In France, Single-Step is going live!

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Aknowledgments

April 2022: first official Single-Step GEBVs!

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A long journey

Software development

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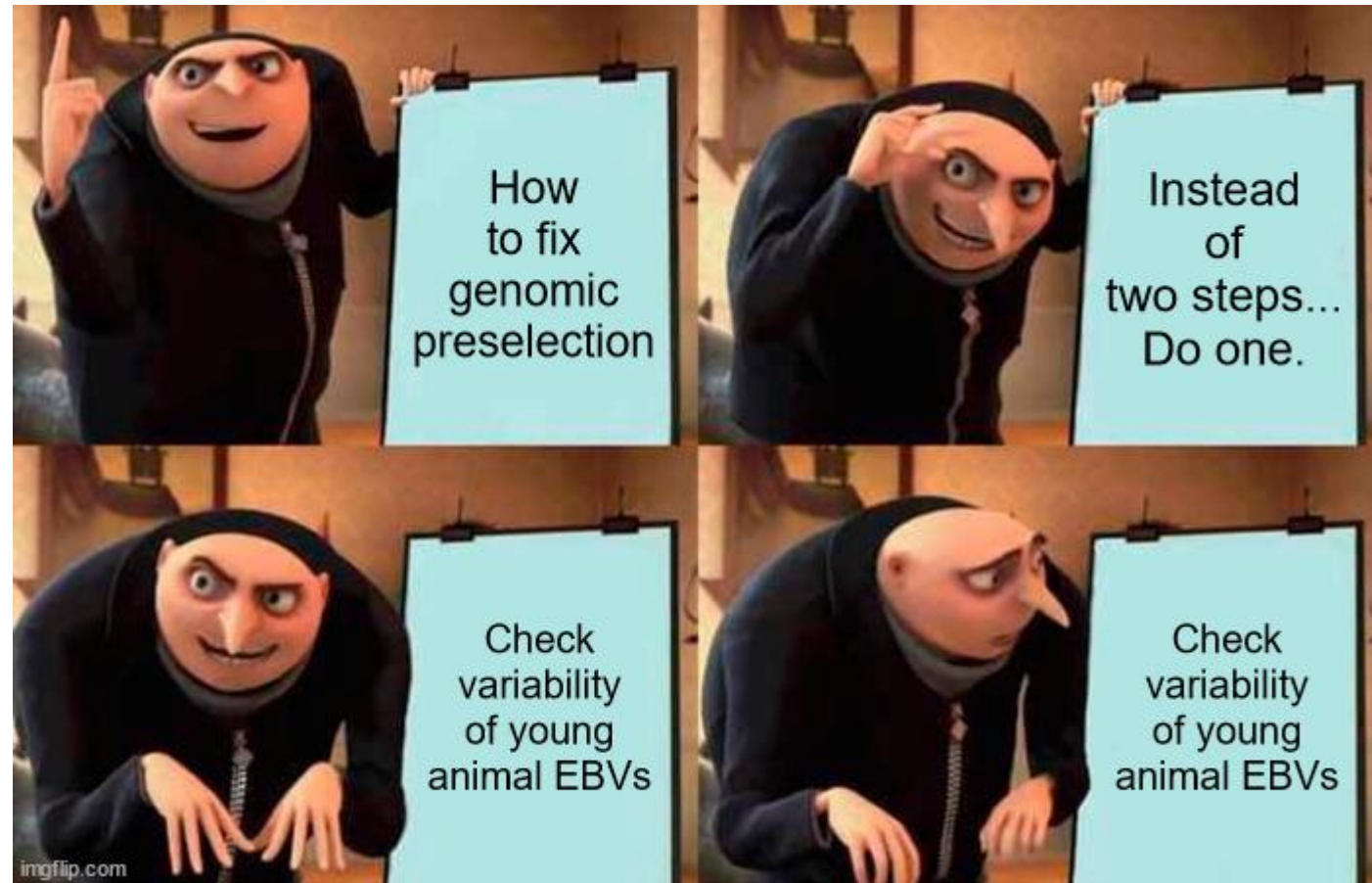
Internal validation

"A journey of a thousand miles begins with a single-step", they said. Noone ever said anything about how BIG it was going to be.

