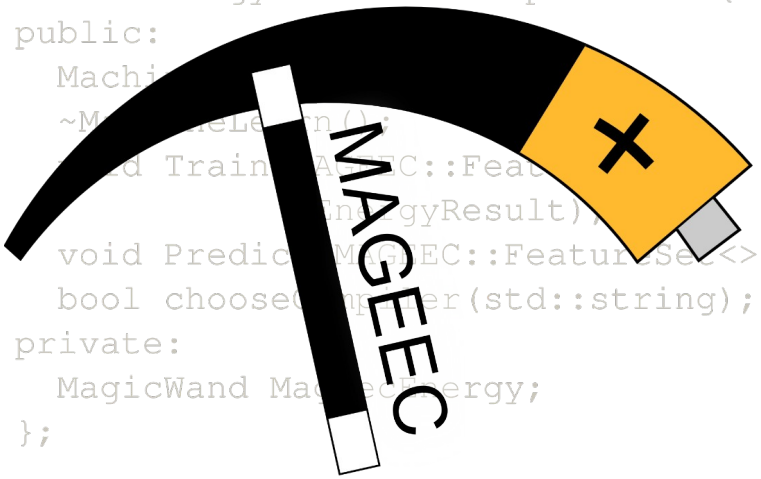


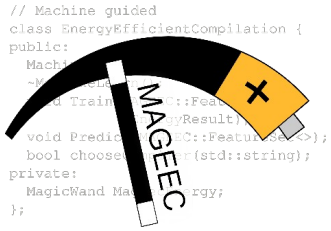
MAchine Guided Energy Efficient Compilation

Jeremy Bennett & Simon Cook, Embecosm

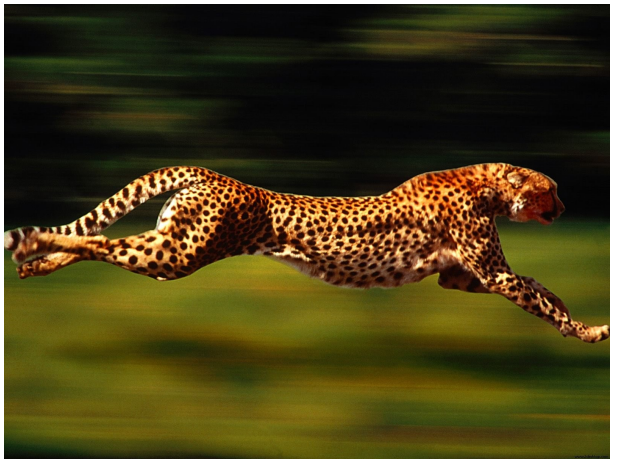
mageec.org

EMBECOSM®

University of BRISTOL

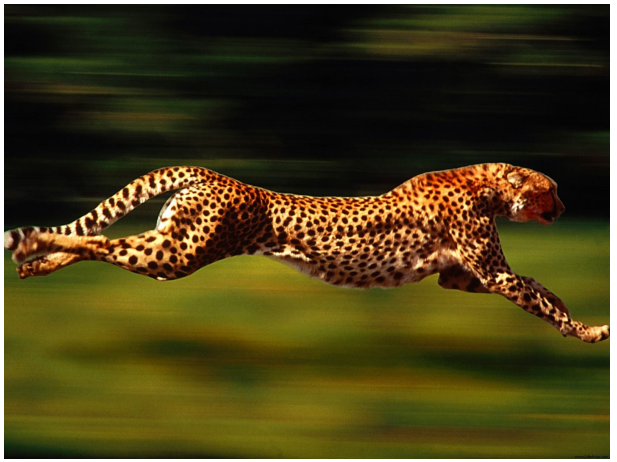


What is MAGEEC?



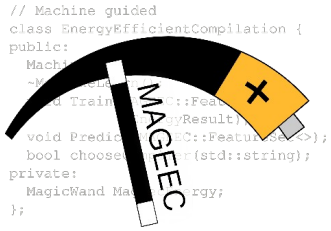
Today we optimize for speed or space

What is MAGEEC?



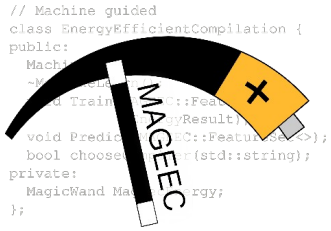
Today we optimize for speed or space

What if we could optimize for energy usage?



How We Got Here

Research into modeling energy usage



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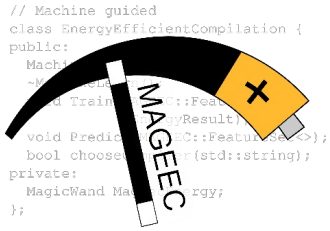
Energy measurement



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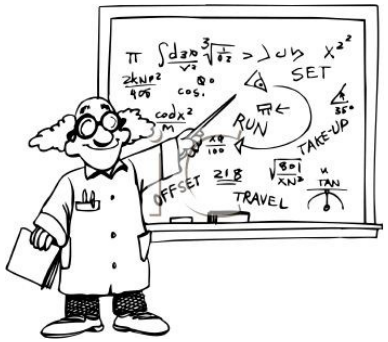
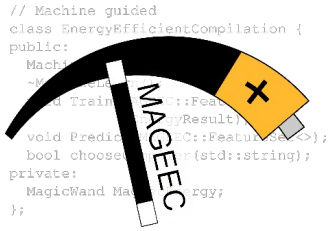


Research into feedback directed optimization



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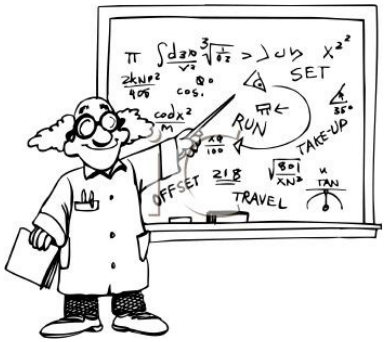
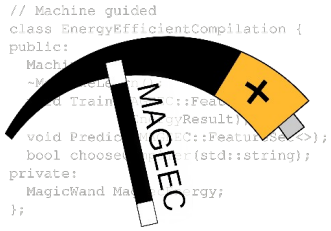


MILEPOST

Research into feedback directed optimization

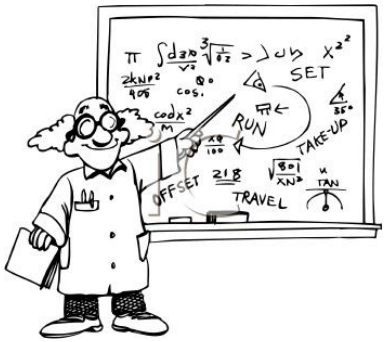


How We Got Here

Research into modeling energy usage

Energy measurement

Technology Strategy Board
Driving Innovation



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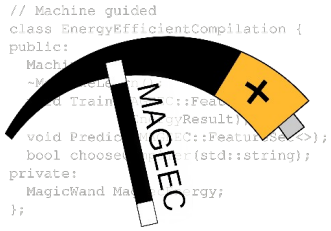

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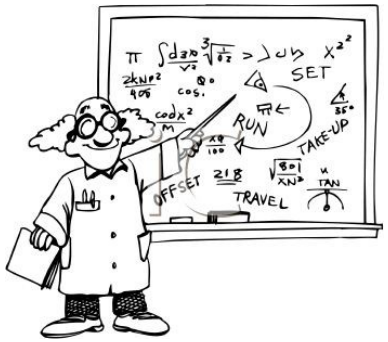
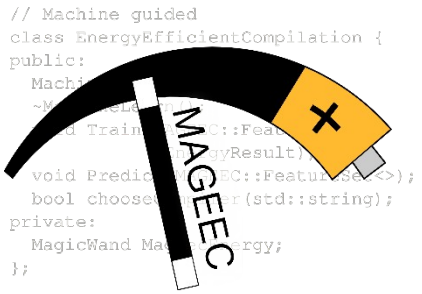
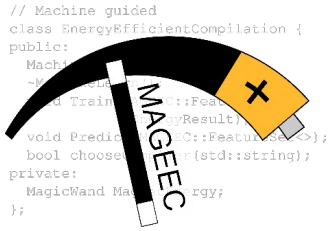


Research into feedback directed optimization

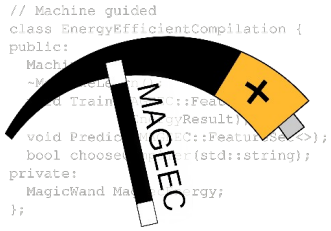
MILEPOST





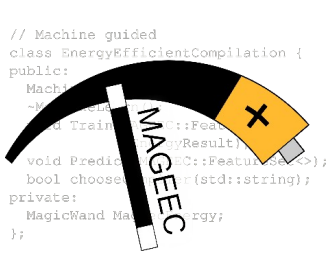
Literature Review

- Energy measuring and modeling
  - *The software drained my battery.* Kerstin Eder & Jeremy Bennett, NMI Yearbook 2012, www.embecosm.com/resources/articles/#EAR12.
- MILEPOST GCC - Feedback directed optimization
  - ctuning.org/milepost-gcc
- Measurement of compiler energy usage
  - *Identifying Compiler Options to Minimize Energy Consumption for Embedded Platforms.* James Pallister, Simon Hollis, Jeremy Bennett arxiv.org/abs/1303.6485
- MAGEEC
  - mageec.org



What's New?

