IRIS-HEP retreat

Current plans for AGC (30’)

Alexander Held (University of Wisconsin–Madison)
Oksana Shadura (University Nebraska–Lincoln)

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Introduction

- We will summarize the **AGC plans** laid out in the strategic plan

- Our views of the best way forward for the AGC project have **evolved** in parts
  - will outline those here to move towards an updated plan
  - discussion session at 13:30 today
  - important: focus on realistic high-impact goals given available personpower

Challenges motivating the project

Scaling & turnaround

- **Scaling to HL-LHC data volumes** with available computing resources
  - Need for new methods for efficient data scaling, caching at AFs to handle more data-intensive analysis pipeline => DOMA, SSL

- **Analysis turnaround time**
  - Reaching interactive analysis turnaround times requires efficient analysis facility (AF) usage => SSL, AS, DOMA, user

UX & sustainability

- **User experience (UX)** for complex analyses: **increase scientific reach** of result => AS
  - User improvement experiences allow physicists to focus on the physics
  - Need expanded Machine Learning (ML) tooling with good user experience + performance
  - Leverage ML technology to automatically optimize analysis sensitivity

- **Sustainability** => ?
  - Limited person power to develop & maintain full stack -> rely on industry solutions & external developments (e.g. tokens)
  - Limited of analysis reproducibility & reusability
  - Need for central gathering point for community to discuss & develop analysis approaches

Work plan from strategic report

Strategic report plan

- Proposed: expand AGC with **new flagship analyses** (high complexity, high volume)

- ATLAS-/CMS-specific analyses were meant to help **bridge the gap to production**
  - e.g. nanoAOD & PHYSLITE formats, systematic uncertainty handling
  - different focus per experiment: on-the-fly systematics in ATLAS, ServiceX & column joining in CMS

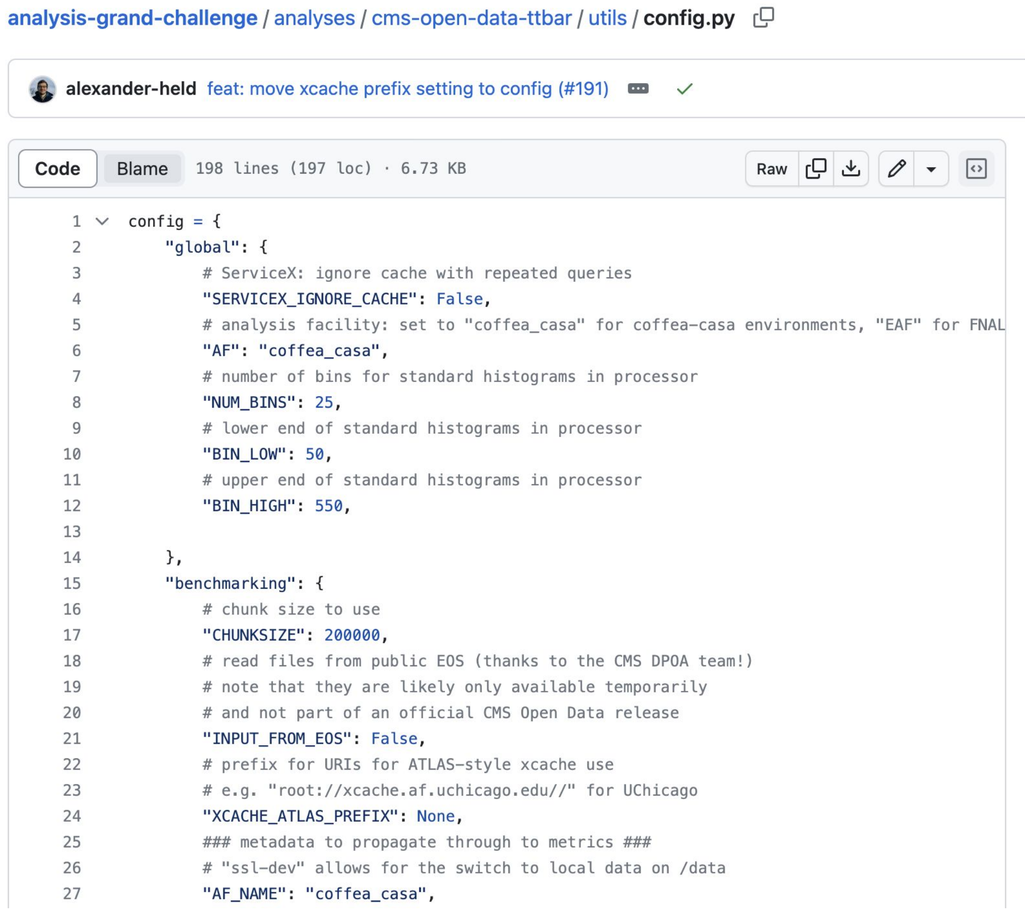
- Designing new analyses is a **significant amount of effort** that requires experienced physicist personpower

