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IRAP - AI Portfolio Growth Predictions

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NRC Industrial Research Assistance Program

- **IRAP's Mandate**
  - Stimulate wealth creation for Canada through innovation.

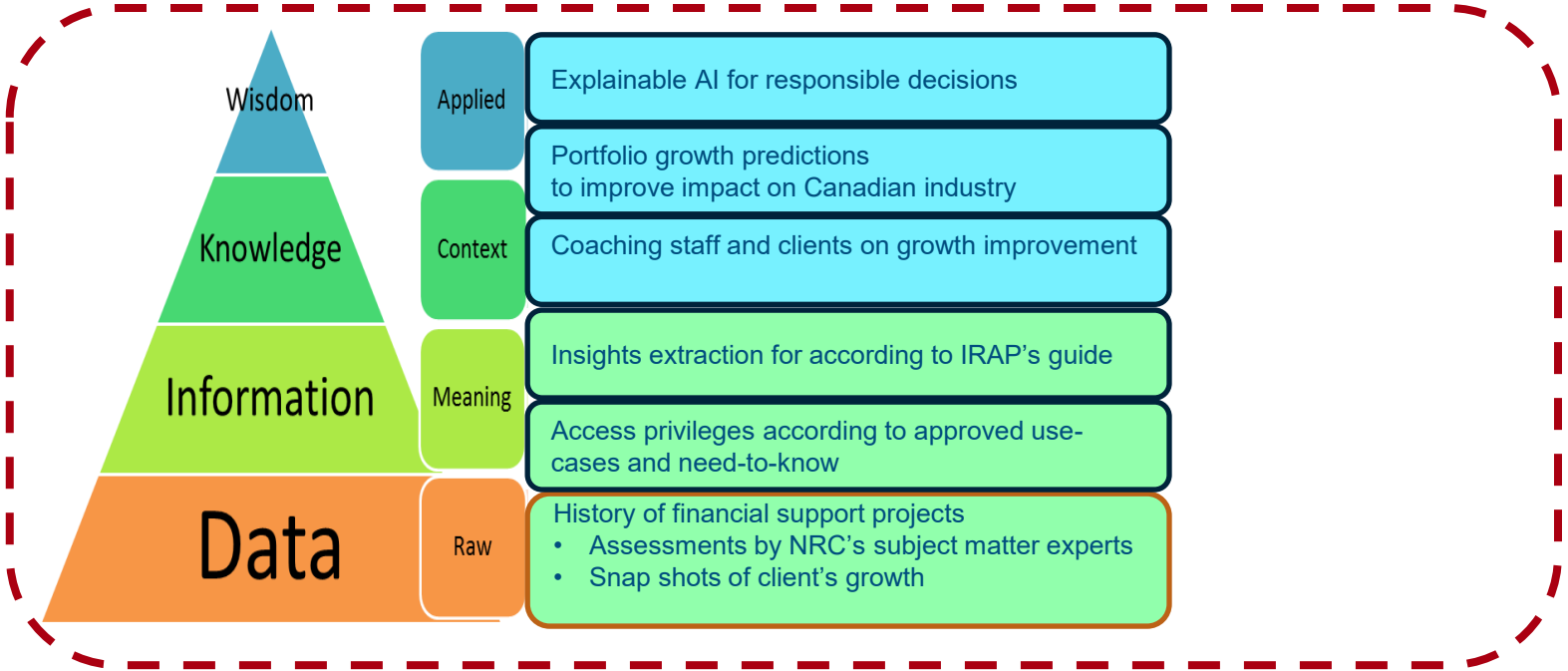
- **IRAP's Mission**
  - Accelerate the growth of small and medium-sized businesses by providing them with a comprehensive suite of innovation services and funding.

- **IRAP's Financial Support**

  When considering your business for project funding, NRC IRAP will assess:
  - the technical aspects of your innovation
  - your business, management and financial capacity
  - the likelihood of achieving results
  - your commercialization plans
  - the market potential of your project and benefits to Canada

reference: [https://nrc.canada.ca/en/support-technology-innovation]

