讨论：机器学习应用

刘北江
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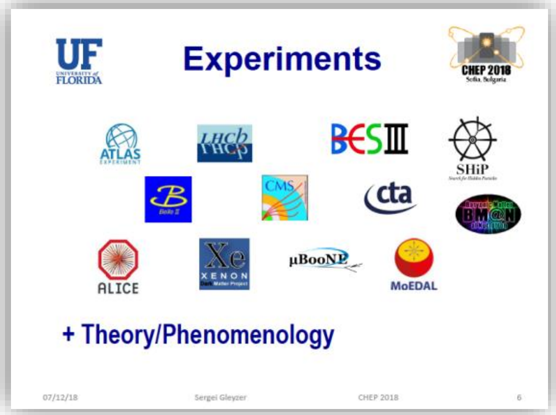
高能物理计算和软件会议， 南京， 2019.5.30-31

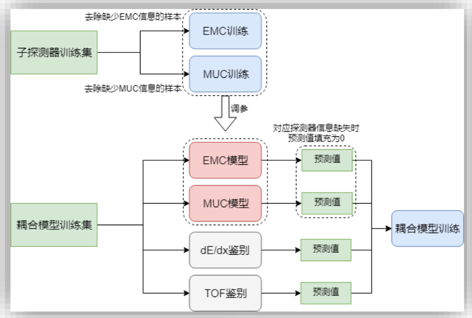
BESIII 的应用

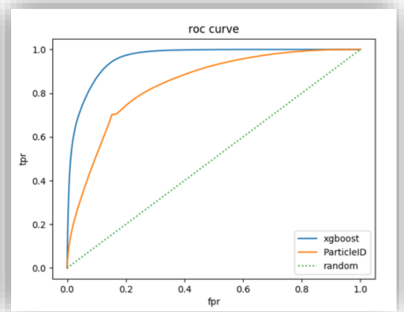
- PoS(ICHEP2018)160 (2018), 39th International Conference on High Energy Physics

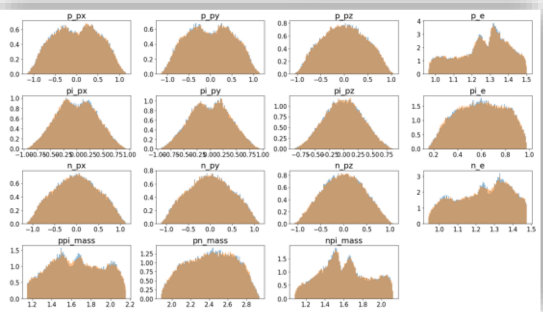
- EPJ Web Conf.CHEP 2018, 23rd International Conference on Computing in High Energy and Nuclear Physics'



Muon
粒子鉴别

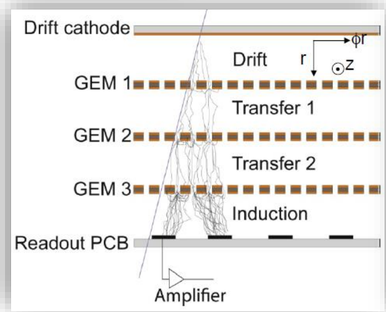


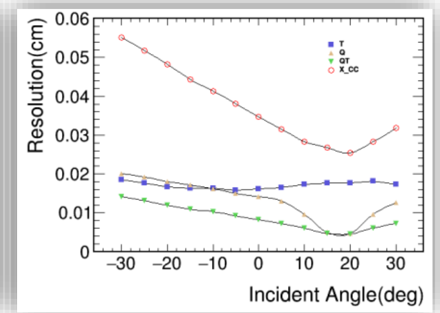




多维修正

CGEM 径迹探测
簇团重建





最近感兴趣的

Machine Learning to Enable Orders of Magnitude Speedup in Mult-Objective Optimization of Particle Accelerator Systems

Auralee Edelen (SLAC), Andreas Adelmann (PSI, Villigen), Nicole Neveu (SLAC), Yannick Huber, Matthias Frey (PSI, Villigen)