- We believe that the **relevant R&D can efficiently happen within the experiments**, with IRIS-HEP members participating and interfacing -> **do not develop additional analyses within AGC**
  - some relevant details are too specific for a broader inter-experimental forum like AGC
  - instead: maximize impact by focusing on dedicated areas

What we already have right now

- ***We have*:**
  - Open Data-based analysis of modest complexity capturing all generic workflow aspects
  - Setup with a lot of configuration options to emulate different types of analyses (including different processing pipelines)

- Many combinations of configuration settings need to be benchmarked & understood



Proposed evolution and new focus of AGC

Focus areas: exploiting AGC setup (1)

- **Benchmarking with existing setup** *(as already mentioned in strategic plan)*
  - we can use the AGC setup as a tool to study facility, library and implementation performance (line profiling, comparing measurements to hardware, …)
  - facility improvements (including ML/MLops), important: stability of distributed execution
  - collaborating with DGC

- ***Deliverables***
  - performance reports at internal meetings, workshops, conferences
  - evolve existing AGC task as needed to capture new functionality
    - estimated 1–2 years of UX & facility improvement work possible from lessons learnt with AGC

Focus areas: exploiting AGC setup (2)

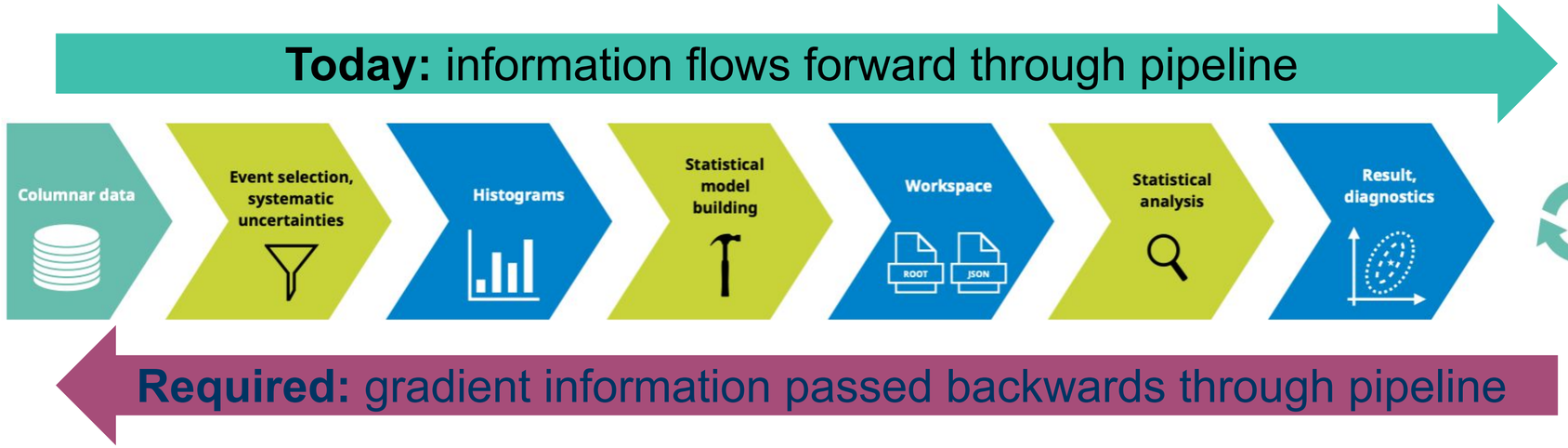
- **Analysis preservation and reinterpretation** *(as already mentioned in strategic plan)*
  - close collaboration with REANA team
  - demonstrate preserved AGC analysis
  - propose plan for relevant services: do we assume those still exist? package them up too?