A long journey

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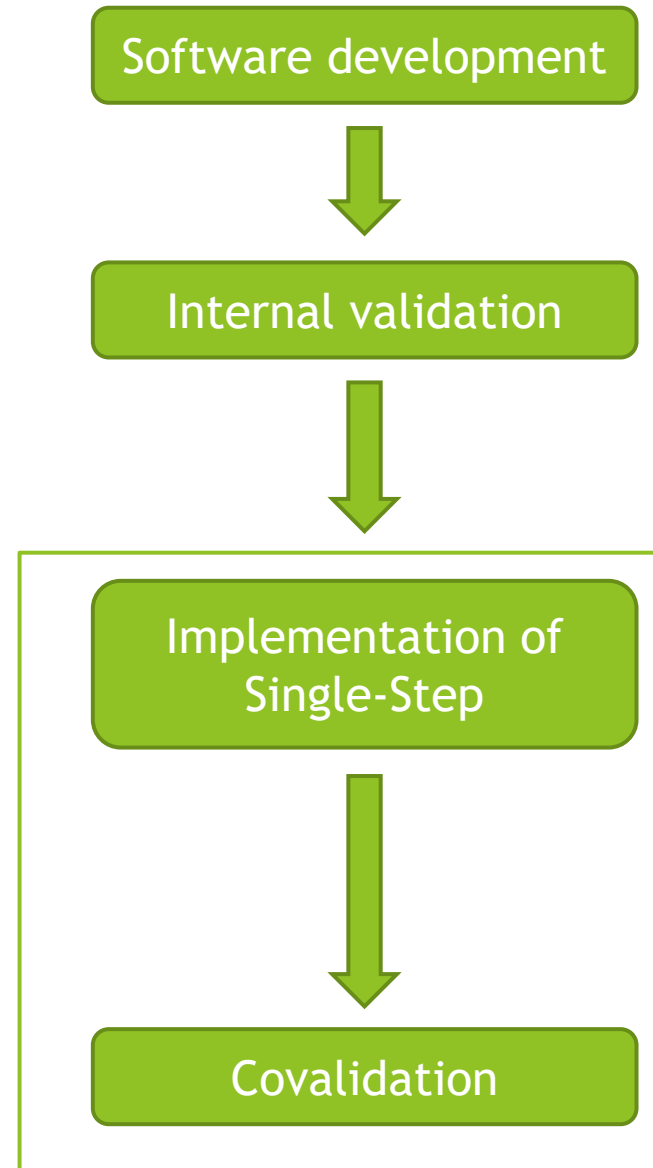
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Internal validation

↓

Implementation of Single-Step

↓

Covalidation

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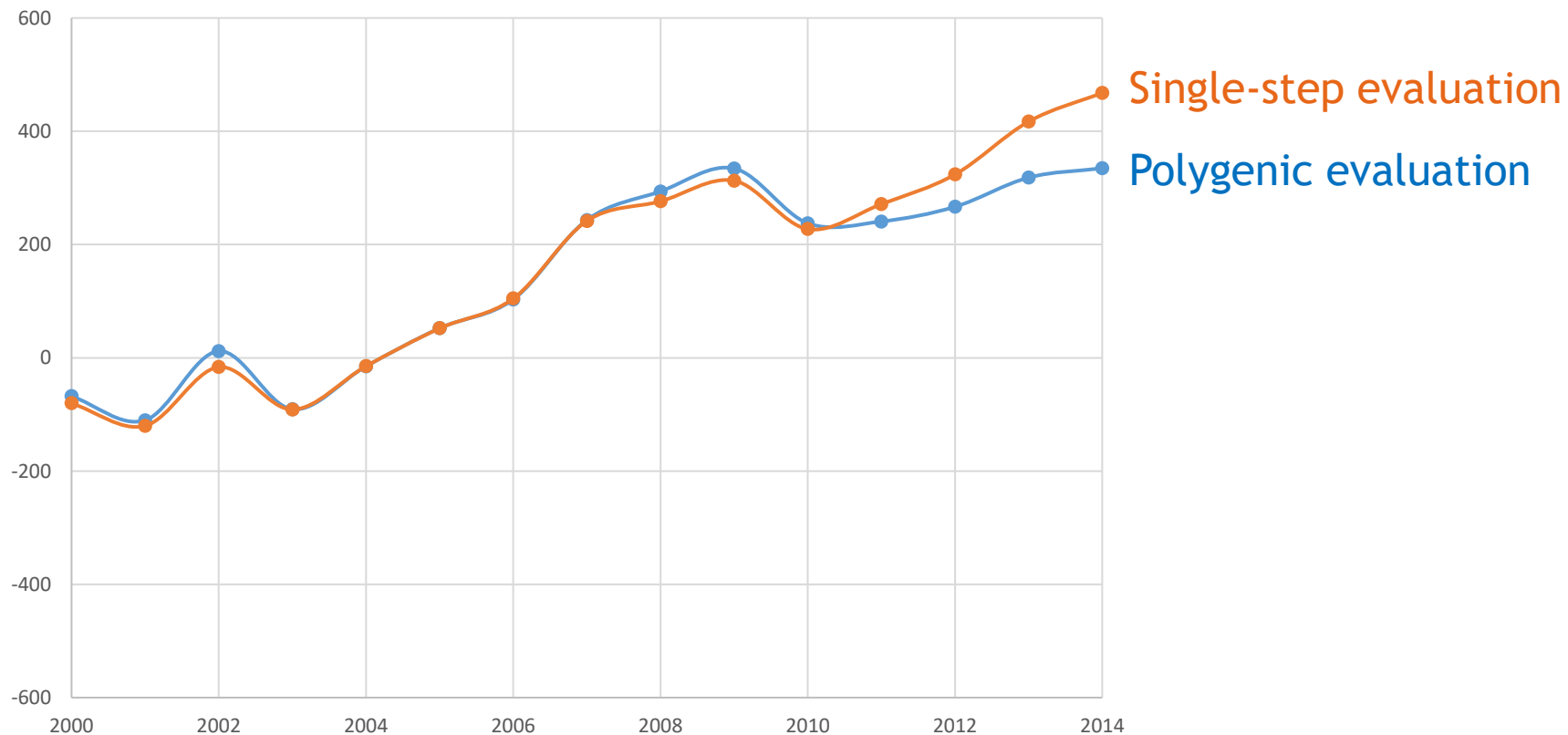# Internal validation – Genetic gain