Objective is energy optimization



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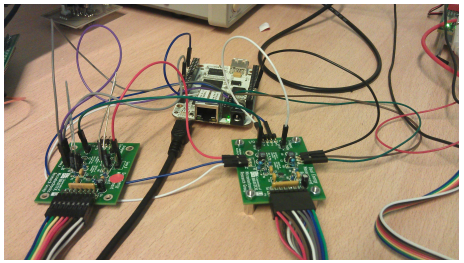
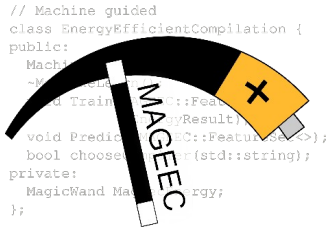
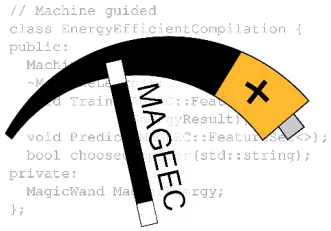


Energy measured *not* modeled



Energy Measurement

- Based on ST Discovery board
  - ARM Cortex A8 with ADC daughter board
- Burst sample rate 6Msample/s
  - 192kB on-board RAM buffer
  - Short code samples e.g. superoptimizer
- Sustained sample rate 2Msample/s
  - Pre-processed and Streamed off-board
  - Used for MAGEEC
- The board in action:
  - mageec.org/wiki/Power_Sensing_Board



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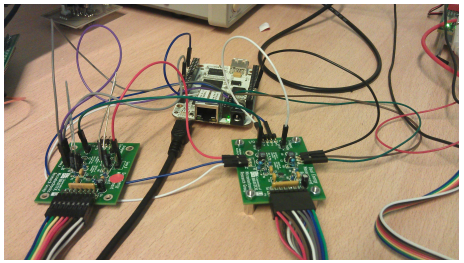
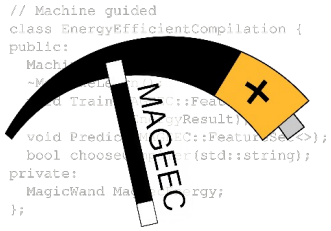


Energy measured *not* modeled

Generic framework: GCC *and* LLVM initially



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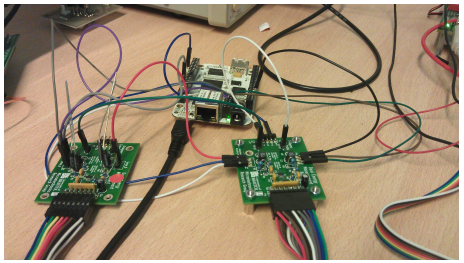
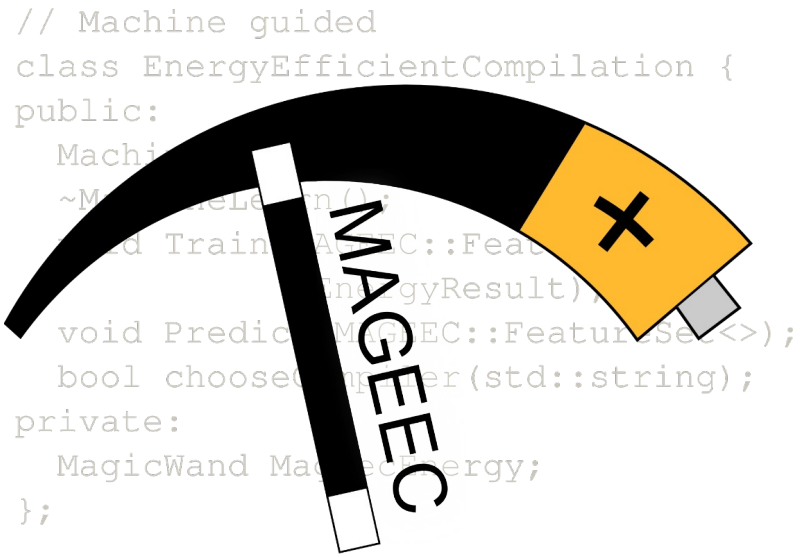
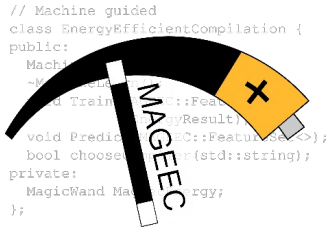


Energy measured *not* modeled

Working system, not research prototype

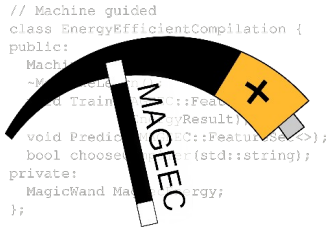


Implementation

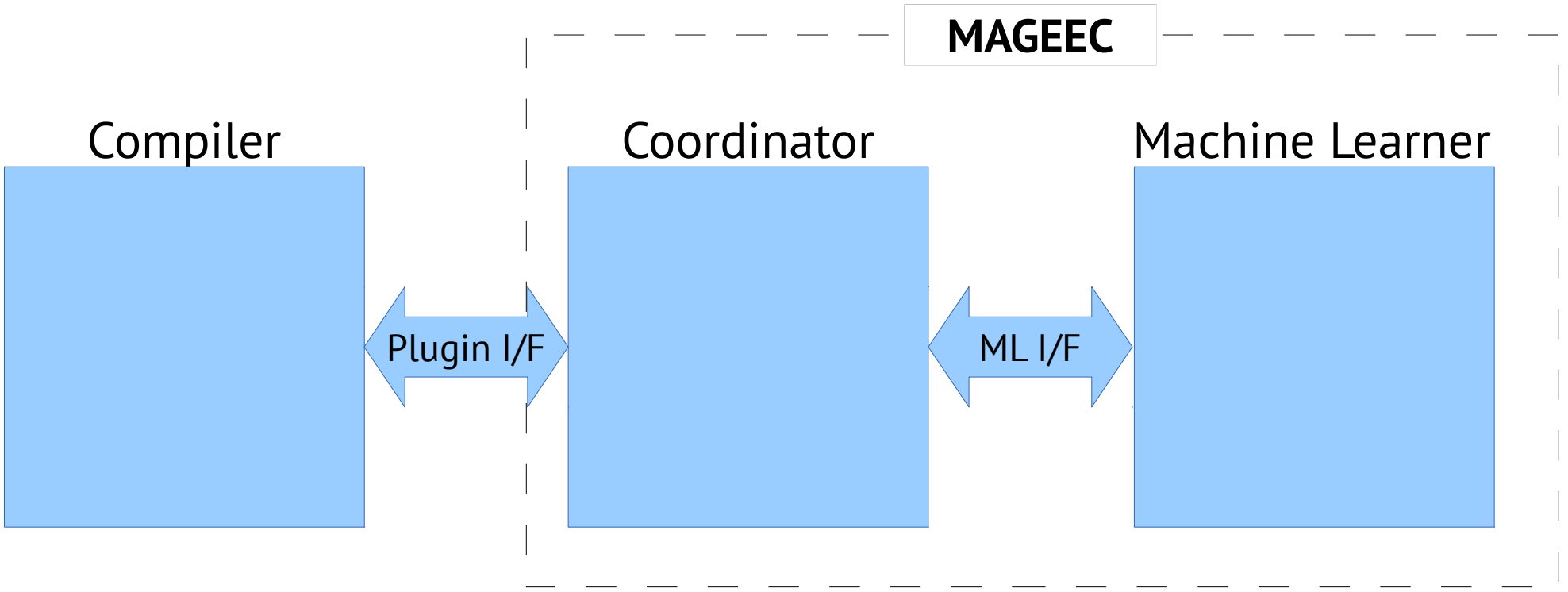


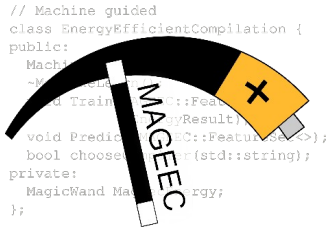
Our Plan

- Implement MILEPOST concepts in a generic way.
- Train and evaluate based on real hardware energy measurements and existing passes.
- Write and evaluate optimization passes specifcally for energy efficiency (Jörn Rennecke).