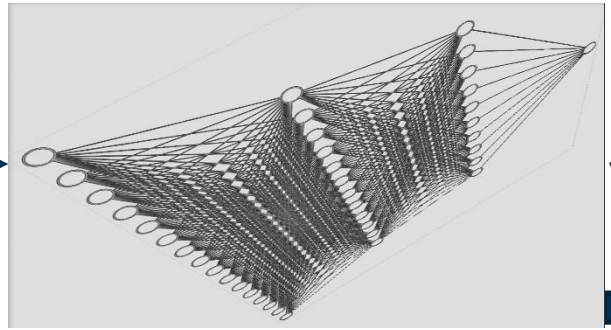
IRAP's AI research journey



Model Integration concept

Text Encoder using Transformer Network

Full text data



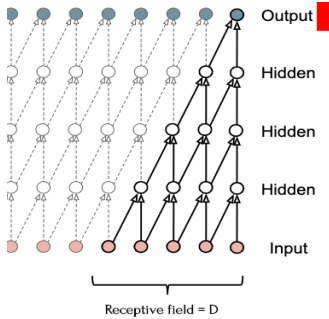
Multidimension Vector

Attention Mapping

Encoder

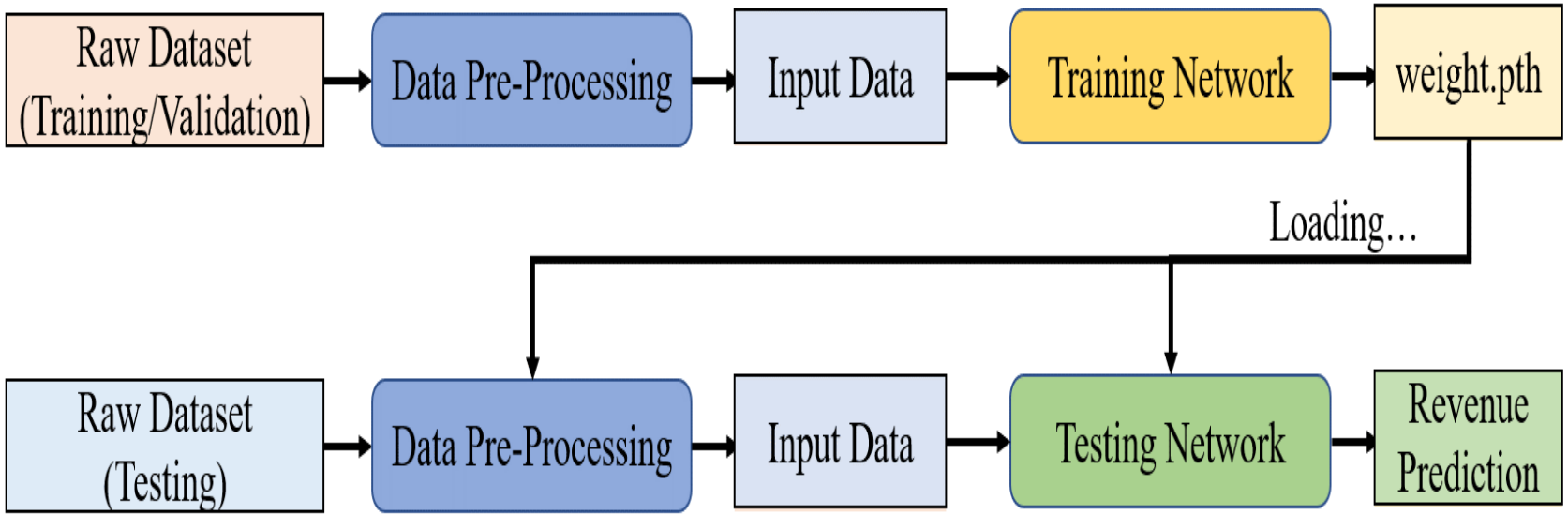
[Ashish, et al. "Attention is all you need." (2017)]

