Sensor-centric synthetic data for system validation

September 10 2024

Javier Salado
Anyverse Product Manager

ANYVERSE

Hochschule Düsseldorf
University of Applied Sciences
HSD

ASAM

Quality

"In essence, quality is about meeting or exceeding expectations, whether those expectations are set by customers, standards, or the goals of a particular process or product."

OpenAI ChatGPT

"Ultimately, quality is a subjective measure that can vary depending on the context and individual perspectives. It's a continuous pursuit that involves ongoing improvement and attention to detail."

Google Gemini

"In summary, quality encompasses a range of definitions that highlight its role in customer satisfaction, fitness for purpose, conformance to requirements, and overall excellence. It is a subjective measure that varies based on individual expectations and the specific context of use."

Perplexity

"Quality is a multifaceted concept that can be defined in various ways depending on the context. In general, quality refers to the degree of excellence, value, or worth of something."

Anthropic's Claude

Simulation Quality

"Simulation quality refers to the degree to which a simulation accurately represents the real-world system, process, or scenario it is intended to model. High-quality simulations provide reliable, valid, and useful results that can inform decision-making, design, or research."

OpenAI ChatGPT-4o

"Simulation quality refers to the degree to which a simulation accurately represents the real-world system it is intended to model. It is a crucial aspect of any simulation, as a high-quality simulation can provide valuable insights and predictions."

Google Gemini

"Simulation quality refers to the degree of accuracy, reliability, and effectiveness of a simulation model in representing the real-world system or process it aims to emulate."

Perplexity

"Simulation quality refers to how well a simulation represents or mimics the real-world system or process it's designed to model."

Anthropic's Claude

3 pillars of simulated data quality for computer vision

Render quality
(accuracy)

Image quality
(reliability)

Data usability
(effectiveness)

Render quality

The final goal is to assess the physically correct light transport simulation. It is the basis of a path-tracing render engine

Render quality

Commission Internationale de l'Eclairage (CIE)

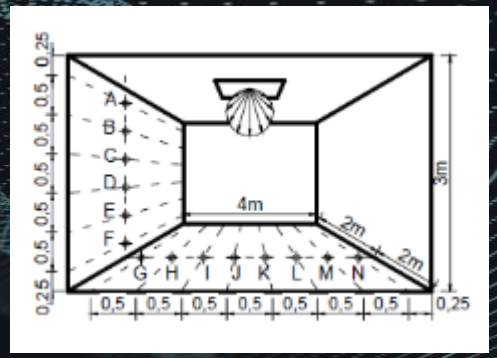
CIE 171:2006. Test cases to assess the accuracy of lighting computer programs

3 types of illumination simulation:

- Area diffuse light source
- CIE sky models illumination
- Point light sources (IES)

Render quality

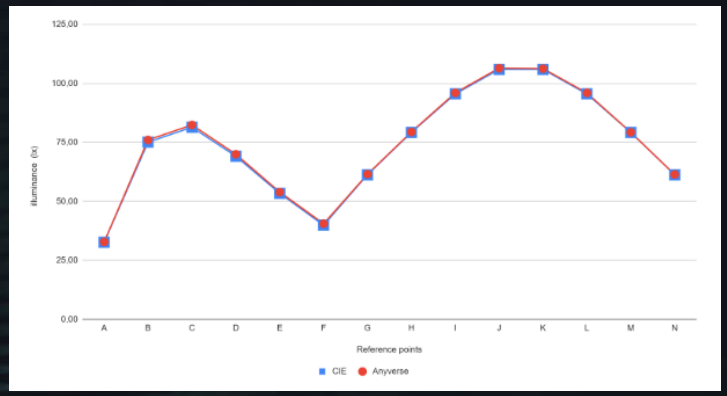
Area diffuse light source



Reference points	A	B	C	D	E	F		
Illuminance CIE (lx)	32,68	75,09	81,38	69,12	53,41	39,90		
Illuminance Anyverse (lx)	32,82	76,00	82,36	69,96	53,94	40,53		
Absolute Error	**0,140**	**0,910**	**0,980**	**0,840**	**0,530**	**0,630**		
Relative Error	**0,43%**	**-1,21%**	**-1,20%**	**-1,22%**	**-0,99%**	**-1,58%**		