Overall Design

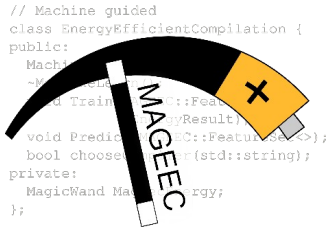




Overall Design

Compiler | Coordinator | Machine Learner

* may be `gen_features()`



Overall Design

	Compiler	Coordinator	Machine Learner
init	`plugin_init()`		

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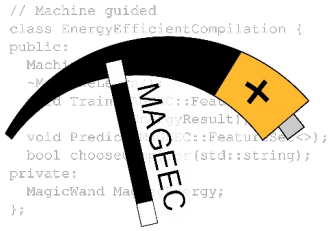

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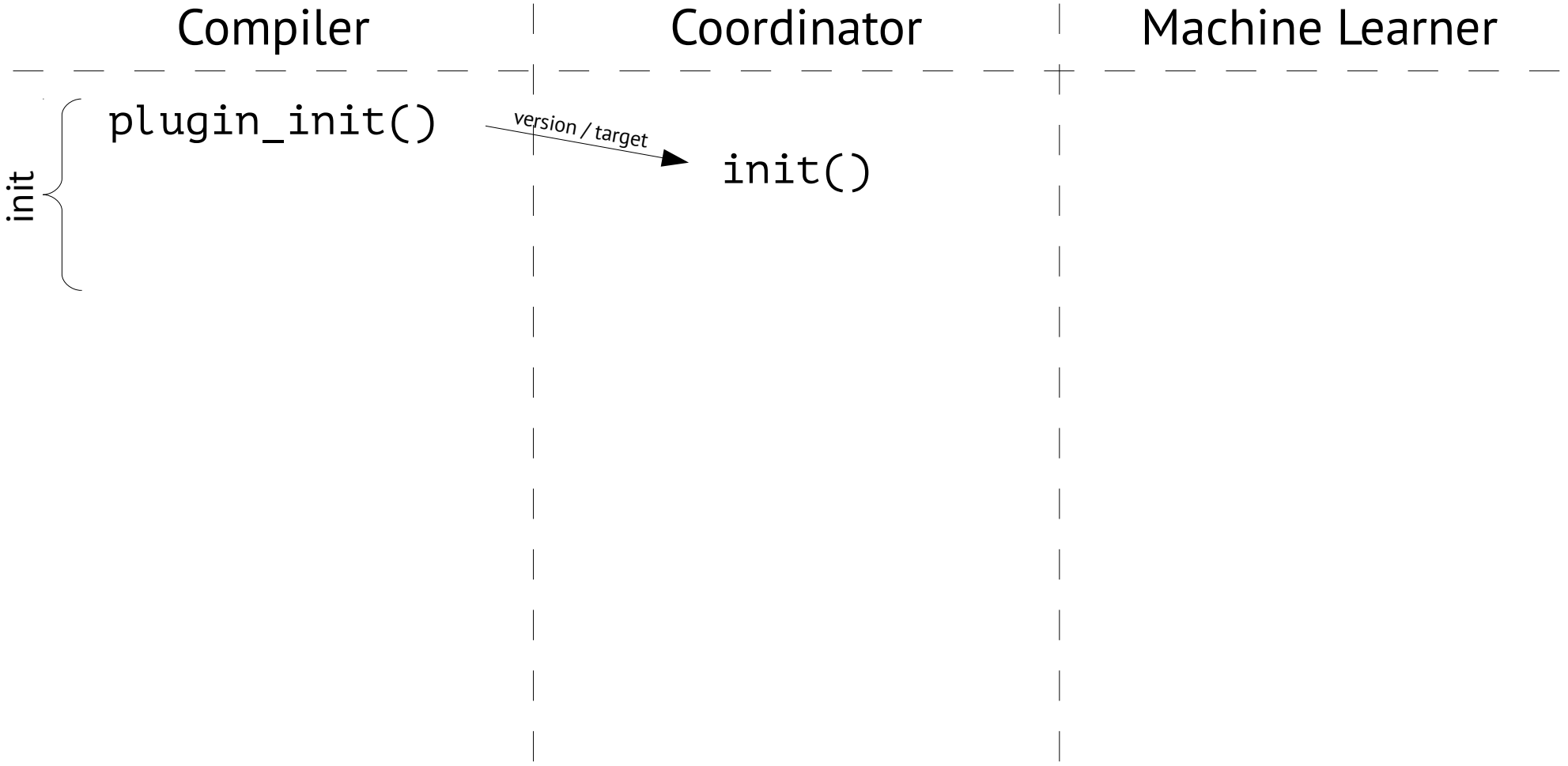

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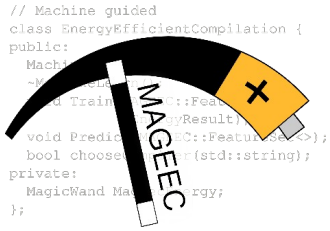

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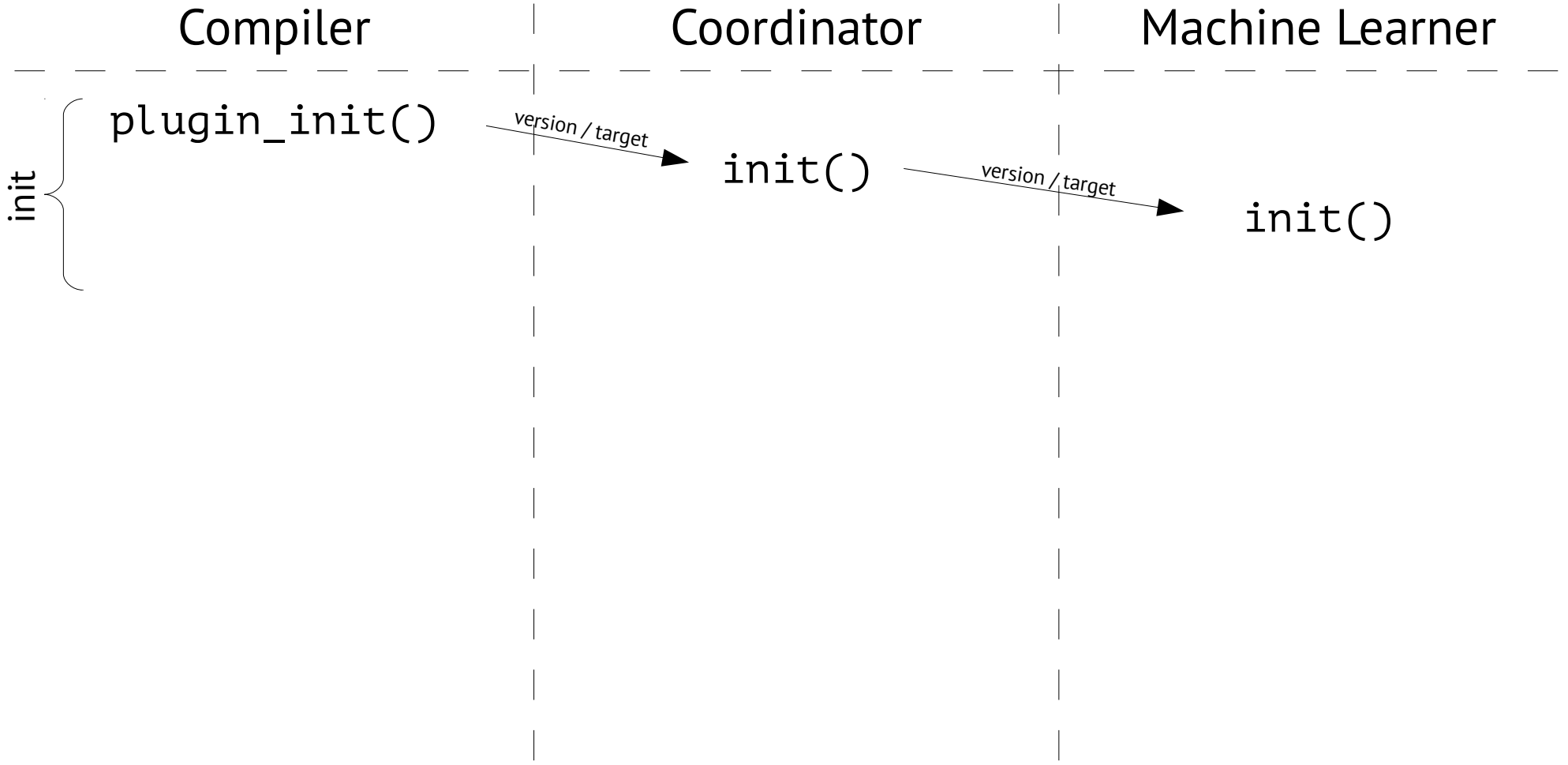