- ***Deliverables:*** AGC running in REANA, reinterpretation example (?)

Focus areas: autodiff

- **Gradient-based analysis optimization demonstrator** *(as already mentioned in strategic plan)*
  - completely new standalone analysis example
  - connects many projects & people: AGC ideal home for this type of effort

- ***Deliverable:*** demonstrator project showcased in public meeting



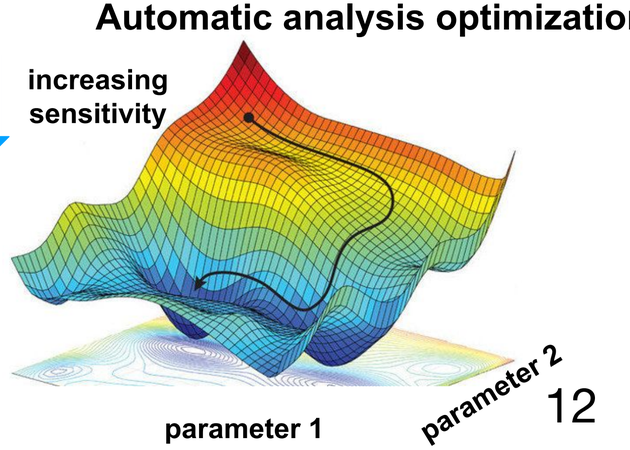


figure source: arXiv:1805.04829 [cs.AI]

Focus areas: support & interfacing

- **Support** for experiment-internal demonstrator projects
  - interface, forum to discuss inter-experimental aspects
  - column joining workflow

- **Community engagement / reaching new audiences**
  - bridge gaps to new user groups in experiments

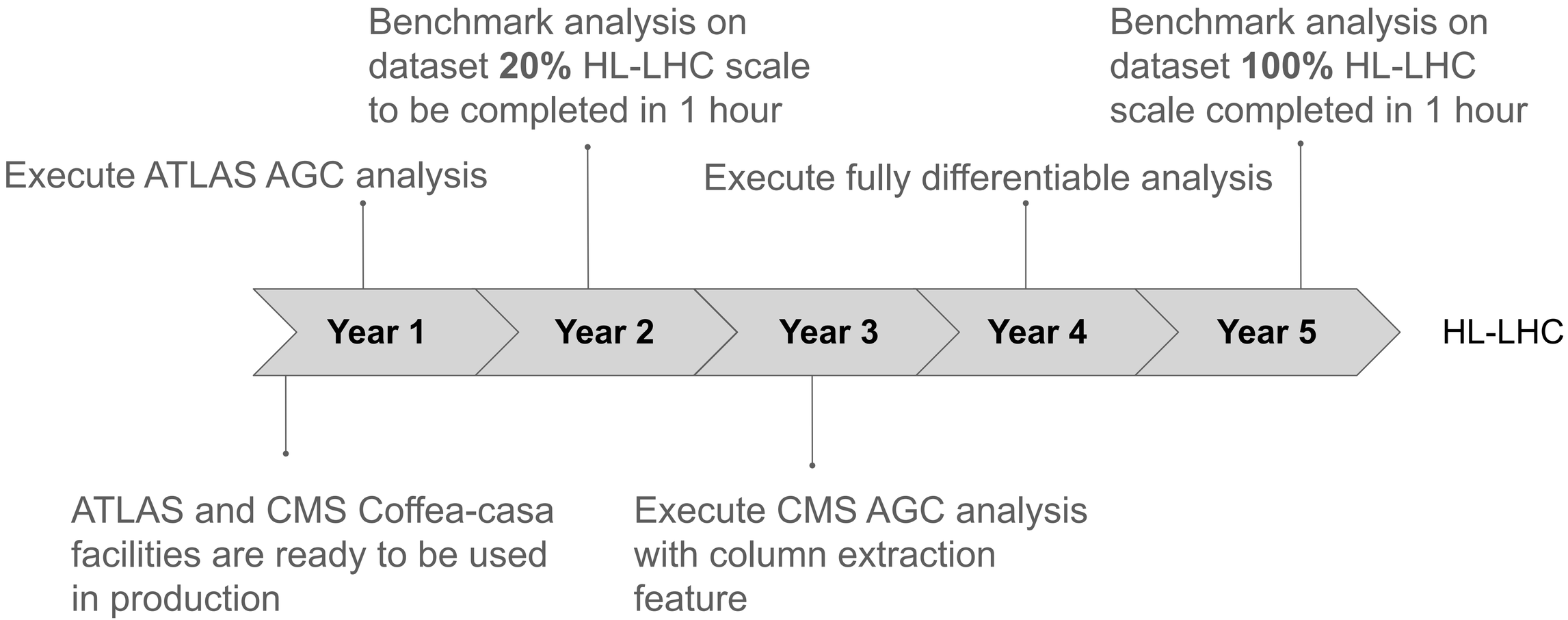
- ***Deliverable:*** ?