Reference points	G	H	I	J	K	L	M	N
Illuminance CIE (lx)	61,27	79,18	95,52	105,89	105,89	95,52	79,18	61,27
Illuminance Anyverse (lx)	61,49	79,40	95,94	106,43	106,23	95,92	79,24	61,35
Absolute Error	**0,220**	**0,220**	**0,420**	**0,540**	**0,340**	**0,400**	**0,060**	**0,080**
Relative Error	**0,36%**	**-0,28%**	**-0,44%**	**-0,51%**	**-0,32%**	**-0,42%**	**-0,08%**	**-0,13%**

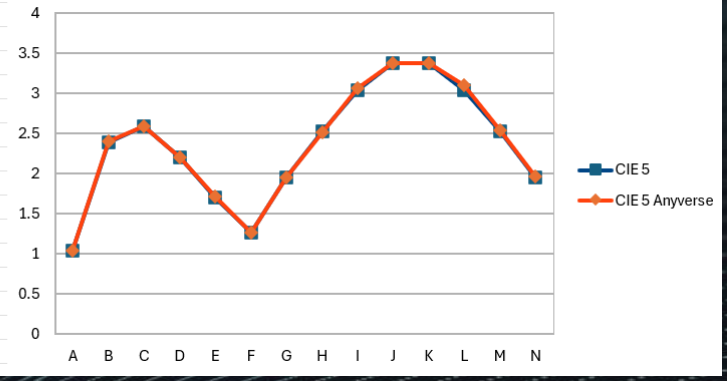
Table 1 – Calculated results and reference values for illuminance under the diffuse light source



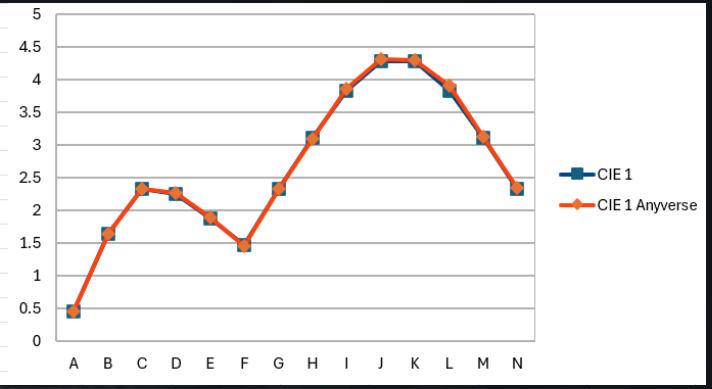
Render quality

CIE sky models illumination

	CIE 5	CIE 5 Anyverse	Error
A	1.04	1.04002213	0.00 %
B	2.39	2.39665914	0.28 %
C	2.59	2.58596635	0.16 %
D	2.2	2.20207191	0.09 %
E	1.7	1.70794666	0.47 %
F	1.27	1.26809752	0.15 %
G	1.95	1.94748712	0.13 %
H	2.52	2.51252675	0.30 %
I	3.04	3.05808258	0.59 %
J	3.37	3.3713572	0.04 %
K	3.37	3.37008476	0.00 %
L	3.04	3.09397388	1.78 %
M	2.52	2.53819227	0.72 %
N	1.95	1.96328533	0.68 %



	CIE 1	CIE 1 Anyverse	Error
A	0.46	0.45989567	0.02 %
B	1.64	1.65082669	0.66 %
C	2.34	2.34081459	0.03 %
D	2.26	2.269696	0.43 %
E	1.88	1.88972783	0.52 %
F	1.47	1.46314991	0.47 %
G	2.33	2.33309984	0.13 %
H	3.11	3.10562491	0.14 %
I	3.84	3.86451697	0.64 %
J	4.29	4.31016159	0.47 %
K	4.29	4.30871677	0.44 %
L	3.84	3.91039491	1.83 %
M	3.11	3.13741207	0.88 %
N	2.33	2.35056734	0.88 %