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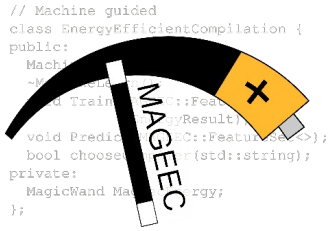

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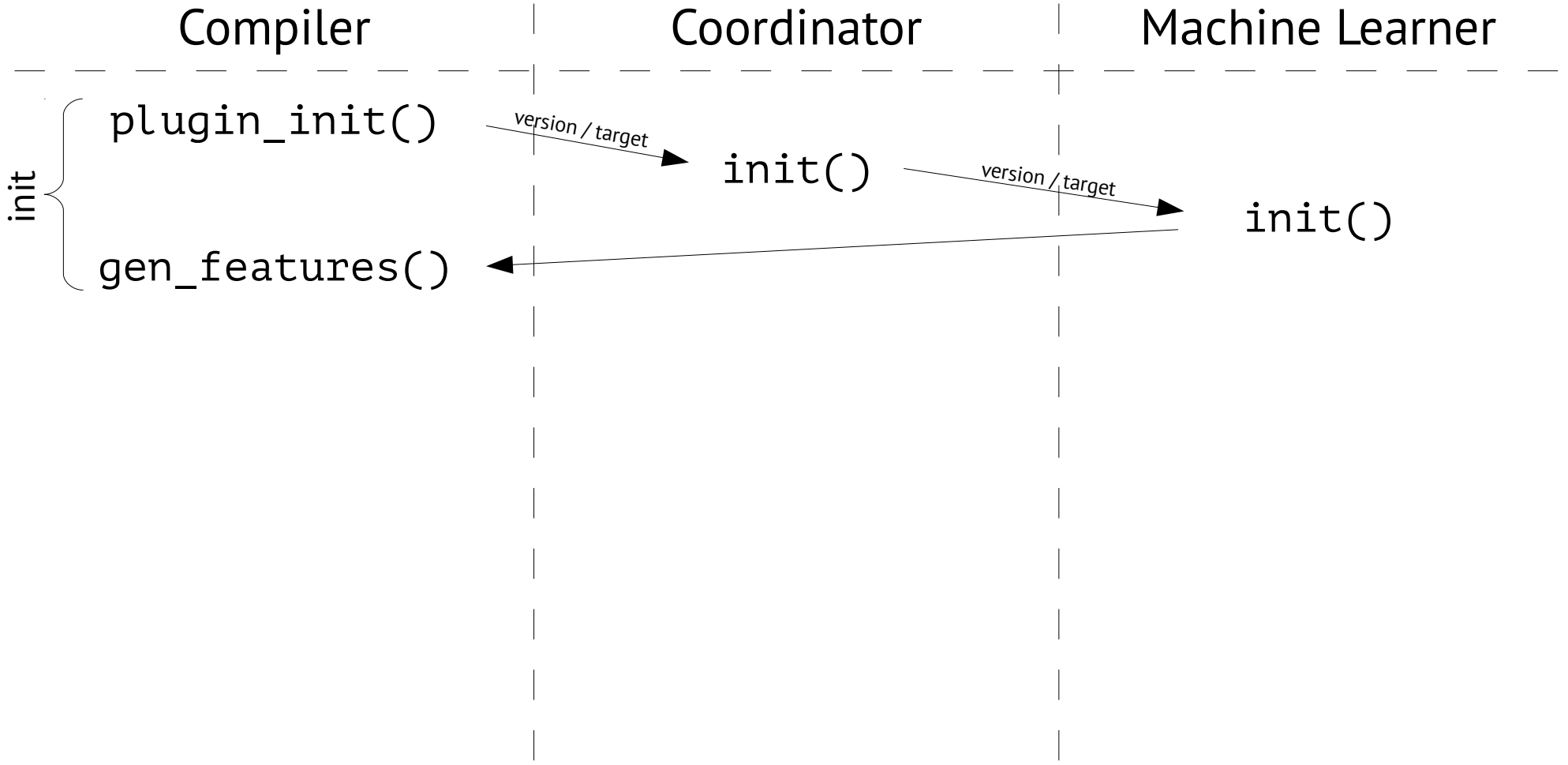

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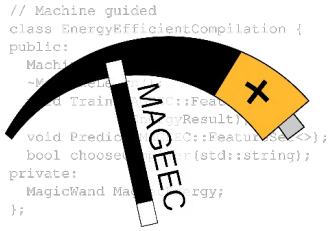

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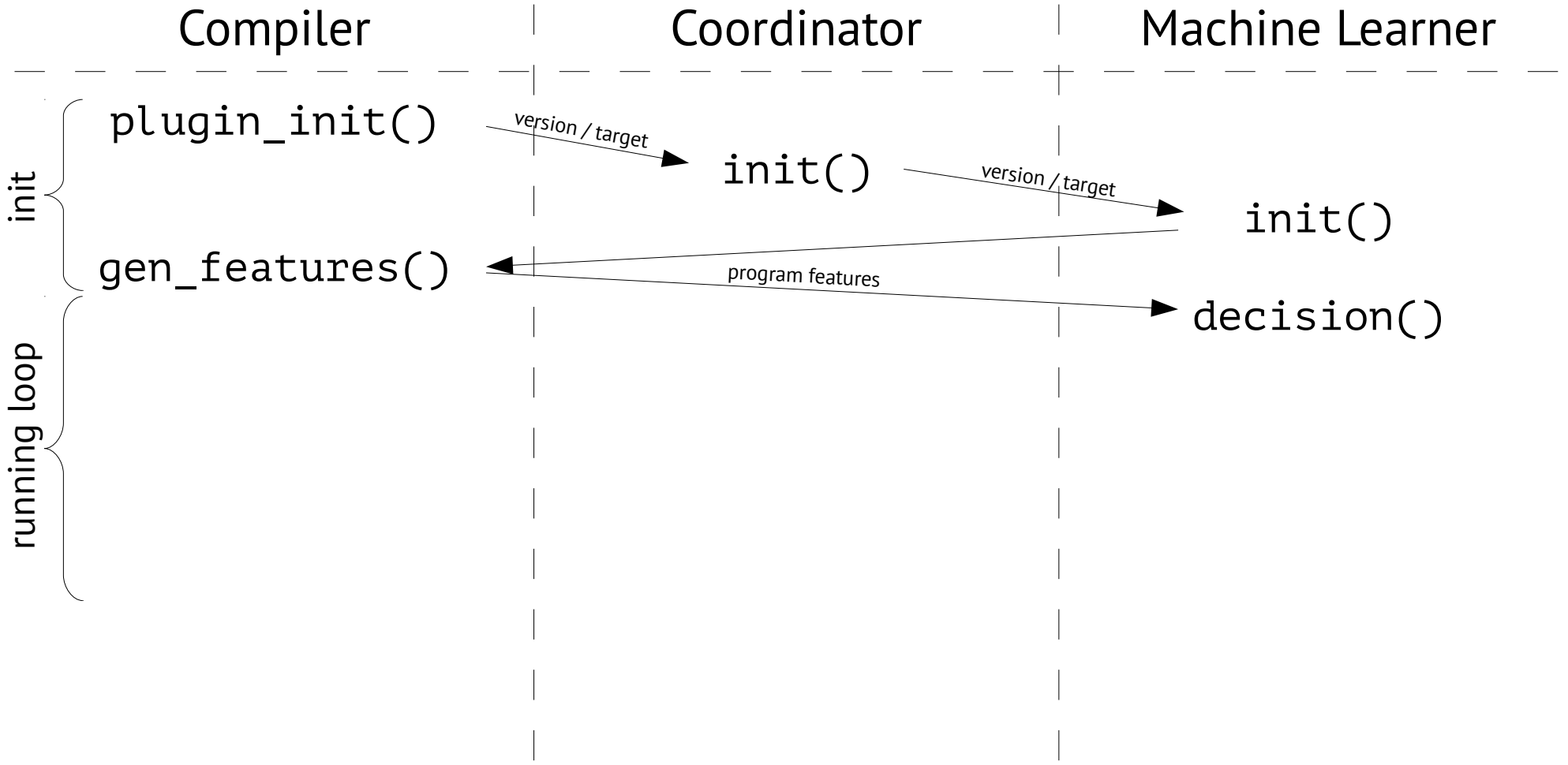

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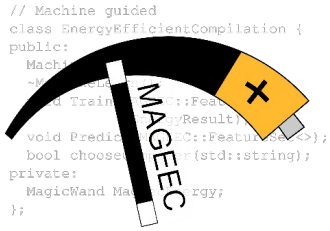