Temporal Convolutional Networks

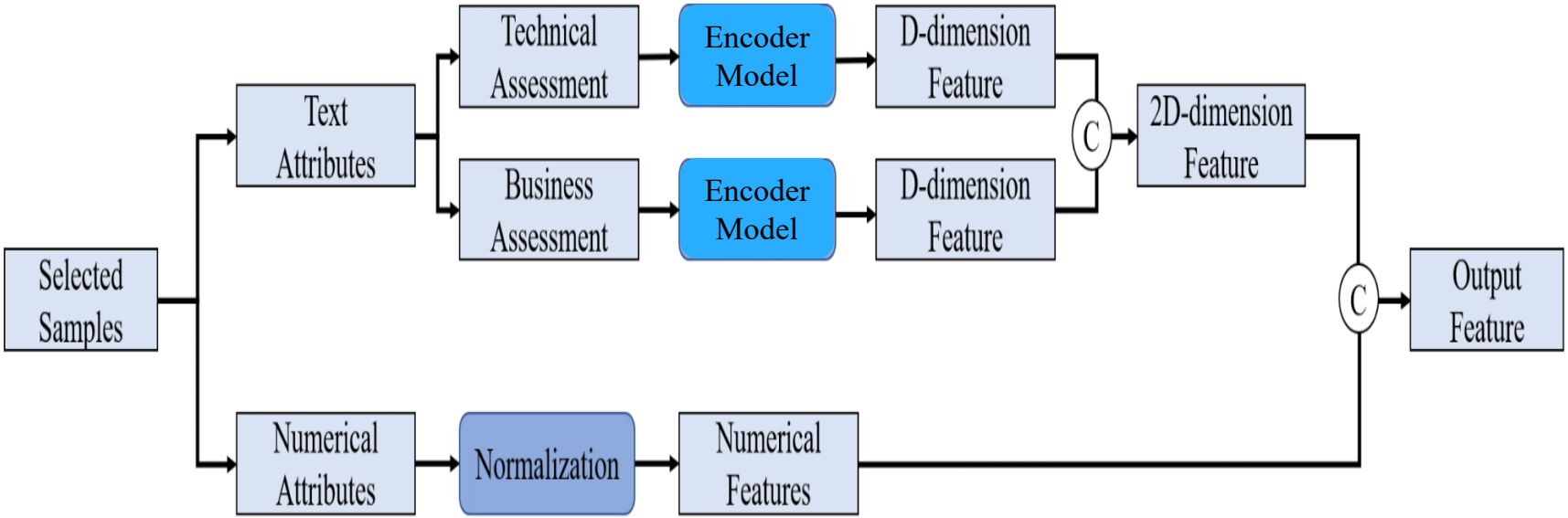


Temporal Predictions

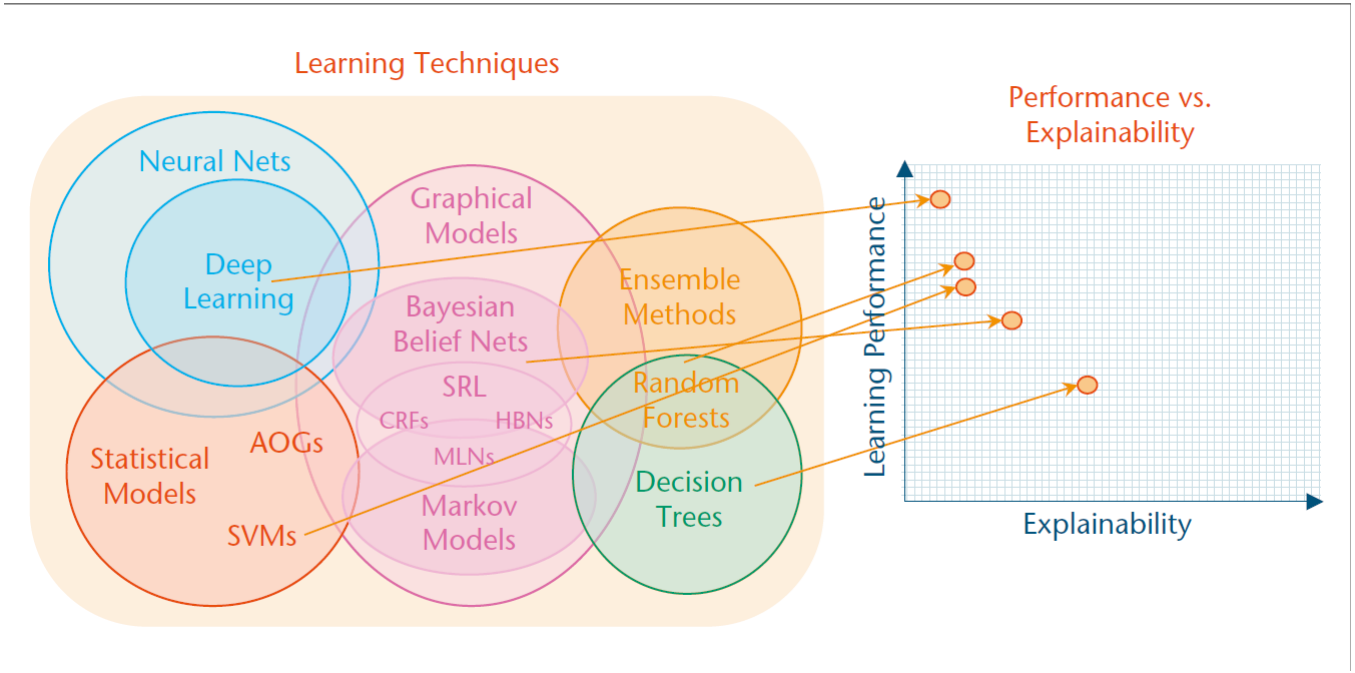
Training/Predictions Concept



Data Pre-Processing Model



Predictions Performance vs. Expansibility



Reference: DW, Gunning D. Aha. "DARPA's explainable artificial intelligence program." *AI Mag* 40, no. 2 (2019): 44.

AI Portfolio vs IRAP portfolio – Revenues

- Based on information from time t predict year-over-year growth (CAGR) for t+5 years
- Compare AI portfolio performance vs IRAP portfolio

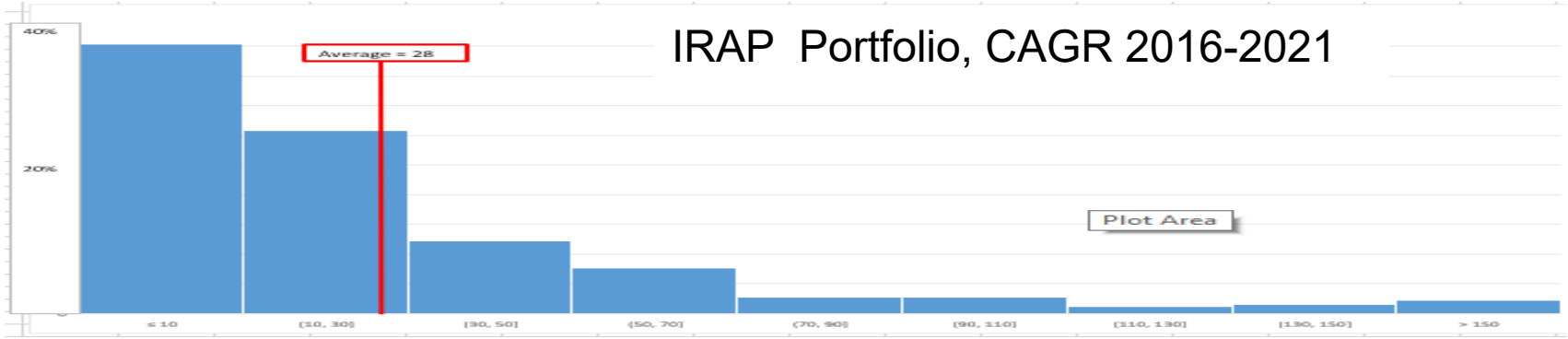
Current year	Future year	Average improvement AI vs ITA Portfolio *170% means 70% better	KPI
2013	2018	163%	Revenue
2014	2019	151%	Revenue
2015	2020	182%	Revenue
2016	2021	198%	Revenue