Mar 18, 2019 - 43 pages

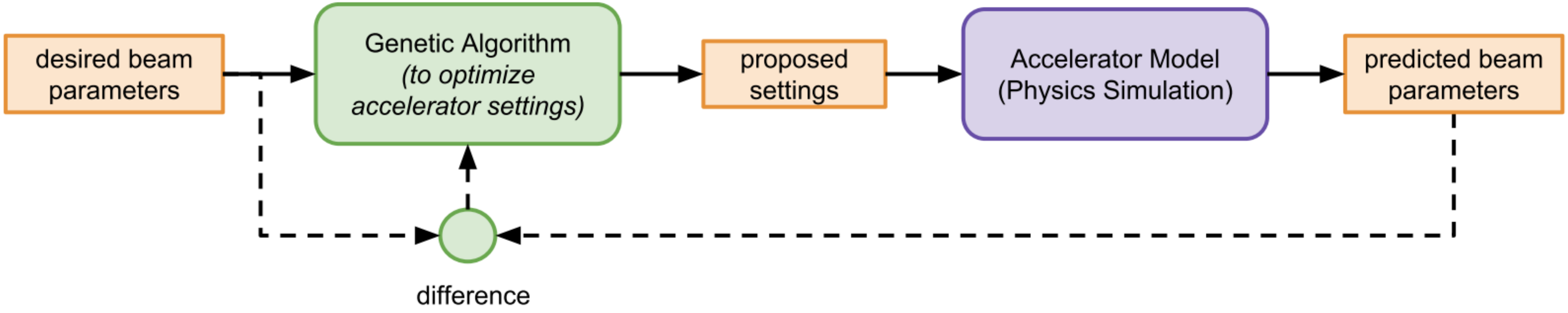
e-Print: arXiv:1903.07759 [physics.acc-ph] | PDF

Opportunities in Machine Learning for Particle Accelerators

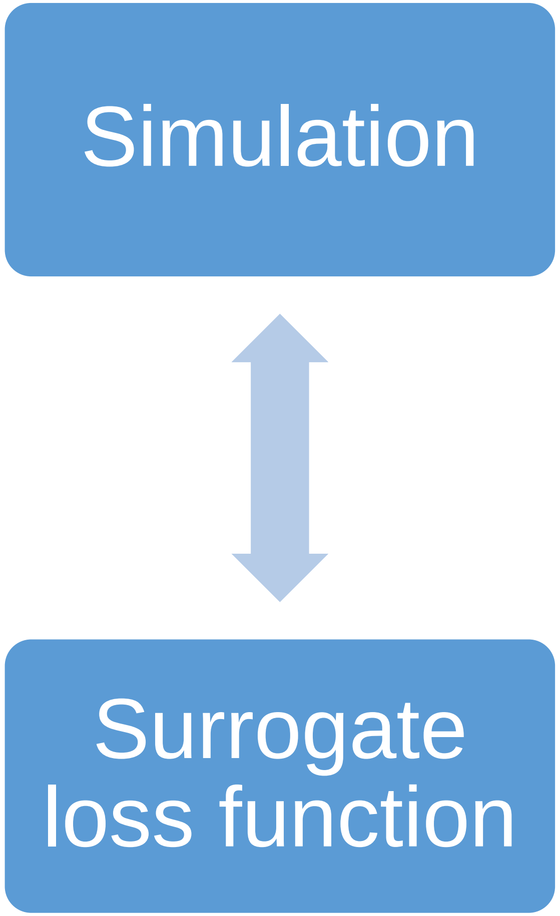
A. Edelen, C. Mayes (SLAC), D. Bowring (Fermilab), D. Ratner (SLAC), A. Adelmann, R. Ischebeck, J. Snuverink (PSI, Villigen), I. Agapov, R. Kammering (DESY), J. Edelen (RadiaSoft, Boulder) *et al.* 显示全部13 名作者