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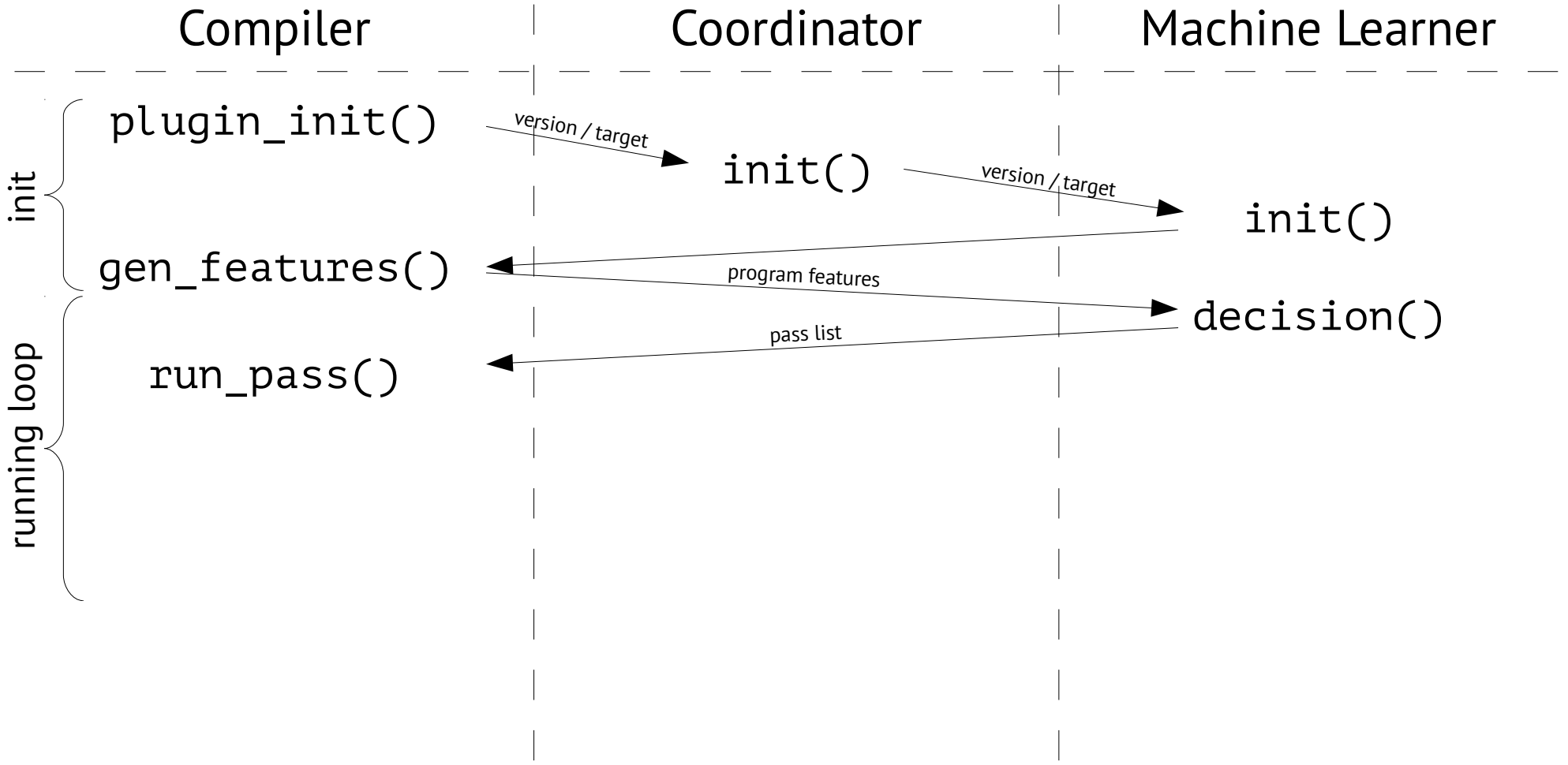

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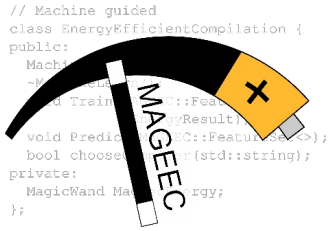

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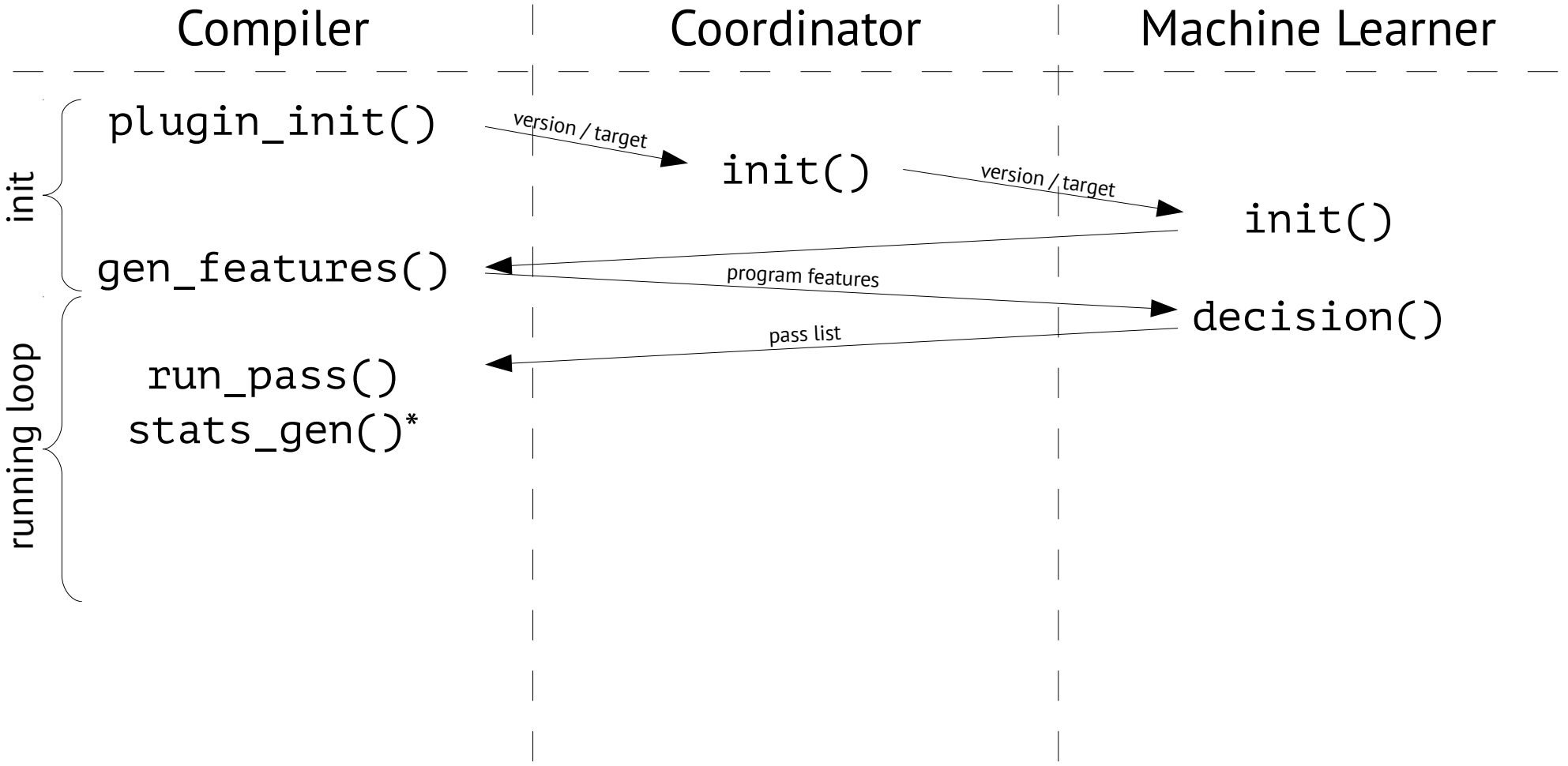

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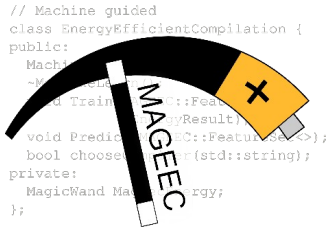