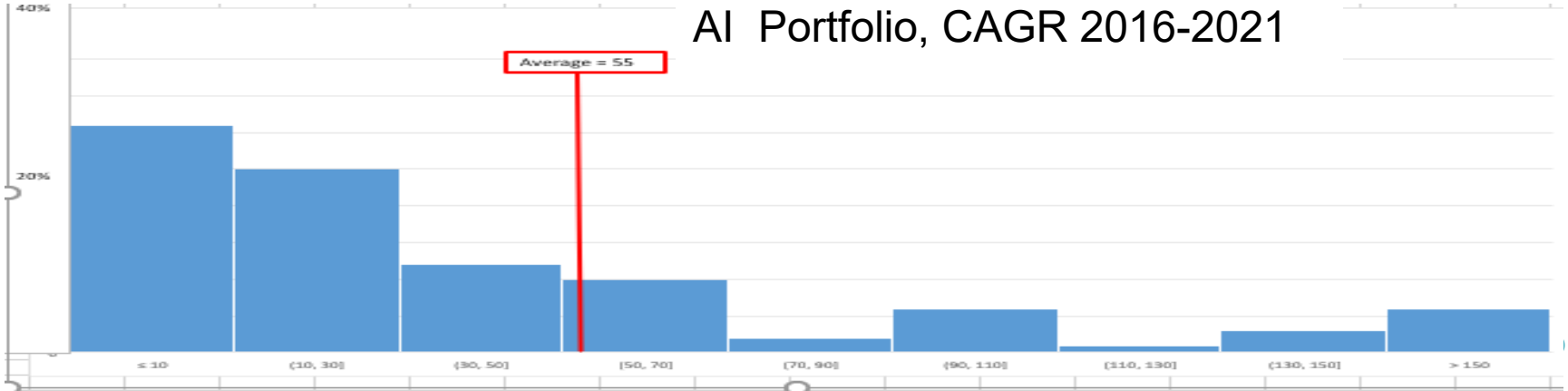
AI Portfolio vs IRAP portfolio – Employees

- Based on information from time t predict year-over-year growth (CAGR) for t+5 years
- Compare AI portfolio performance vs IRAP portfolio

Current year	Future year	Average improvement AI vs ITA Portfolio *170% means 70% better	KPI
2013	2018	153%	Employee
2014	2019	155%	Employee
2015	2020	220%	Employee
2016	2021	168%	Employee

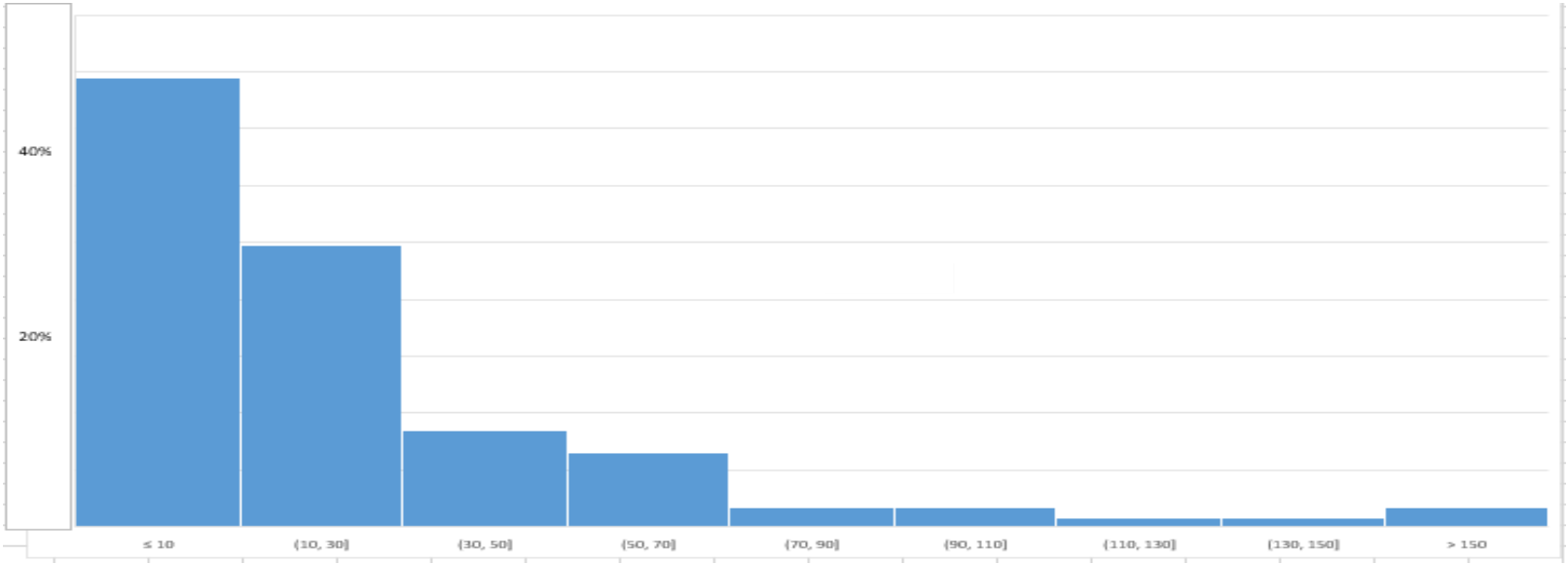
AI Portfolio vs IRAP portfolio – Distribution