Point light sources (IES)
WIP

Image quality. Sensor simulation

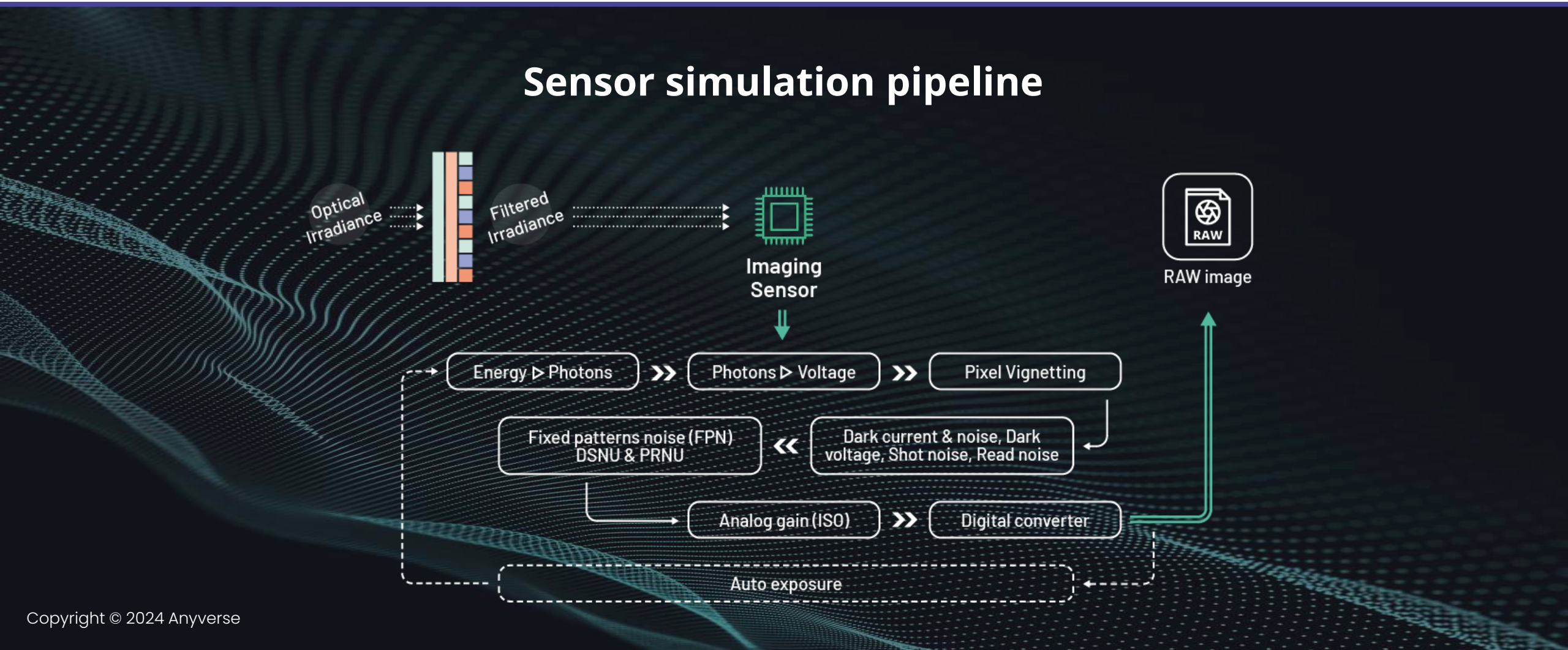


Image quality. Sensor simulation

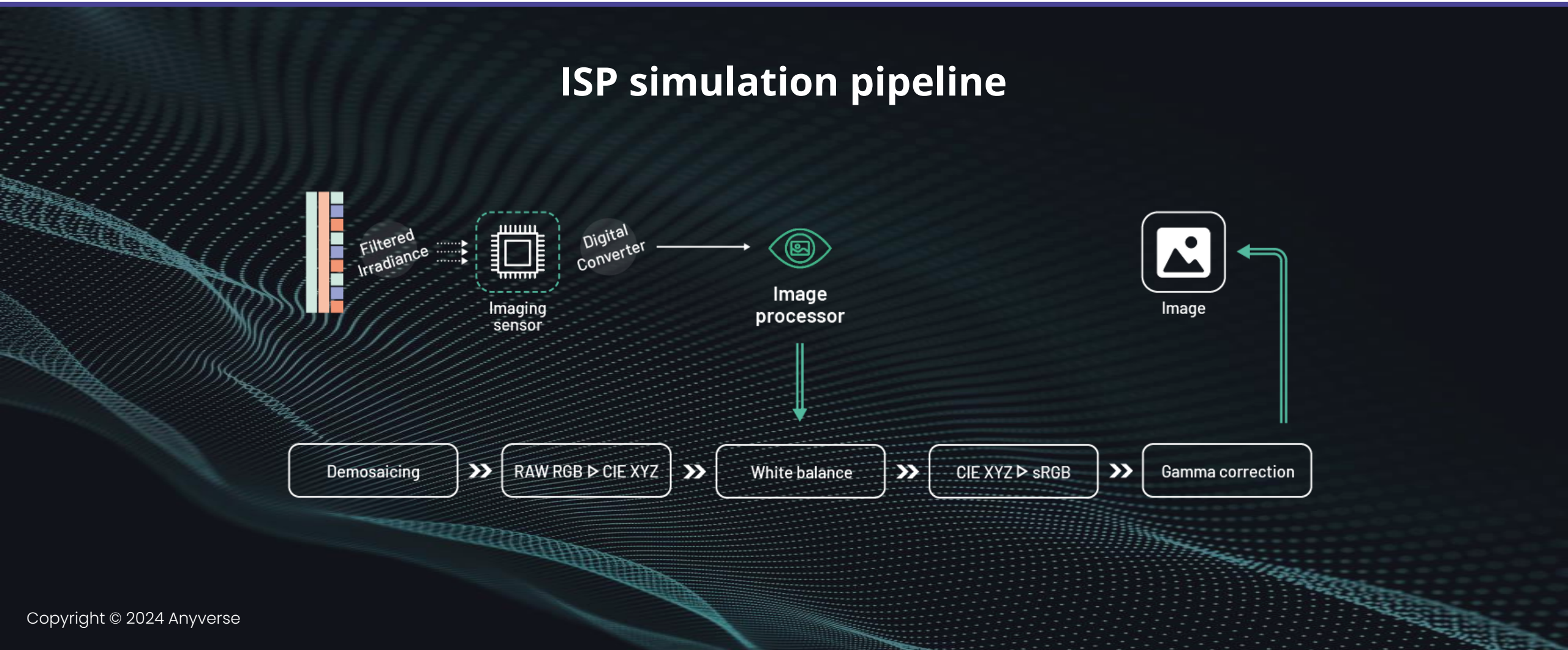


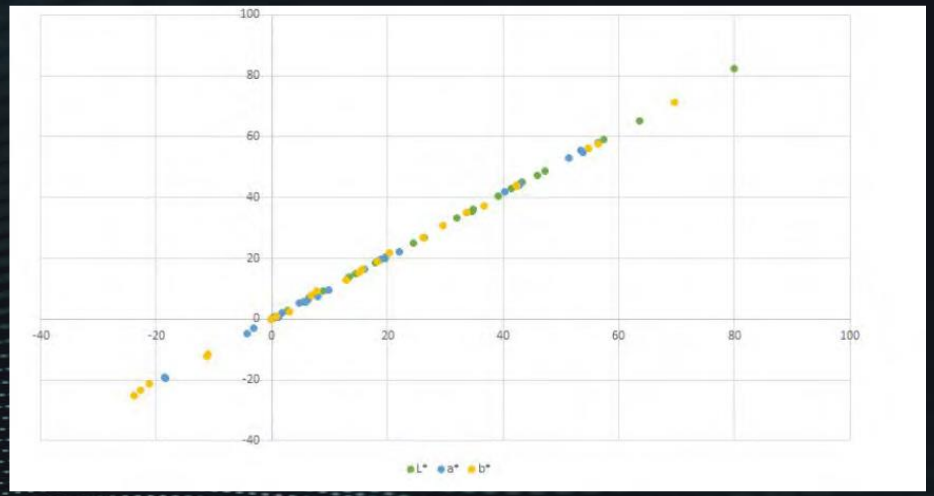
Image quality. Sensor simulation

CIELAB color space validation

Macbeth chart (real)

Macbeth chart (simulation)