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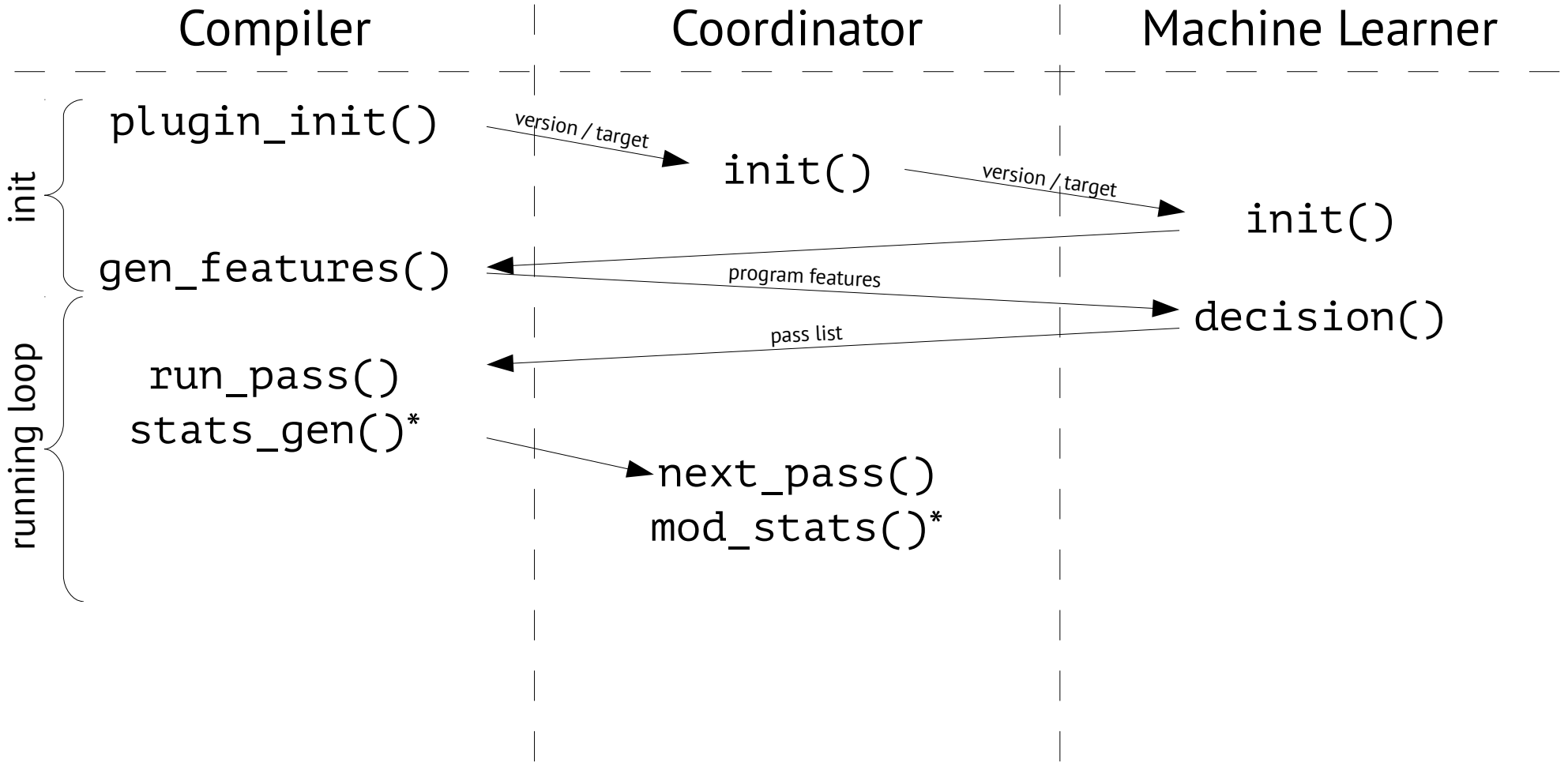

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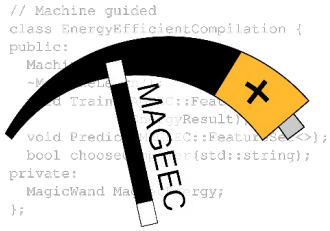

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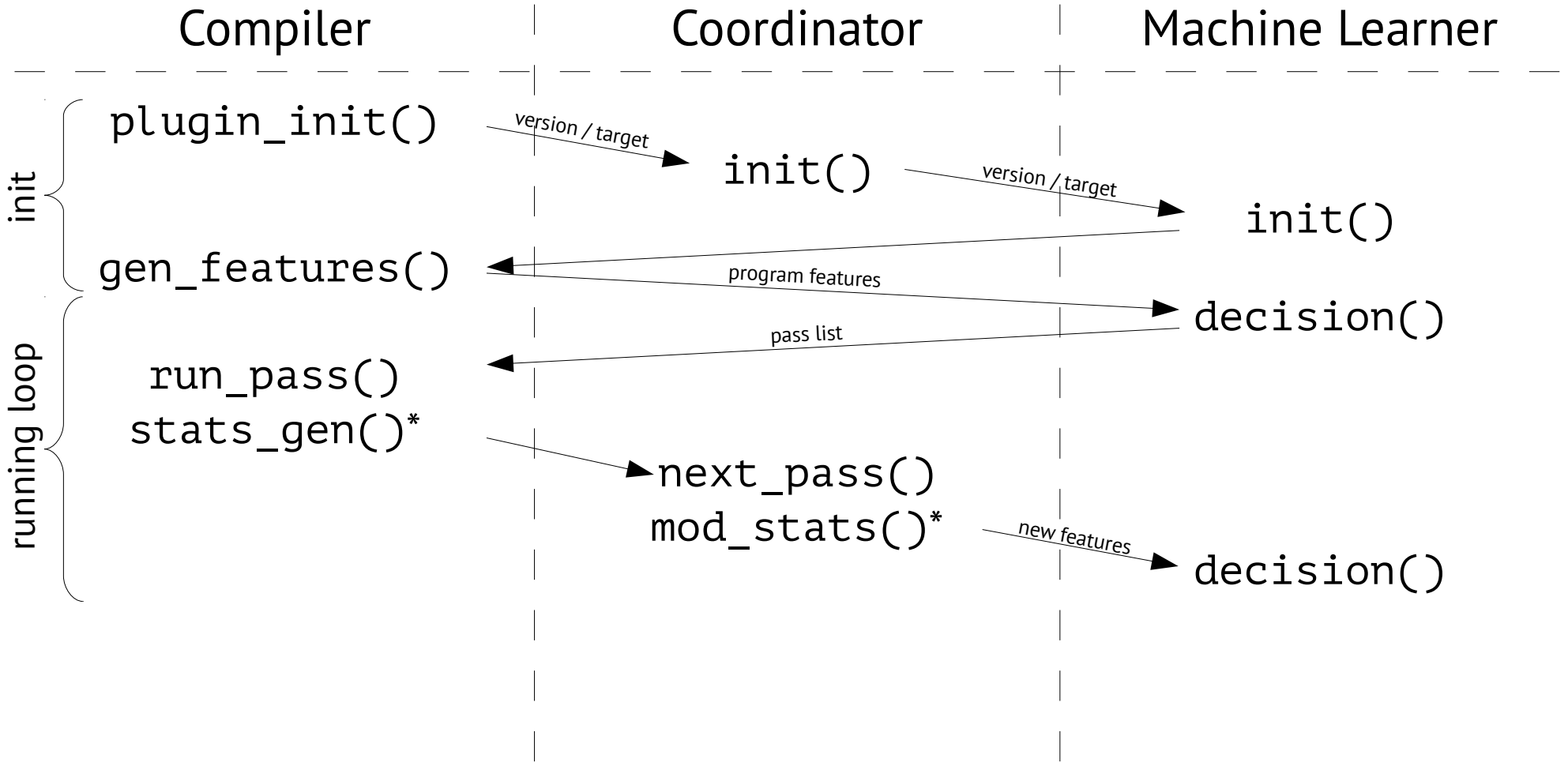

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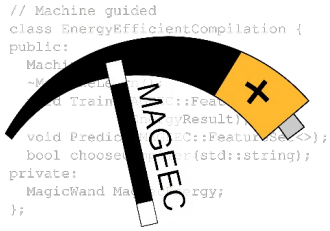

