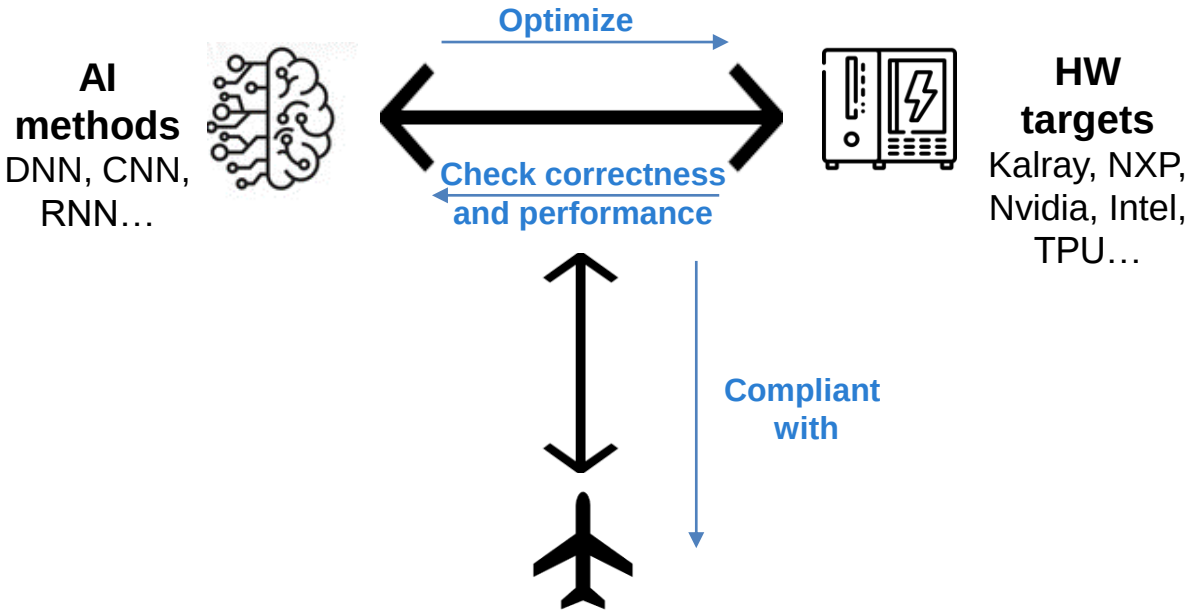
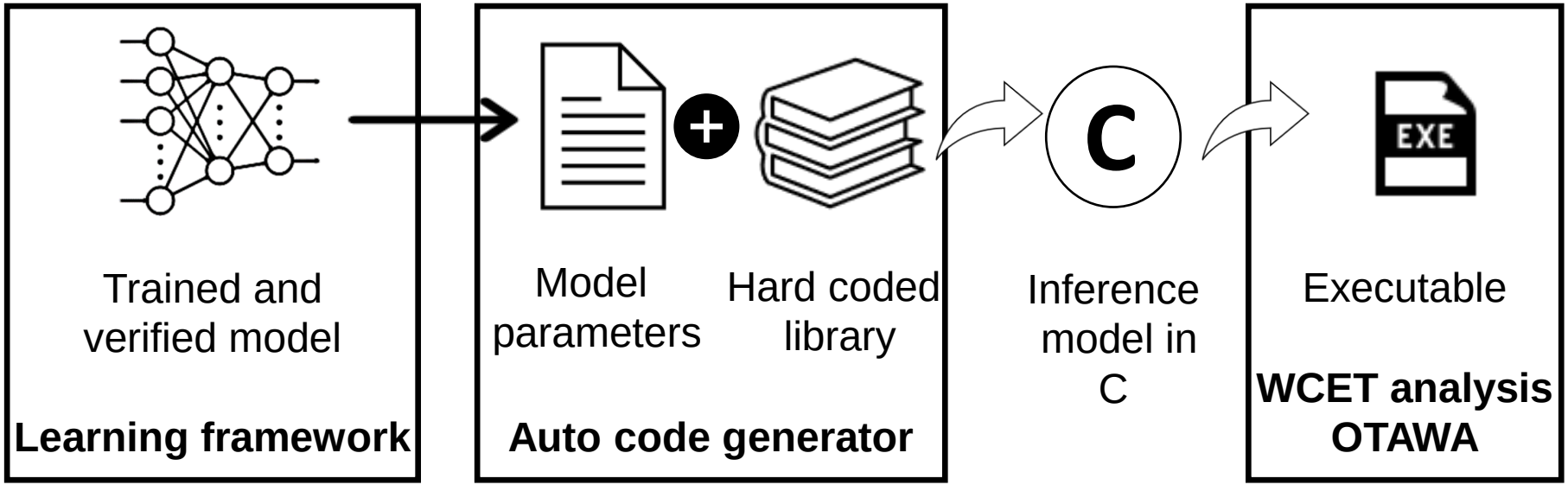
Automatic predictable C code generation of machine learning models for avionics systems

Iryna DE ALBUQUERQUE SILVA
Thesis supervisors: Claire Pagetti, Thomas Carle, Adrien Gauffriau
ONERA/DTIS

Context


AI
methods
DNN, CNN,
RNN…
Optimize
Check correctness
and performance
HW
targets
Kalray, NXP,
Nvidia, Intel,
TPU…
Compliant
with
Avionics constraints
Real-time execution, limited resources,
energy constraints, capacity to compute
tight WCET, deterministic behavior

Trained model to embedded function



Challenges for embedding ML code

- **Semantic preservation**: capacity to reproduce the same functional behavior as the reference;
- **Predictability**: capacity to assess a tight WCET ;
- **Efficiency:** capacity to correctly use hardware resources and be executed quickly.

Evaluation

Benchmark	Maximum error	WCET [cycles]
16 hidden layers, regular structure, **ReLU** and **FP64**	0	109073386745
8 hidden layers, regular structure, **tanh** and **FP64**	2.220446e-16	111112160
(16, 16, 32, 64, 128, 64, 32, 16, 4, 1), **sigmoid** and **FP32**	5.960464e-08	269646545
(5, 128, 128, 64, 32, 16, 5) **ReLU** and **INT**	0	90748125
Acas-Xu *decreasing128 COC*	4.638672e-03	136677250
Acas-Xu *regular50 COC*	0	29349530

Thank you!
Any questions?

iryna.de_albuquerque_silva@onera.fr