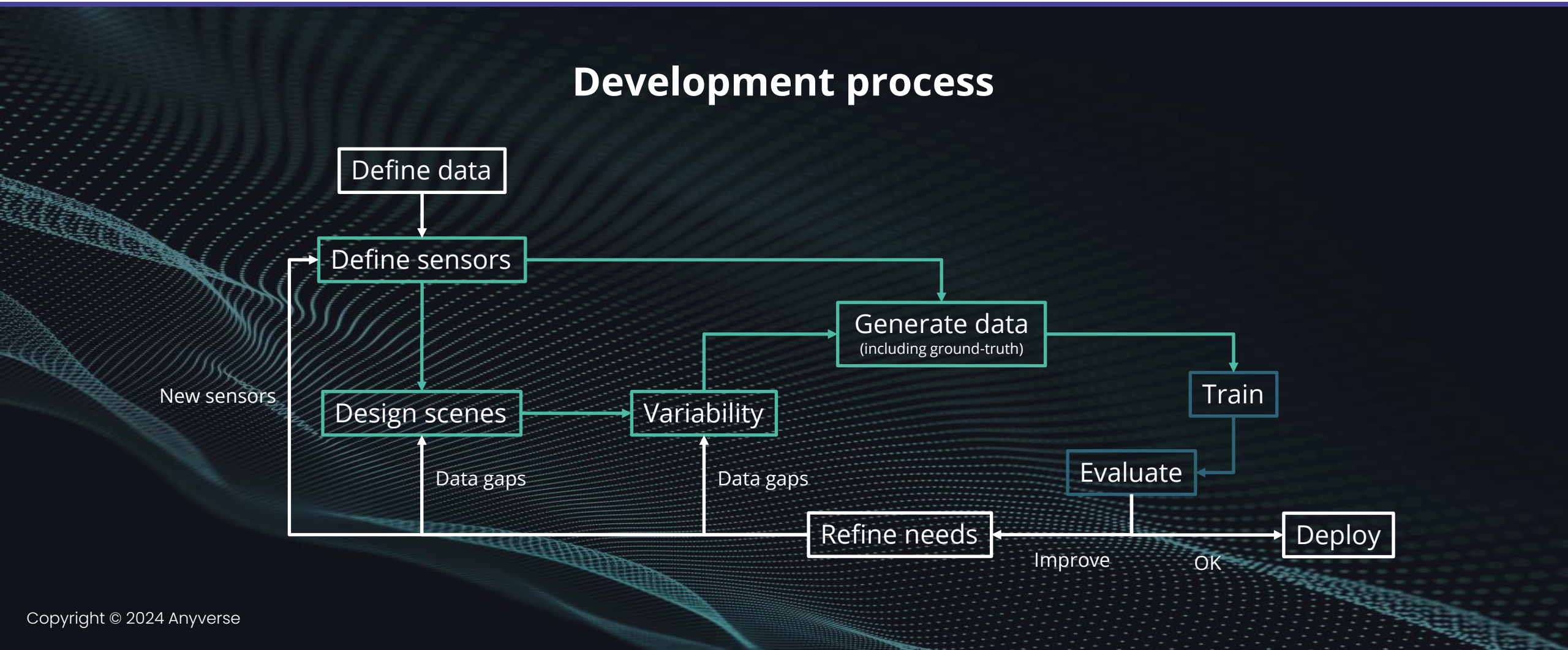
L*	a*	b*	L*	a*	b*
13.4	22	15.6	14	22.3	16.5
45.9	42.7	33.6	47.3	44.1	34.9
19.5	-3.1	-11	20	-2.9	-11.6
13	0.3	15	13.1	0.8	15.2
26.4	19.5	-11.2	27	20.2	-12.2
41.4	-18.4	7.8	42.8	-19.5	9.3
43.2	53.5	54.8	45	55.4	56.3
15.5	5.9	-22.8	15	5.8	-23.5
34.7	53.8	36.7	35.46	54.9	37.3
8.9	18.8	-0.1	9.3	19.8	-0.1
39.1	0.2	42.4	40.4	0.4	44
47.3	42.9	56.4	48.7	44.3	57.5
5.5	6.4	-23.8	5.7	7.2	-25
24.4	-18.6	26.1	25.2	-19.1	26.9
33.6	56.4	42.3	35	58	43.5
63.6	40.2	69.6	65.3	41.9	71.2
31.9	51.4	18.3	33.3	52.9	19.1
18.5	-4.3	-21.3	19.4	-4.6	-21.3
79.9	7.9	29.6	82.4	7.6	30.9
57.4	16	20.4	59.1	16.6	21.7
34.9	9.8	12.8	36.1	9.7	12.7
17.8	4.8	6.8	18.4	5.2	7.7
6.3	1.8	3	6.3	1.9	2.5
2.7	1.1	0.8	2.9	0.7	1.1