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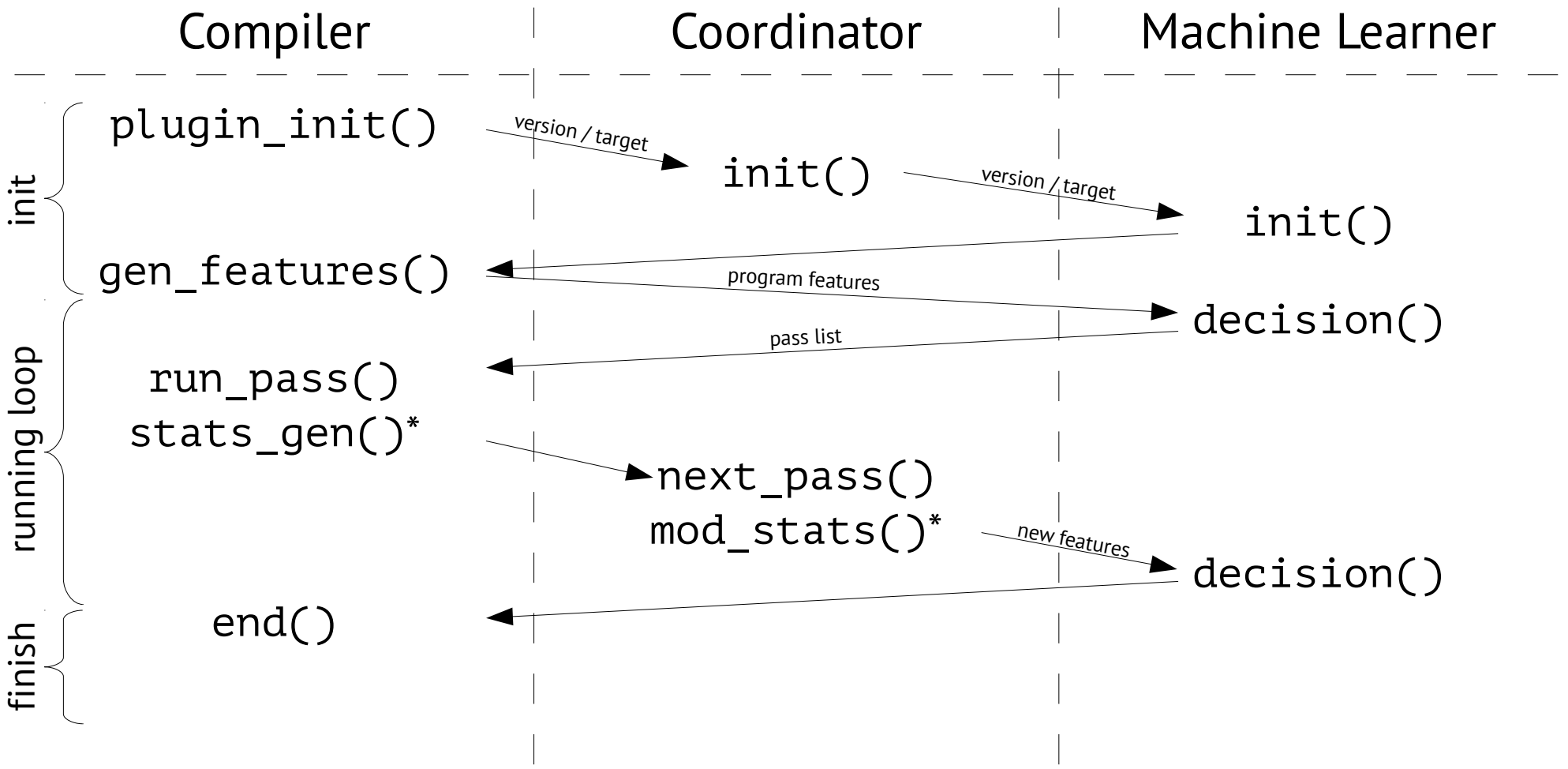

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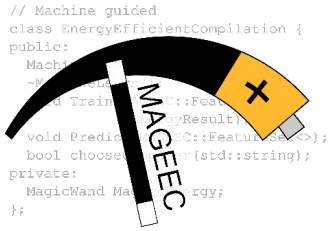

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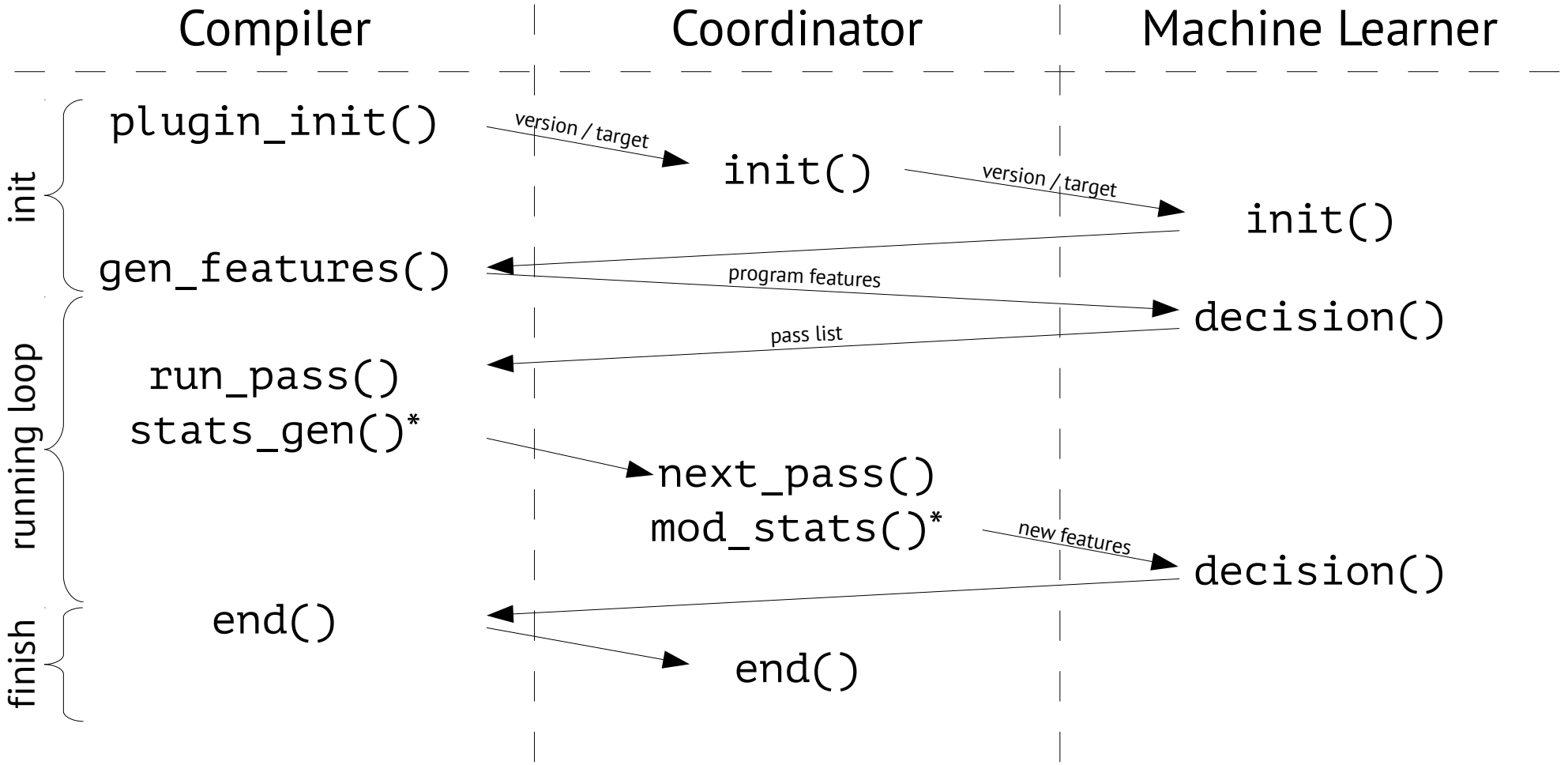

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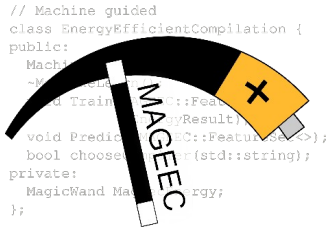

