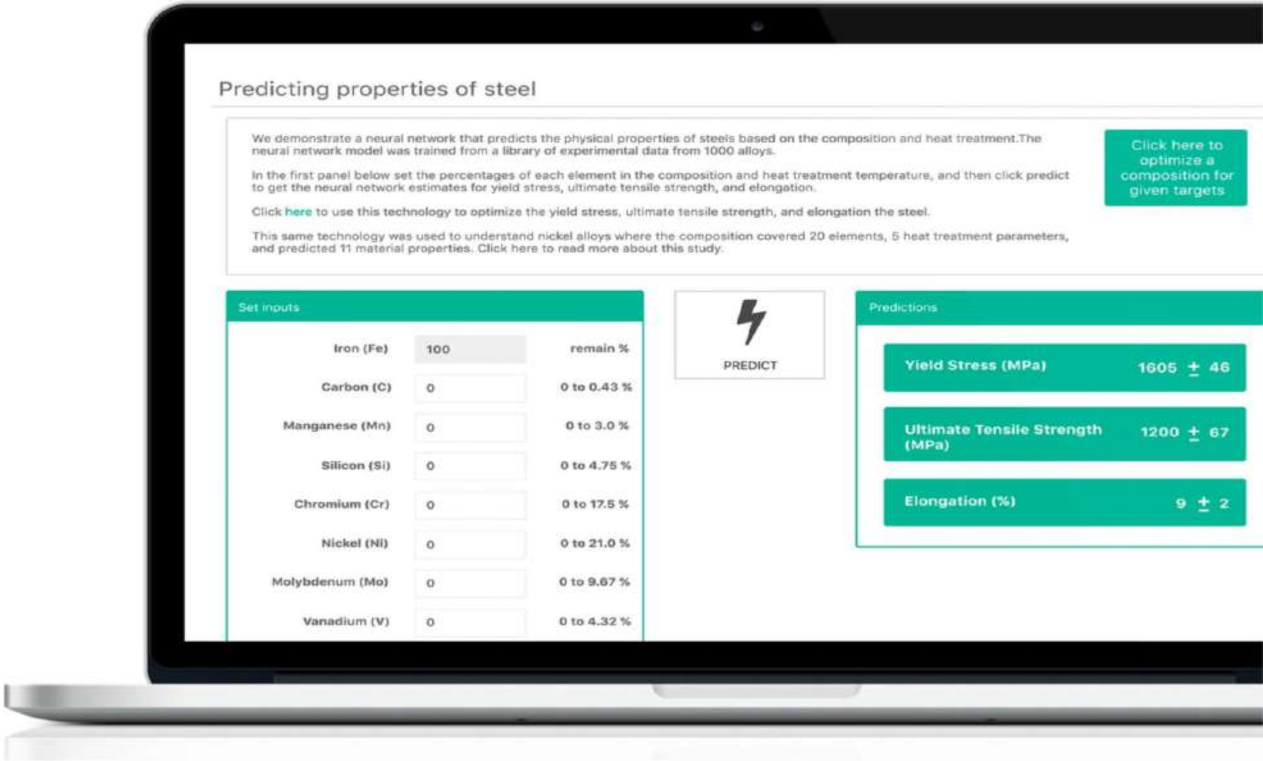
Productizing machine learning

Intellegens

1 Upload data

2 Train models

3 Design materials



https://intellegens.ai

Summary

Merge different experimental quantities and computer simulations into a holistic design tool

Proposed and experimentally verified alloy for direct laser deposition

Designed many other materials, marketed by Intellegens