Discarded Portfolio Section – Distribution

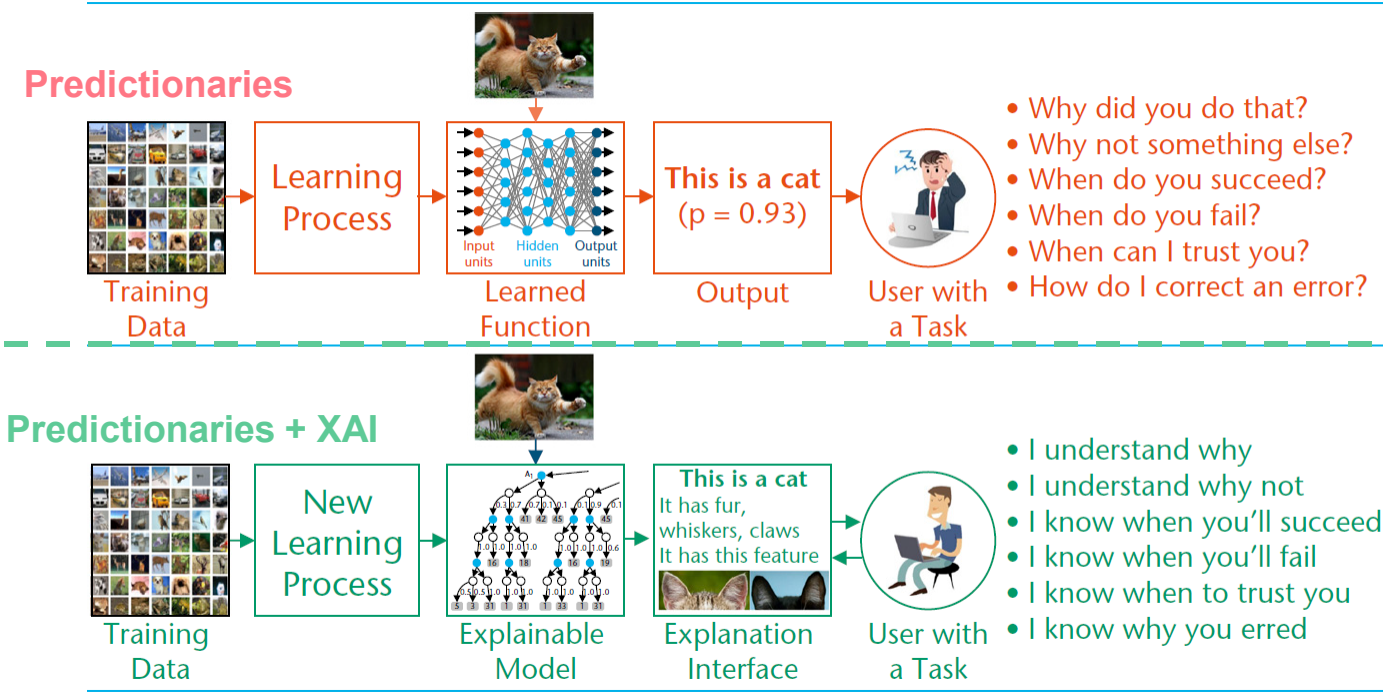
Discarded from IRAP Portfolio by AI CAGR 2016-2021



Predictions Project Results Summary

- AI portfolio achieved significant improved growth (73% improvement) compared to IRAP portfolio, using revenue as well as employee growth KPIs (5-years in the future).
- Predictions based on leading indicators, such as ITAs assessment provides successful predictions. While predictions based on lagging indicators only, such as accounting information is inefficient for predictions.
- IRAP client's growth is exponential in nature, with few firms grow rapidly while the big majority has low growth (70% below 20% CARG and 30% below 5% growth). The AI model optimized prediction performance by excluding many low performers.
- The Improvement of the AI portfolio vs IRAP portfolio in terms of revenue created with 1$ contribution is 107% in average.
- AI portfolio has much higher correlation between contributions and revenue created (42%-54%) compared to much lower collation for IRAP portfolio (5% - 18%) for the same time periods.