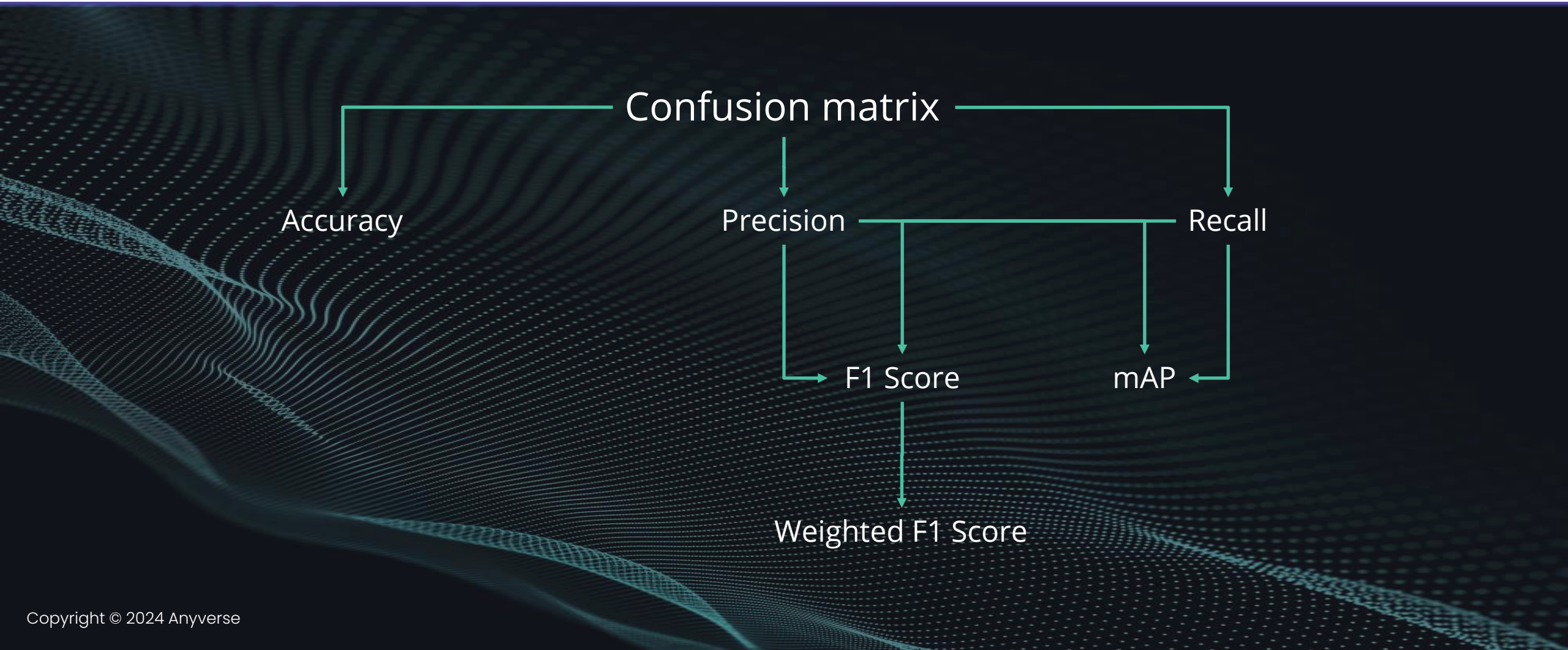
Data usability

Reduce the domain gap

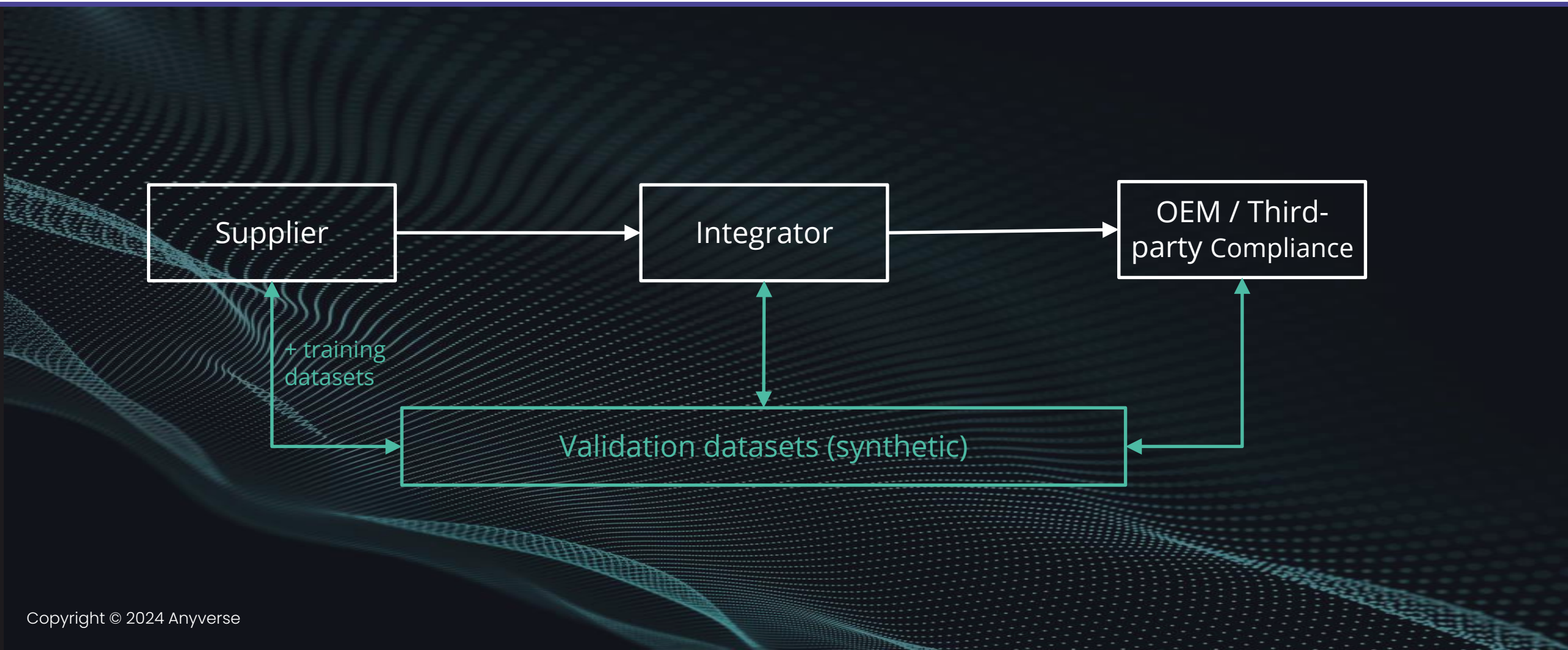
Data usability