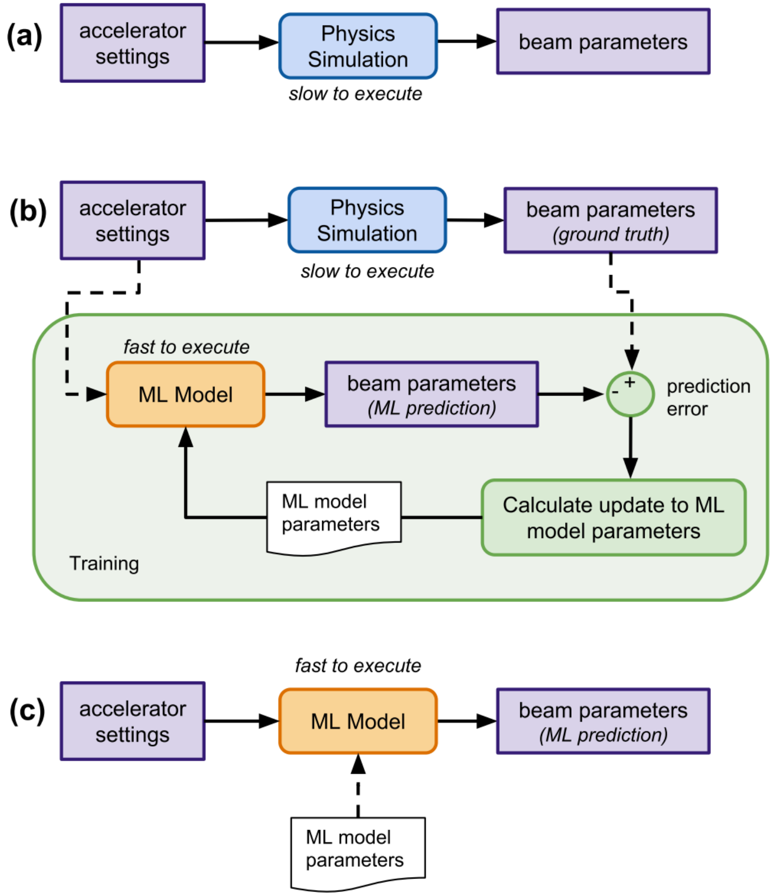
Nov 7, 2018 - 25 pages

FERMILAB-PUB-19-017-AD
e-Print: arXiv:1811.03172 [physics.acc-ph] | PDF



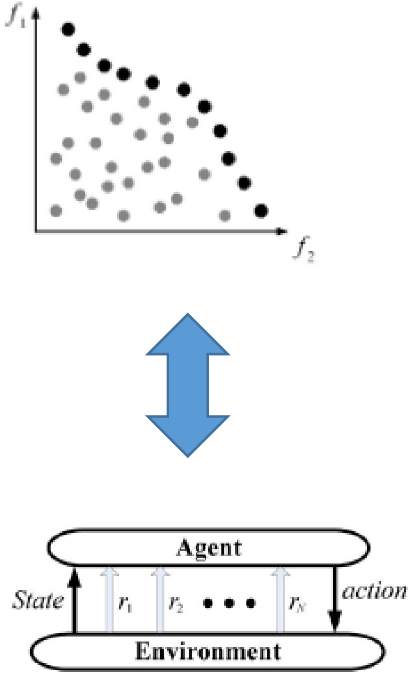
替代函数


Simulation
Surrogate loss function


(a)
accelerator settings
Physics Simulation
slow to execute
beam parameters
(b)
accelerator settings
Physics Simulation
slow to execute
beam parameters (ground truth)
fast to execute
ML Model
beam parameters (ML prediction)
+
-
prediction error
ML model parameters
Calculate update to ML model parameters
Training
(c)
fast to execute
accelerator settings
ML Model
beam parameters (ML prediction)
ML model parameters

Further step? 多目标优化

- MOO(Multi-objective Optimization)
  - multi-objective to single-objective strategy
  - Pareto strategy
- MORL(Multi-objective Reinforcement Learning)
  - single-policy MORL approaches (scalar)
  - Multiple-policy MORL approaches (approx. of Pareto)



MORL Approaches		Basic Principle
Single-policy approaches	The weighted sum approach	A linear weighted sum of Q-values is computed as the synthetic objective function.
	The W-learning approach	Each objective has its own recommendation for action selection and the final decision is based on the objective with the largest value.
	The AHP approach	The analytic hierarchy process (AHP) is employed to derive a synthetic objective function.
	The ranking approach	"Partial policies" are used as the synthetic objective function.
	The geometric approach	A target set satisfying certain geometric conditions in multi-dimensional objective space is used as the synthetic objective function.
Multiple-policy approaches	The convex hull approach	Learn optimal value functions or policies for all linear preference settings in the objective space.
	The varying parameter approach	Performing any single-policy algorithm for multiple runs with different parameters, objective threshold values and orderings.