XAI Top Level Objective



IRAP context

-Predictions Proof of Concept to:

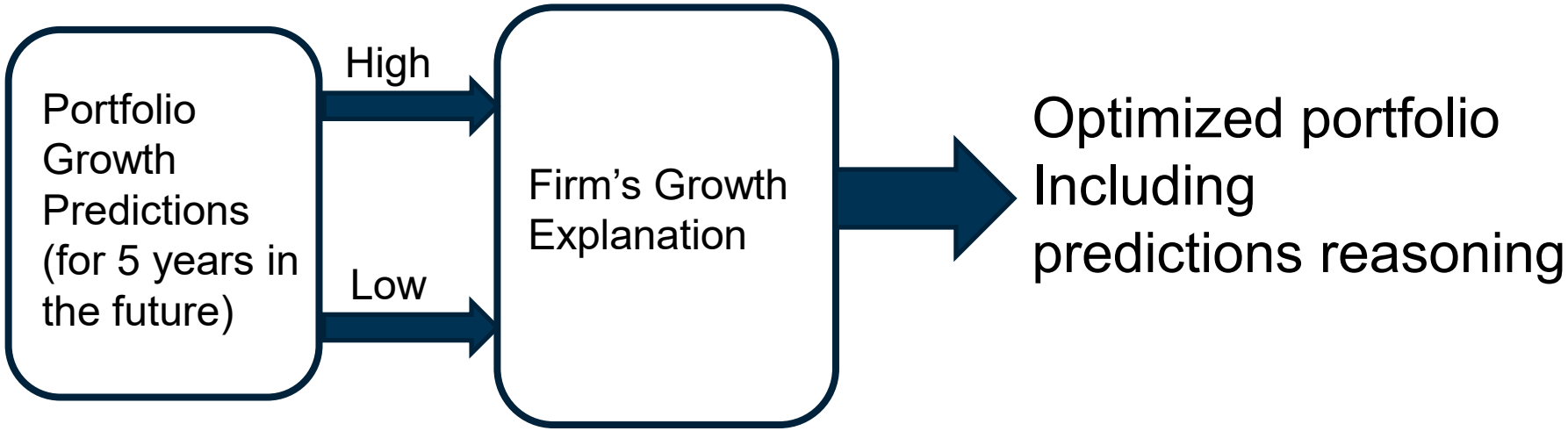
Predict IRAP portfolio growth performance 5 years in the future

Prediction + XAI - Implementation

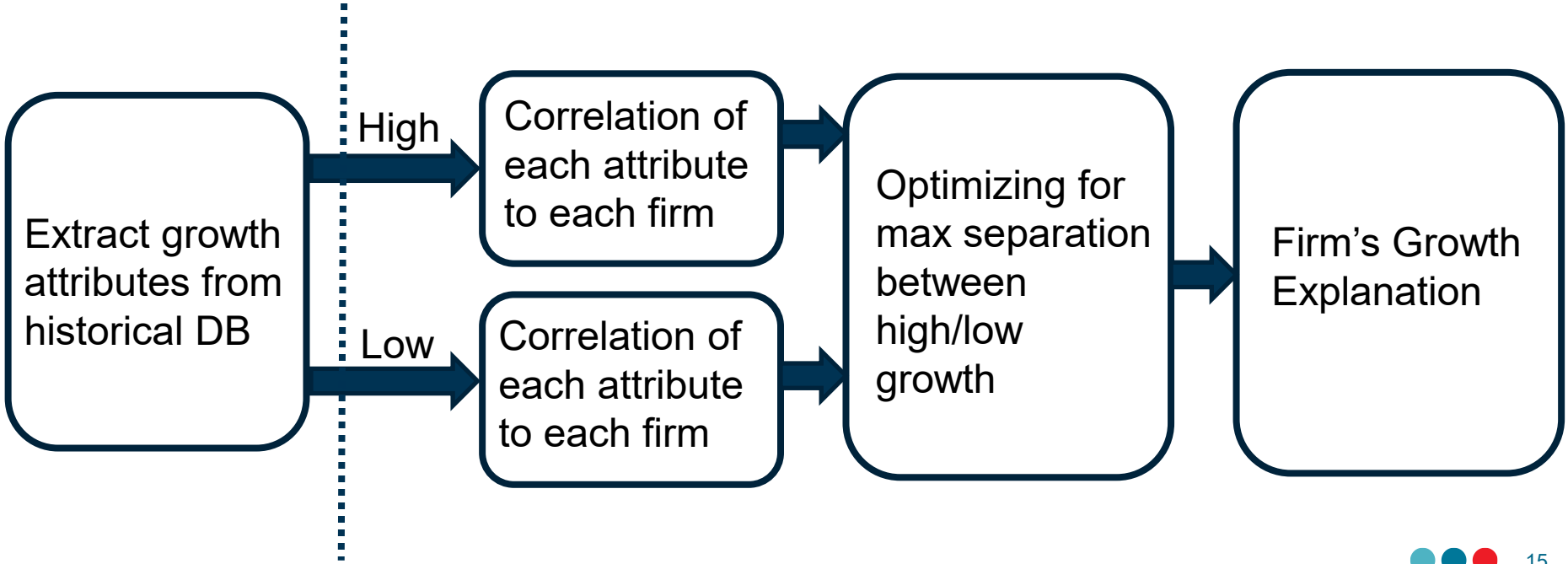
- Defendable guided portfolio
- Reasoning for IRAP's staff
- Coaching clients
- Program Scale-up through intelligent portfolio management

Reference: DW, Gunning D. Aha. "DARPA's explainable artificial intelligence program." *AI Mag* 40, no. 2 (2019): 44.