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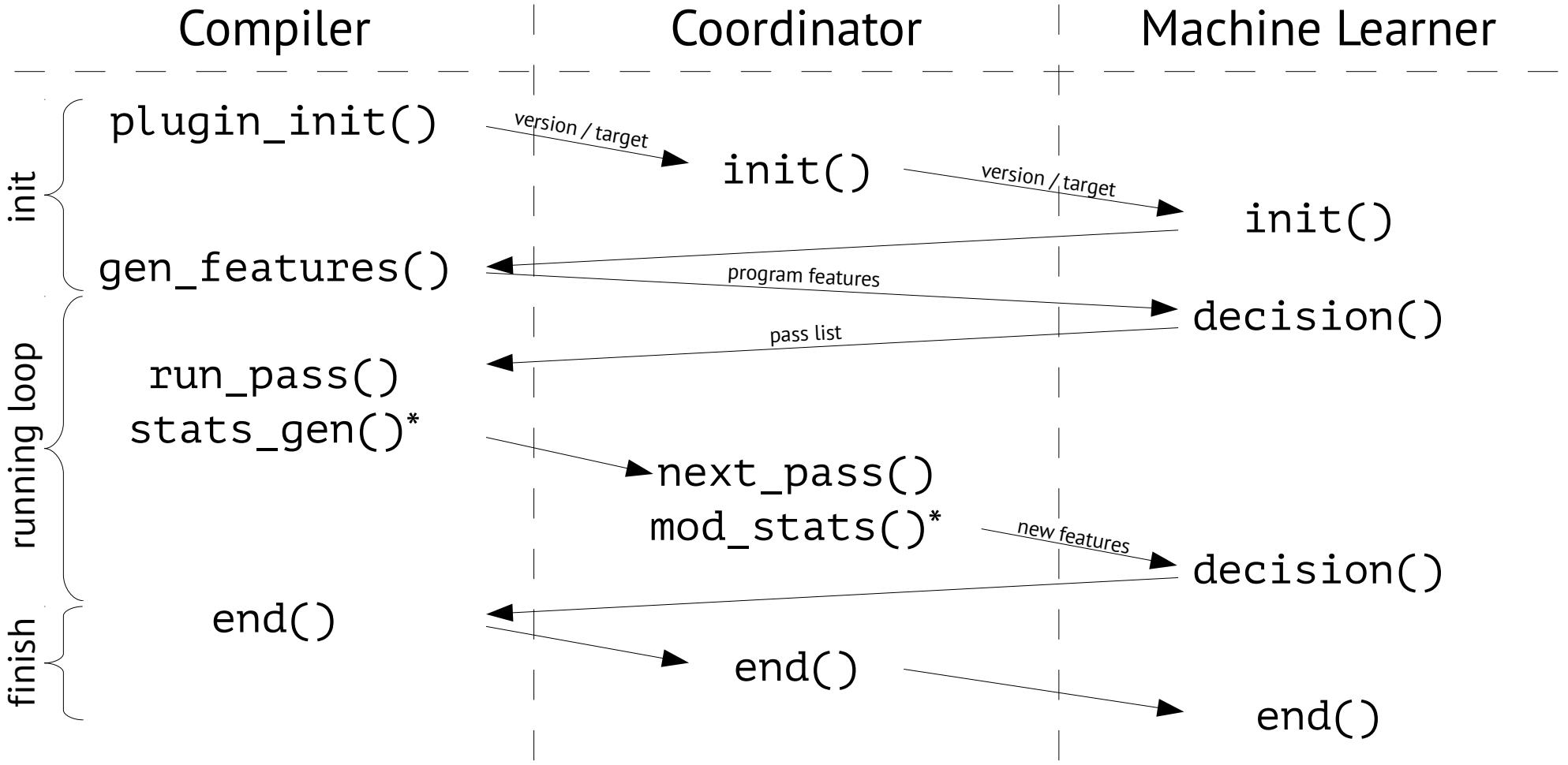

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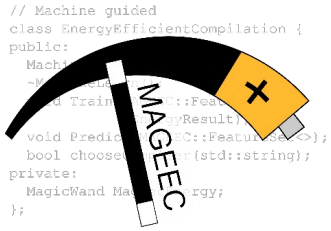
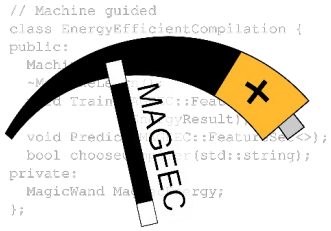


Pass Constraints

- *The* challenge for an arbitary order pass manager: **only using valid combinations.**

- The machine learner can additionally learn about what options to avoid when selecting passes.



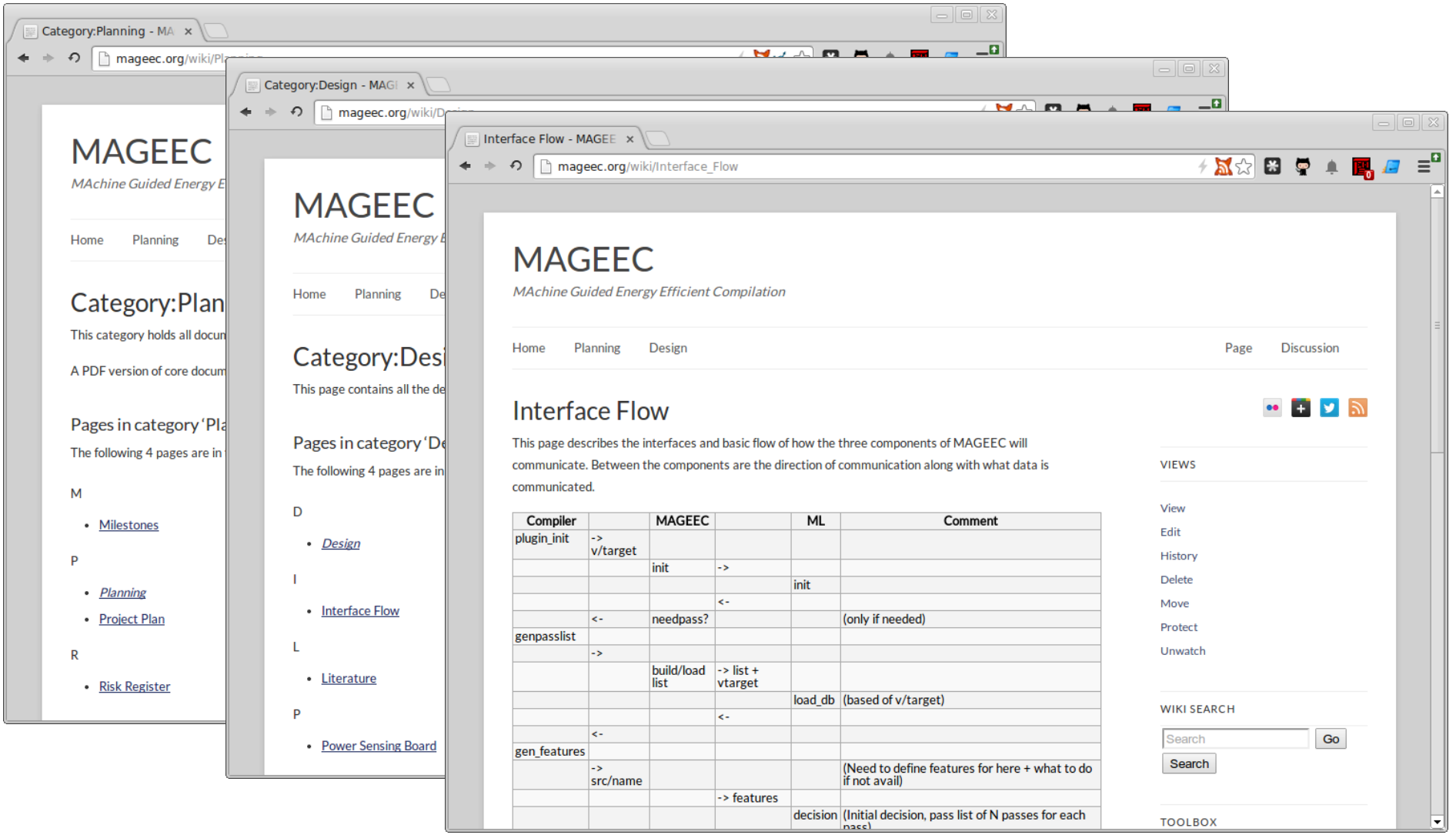
Flags

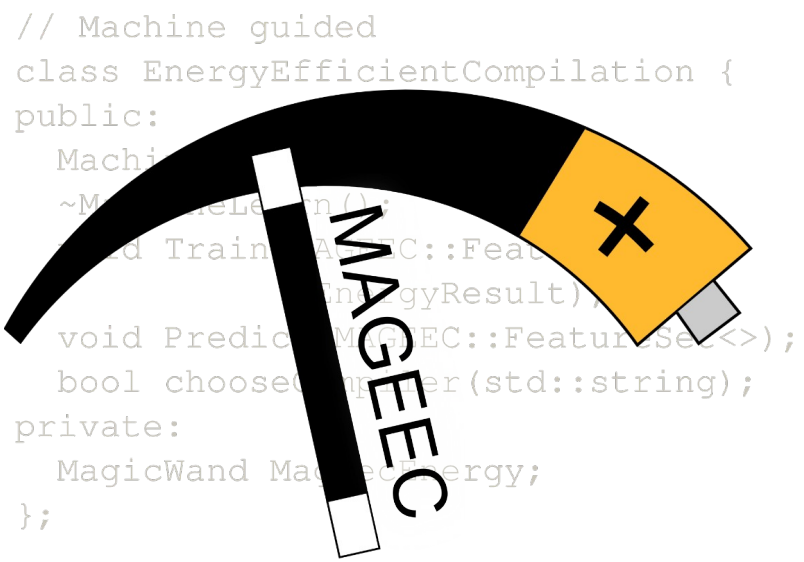
- Today's optimisaction passes optimize for speed... again, why not have passes ***dedicated*** to energy?

`gcc -fenergy`

(or a more descriptive name)

Community Involvement





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