讨论

历史

CHEP2018, ACAT2019, HOW2019, …

Machine Learning in High Energy Physics Community White Paper

Machine learning at the energy and intensity frontiers of particle physics

Computing and Software for Big Science
December 2019, 3:7 | Cite as

A Roadmap for HEP Software and Computing R&D for the 2020s

90's
MVA

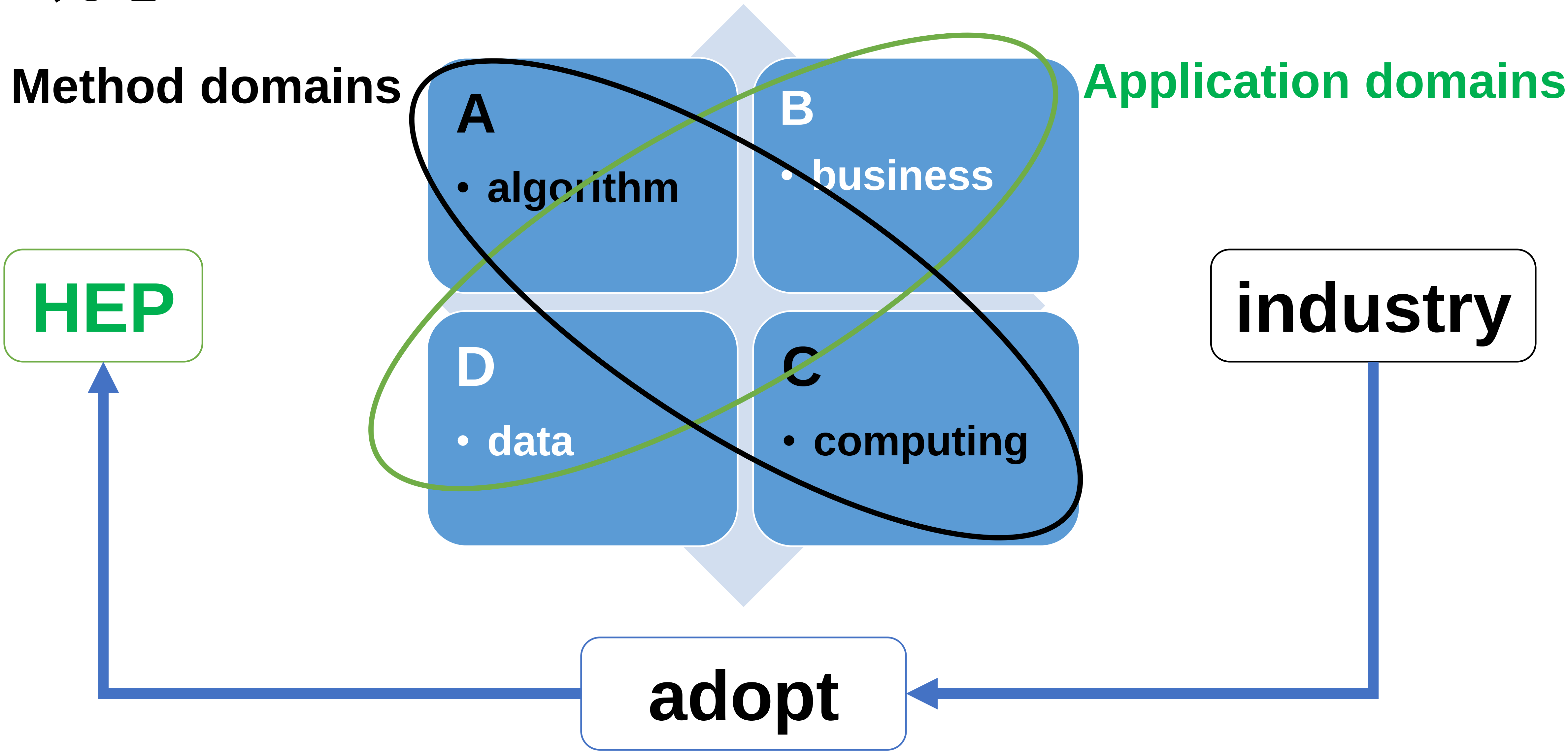
Deep learning
- Fast differentiability
- High performance computing

ML Applications and R&D (from the HSF CWP)

1. Simulation
2. Real Time Analysis and Triggering
3. Object Reconstruction, ID, and Calibration
4. End-To-End Deep Learning
5. Sustainable Matrix Element Method
6. Matrix Element Machine Learning Method
7. Learning the Standard Model
8. Theory Applications
9. Uncertainty Assignment
10. Data Quality Monitoring
11. Operational Intelligence

HSF
HEP Software Foundation

观感


Method domains
Application domains
A
• algorithm
B
• business
D
• data
C
• computing
HEP
industry
adopt

观感

- Algorithm: 工具、技术高速更新 → 需要学科交叉，如何开展?
- Computing: 专用硬件，高度优化 → 如何利用？Workflow需要改变
- Business：
  - 广泛的应用场景 → 更好（discriminative）/ 更快（generative）
  - 对问题本身的理解是关键 → feature extraction / inference
  - “起跑线机遇”？起跑线由此向西8000公里… → 学习和创新
- Data：高能物理自古以来就是大数据 → 优势何在?

Gartner Hype Cycle for Emerging Technologies, 2018

Widespread artificial intelligence, biohacking, new platforms and immersive experiences dominate Gartner Hype Cycle for Emerging Technologies