Predictions with Explanations



XAI Model


Extract growth attributes from historical DB
High
Low
Correlation of each attribute to each firm
Correlation of each attribute to each firm
Optimizing for max separation between high/low growth
Firm's Growth Explanation

High/Low growth separation in 2D – Illustration

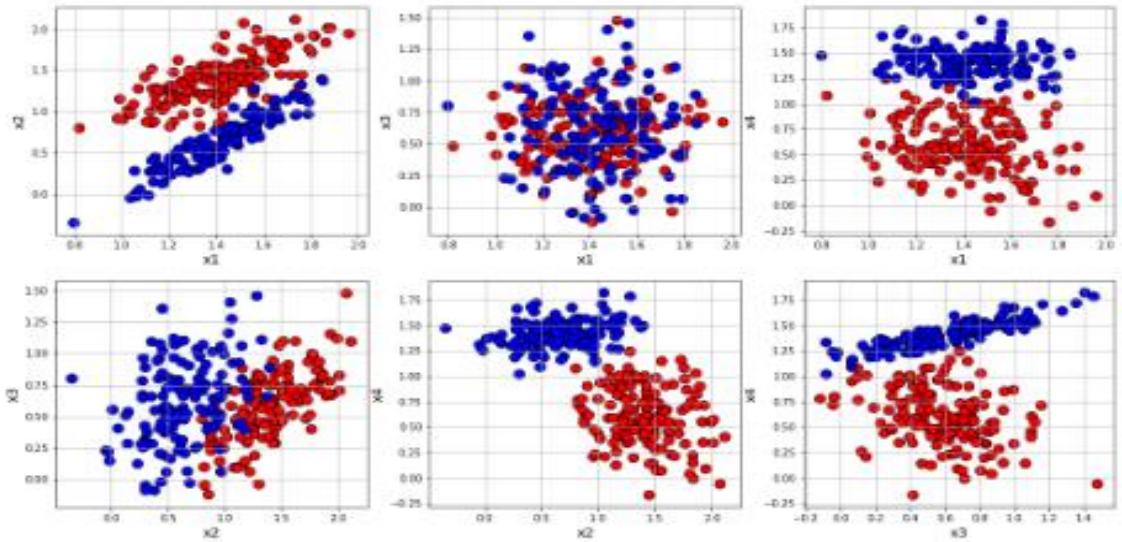


Image credit: Almutairi, Waleed A., and Ryszard Janicki. "On relationships between imbalance and overlapping of datasets." *Proceedings of 35th International Confer* 69 (2020): 141-150.

THANK YOU

D Lu, S Schwartz, et. el. “Integrating deep transformer and temporal convolutional networks for SMEs revenue and employment growth prediction” , Expert Systems With Applications, 252 (2024), p. 124-129

https://doi.org/10.1016/j.eswa.2024.124129

Growth Attributes - example

- Innovative Technology
- Strong Partnerships
- Market Opportunity
- Experienced Team
- Scalability
- Customer Focus
- Strong Business Case
- Focus on Innovation
- Competitive Pricing
- Regulatory Compliance
- Proven Track Record
- Strong Leadership
- Agility
- Defensible IP
- Revenue Model
- Market Expansion
- Product Innovation
- Strong Marketing Campaign
- Focus on Sustainability
- Technological Edge
- Customer Engagement
- Financial Stability
- Adaptability
- Focus on R&D
- Strong Sales Strategy

PGI - Portfolio Growth Improvement

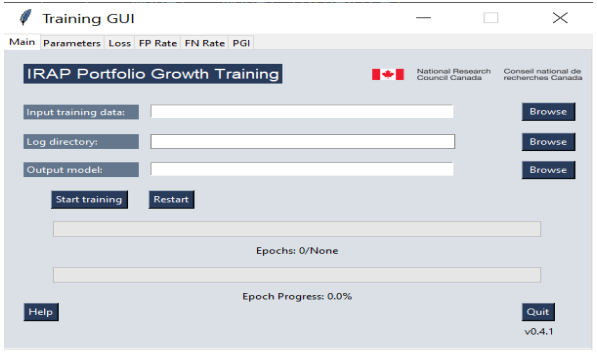
$$PGI = \left(\frac{\sum A_i}{m}\right) / \left(\frac{\sum B_i}{n}\right)$$

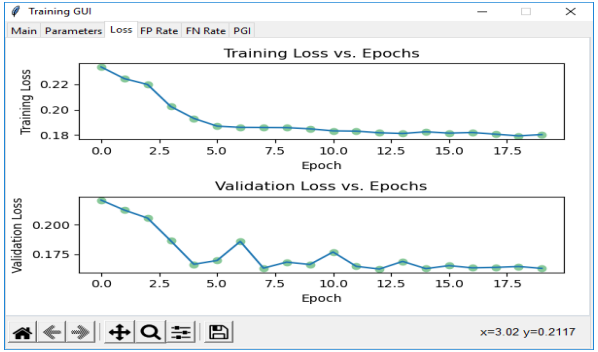
In words, PGI is the average actual growth of the AI portfolio (CAGR over 5 years) divided by average actual growth of IRAP portfolio over the same period.