An idea of a timeline

- **Year 1**
  - 25% faster analysis via improvements following benchmarking, stable execution at scale
- **Year 2**
  - partially complete fully differentiable analysis example
- **Year 3**
  - ?
- **Year 4**
  - showcase substantially complete fully differentiable analysis example
- **Year 5**
  - 1h turnaround time for analysis at HL-LHC scale (lots of variables to be determined here…)

Backup

Overall view on AGC timeline



Metrics and targets

- Number of deployed **analysis facilities in production** operation: **[at least 2]**
- Number of **AS components fully supporting distributed analysis**:
  [at least 5]
- **Fraction of components fully preserved in AGC pipeline**: **[100%]**
- Fraction of benchmark analysis at HL-LHC scale executed in 1 hour:
  [20% / 50% / 100%]
  - Compare efficiency through **time & data rate** metric
- Number of **AS tools** that support integration with **automatic optimization**: **[at least 3]**
  - Tracks progress towards fully-differentiable analyses, which the institute believes is a powerful and critical tool for HL-LHC analysis

Timeline: year 1

- **Setting up** facilities, services, and analysis task for the **next generation of the AGC**

DOMA	ATLAS and CMS Coffea-casa facilities are ready to be used in production	Year 1
SSL / DOMA	ServiceX deployed inside Fabric at CERN	Year 1
AS	All components of AS pipeline are fully supporting distributed analysis	Year 1
AS	Define analysis tasks for the top quark mass and di-Higgs measurement, create implementations	Year 1
AS	New version of AGC analysis with incorporated ML techniques	Year 1

Timeline: year 2

- **Checkpoint for performance** and throughput & **functionality** demonstration

AS	Benchmark analysis on dataset 20% HL-LHC scale to be completed in 1 hour	Year 2
DOMA	Demonstrate analysis running at 200 Gbps as a part of AGC	Year 2
AS	Demonstration of running full analysis able to use statistical models defined in unified HS3 serialization format	Year 2
AS	All core components of Analysis System pipeline support integration of differentiable operations and passing of gradients	Year 2
AS	Demonstrate AOD extraction prototype	Year 2

Timeline: years 3–5

- New **functionality**: column joining, reinterpretation, differentiable analysis
- **Scaling** to full HL-LHC requirements

AS	Demonstrate AOD extraction with column joining workflow	Year 3
DOMA	Demonstration of an AGC analysis used in reinterpretation platform	Year 3

AS	Demonstrate fully differentiable analysis	Year 4

DOMA	Benchmark analysis on dataset 100% HL-HL scale completed in 1 hour	Year 5

Primary risks for AGC

Analyzers not adopting proposed workflows

- *Impact:* Activity not useful to community
- *Probability:* Low to Medium
- *Mitigation:* Deep investment in community engagement

Unable to achieve **intended throughput rates**

- *Impact:* Slow analysis turnaround time for analyzers
- *Probability:* Low to Medium
- *Mitigation:* Give guidance on patterns and workflows to avoid

Facility evolution diverging from patterns used in AGC implementations

- *Impact:* Need to adopt technologies
- *Probability:* Low
- *Mitigation:* Invest in partnership with AFs and plan for technology nimbleness

Unable to put together **a substantially complete differentiable pipeline**

- *Impact:* Cannot study and benefit from gradient-based optimization, physics reach limited
- *Probability:* Low to Medium
- *Mitigation:* Rigorous integration testing between all components