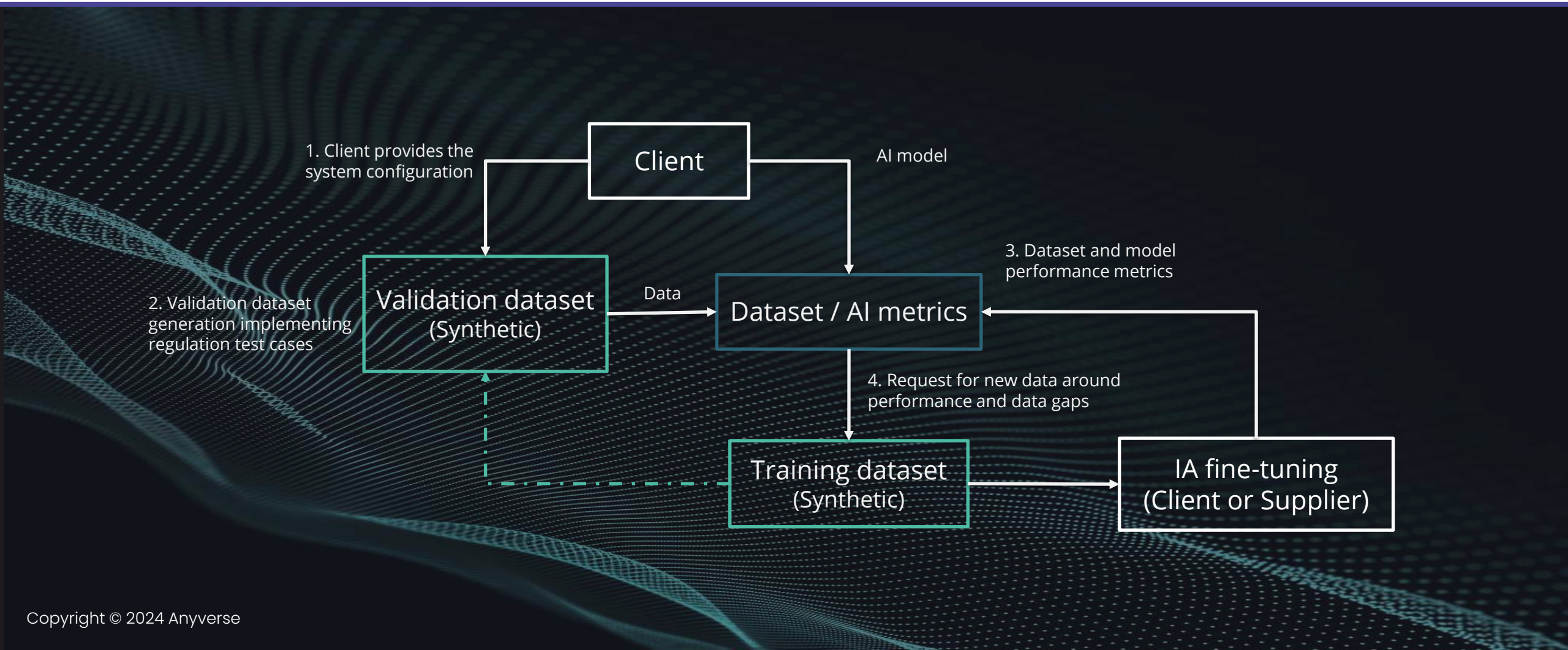
Data usability. Performance



System validation



System validation



Javier Salado
Anyverse Product Manager

Thank you

aniverse.ai
https://www.linkedin.com/in/javiersalado/

ANYVERSE

Hochschule Düsseldorf
University of Applied Sciences
HSD

ASAM