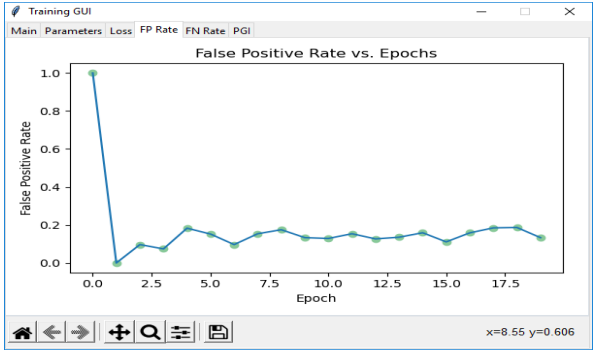
PGI higher than 100% indicates that AI portfolio outperforms IRAP portfolio when measured by CAGR. For example, if PGI is 100% the AI portfolio performs identically to IRAP portfolio. While in the case of PGI 200%, AI portfolio performs with twice better growth rate compared to IRAP portfolio growth (measured in CAGR)

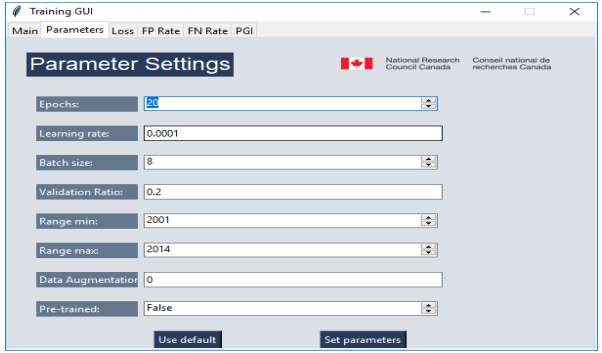
More formally, where $B = \{B_i\}_{i=1}^{n}$, which represents the set of real year-(t+5)-CAGRs of all Firms in the testing dataset, n is the number of the Firms in the testing dataset, $A = \{A_i\}_{i=1}^{m}$, which represents a subset of B, containing the real year-(t+5)-CAGRs of Firms whose predicted year-(t+5)-CAGRs are greater than 20%, m is the number of year-(t+5)-CAGRs in A.

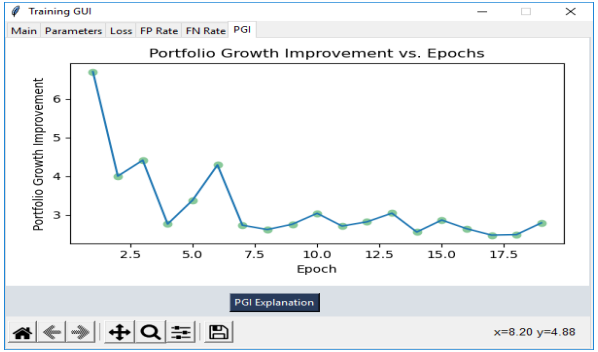
Training GUI example

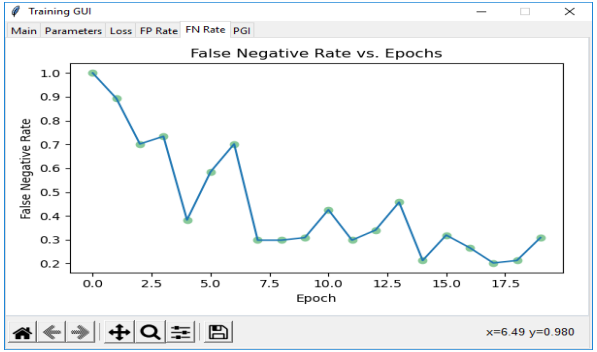












Prediction GUI example

	A	B	C	D	E	F	G	H	I	J	K
1	CAAmt	OrgID	ProjectNo	ProjectStartDate	Province	Revenue2016	Revenue2017	Revenue2018	Revenue2019	Revenue2020	Revenue2021
2	58000	52D5A8DE-7713-E411-9007-005056AB0035	871133	2016-06-30 20:00	BC	$2,813,042	$3,702,074	$4,570,409	$5,230,246	$5,977,866	$5,344,888
3	62000	AC6771B3-FD91-E511-A132-0050569F4846	868051	2016-06-30 20:00	ON	$10,279,105	$11,823,410	$12,261,500	$15,585,543	$18,289,832	$21,849,321
4	250800	0C5977E7-3A3D-E511-A0E9-0050569F4846	878129	2016-12-11 19:00	QC	$1,623,619	$1,914,605	$2,134,789	$2,830,827	$3,550,527	$4,439,718
5	149170	A009FCA2-A41F-E311-9297-005056AB0035	875820	2016-07-31 20:00	ON	$245,000	$281,808	$292,250	$371,478	$435,934	$520,773
6	138280	C7352209-17C4-E211-9A6D-005056AB0035	876252	2016-10-31 20:00	ON	$2,080,000	$2,392,494	$2,481,142	$3,153,770	$3,700,989	$4,421,260
7	199000	C0BD50E5-16C4-E211-9A6D-005056AB0035	871277	2016-08-06 20:00	AB	$3,028,112	$3,517,002	$3,766,146	$4,236,637	$4,348,177	$4,813,267
8	292216	20D55F2F-A5FD-E511-AB7E-0050569F4846	867718	2016-06-12 20:00	NB	$17,745,014	$20,346,543	$19,858,237	$23,124,370	$24,870,073	$27,046,862
9	92200	CD1D58DF-16C4-E211-9A6D-005056AB0035	868766	2016-06-26 20:00	ON	$1,607,751	$1,913,857	$2,055,273	$2,693,899	$3,281,498	$3,659,717
10	300000	55931A0F-17C4-E211-9A6D-005056AB0035	871252	2016-08-14 20:00	AB	$391,586	$454,808	$487,026	$547,869	$562,293	$622,437