▶ Holstein - Milk production (sires with offspring)

Single-step evaluation

Polygenic evaluation

Internal validation – cross-validation

▶ **8 breed*trait combinations**
- Big/small population
- Dairy/beef breed
- High/low heritability

▶ **Cross-validation study: comparison of N-4 GEBVs with N DYDs**
- Correlation between (G)EBVs and DYDs
- Slope of regression of DYDs on (G)EBVs
- DYDs from Single-Step or BLUP
- (G)EBVs from BLUP, MA-BLUP or Single-Step

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▶ **Single-Step >= MA-BLUP**
  o Generally similar precisions
  o Generally lower biais

Co-validation of Single-Step – Concept

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▶ Multi-partner validation, so that every partner performs a detailed validation, focused on points relevant to them

▶ Traits were split by groups depending on model characteristics (simpler to more complex)

▶ For each group, the approach was:

○ Pipeline development

○ Result validation by technical operators (GenEval + Idele)

○ Test phase: GEBV files are sent to breeding companies and breed societies for validation and feedback on anything odd in the results

○ Transition phase: breeding companies and breed societies receive both official 2-step GEBVs and final Single-Step GEBVs for final validation + preparation to Single-Step selection

Pipeline development	Technical validation	Test phase	Transition phase	Implementation!

Co-validation of Single-Step – Step 1: test phase

▶ Single-Step EBVs are estimated and sent to breeding companies and breed societies + detailed documents to summarize the main results

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▶ Hold on the validation process: higher variability on Single-Step GEBVs than current

   ○ Very high ISU (= total merit index) for extreme animals with Single-Step EBVs

   ○ Particularly high variability of young animal SS GEBVs

> Look for Boichard *et al. a*t the WCGALP!

> => New adaptation of the Single-Step approach: erosion factor
> Correct for the distance between a candidate and the reference population

Implementation of erosion factor

▶ Cross-validation study on all traits for all 8 dairy breeds with genomic evaluations in France

▶ Average slopes of regression on candidates (N-4 GEBVs on N GEBVs) for all groups of traits

	Production	Type traits	Cell count	Reproduction
Without erosion	0,938	0,992	0,938	0,991
With erosion	0,996	1,016	0,990	1,020

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▶ Even in Single-Step, highly selected traits would not be validated without the erosion factor. Slopes for all traits are very close to one with the erosion factor => Single-Step corrects the biais due to genomic preselection!

Co-validation of Single-Step – Step 2: transition phase

▶ Single-Step GEBVs with erosion factor shared with the industry

▶ 6 months of transition phase

  o Final checks

  o Prepare for a Single-Step selection

Co-validation of Single-Step – Step 3

▶ Not always easy to explain the point of the method swap to AI technicians + some reassurance needed

▶ Some complementary easy to understand studies done in addition

o Simpler Single-Step – Two-step comparisons and genetic gain studies
o Reranking

TOP 100 ISU bulls 54 common 46 new	TOP 20 ISU bulls 8 common 12 new, all from TOP 100	TOP 200 ISU females 84 common 116 new

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○ Simpler Single-Step – Two-step comparisonss and genetic gain studies

○ Reranking

○ « Génoperf » study: comparison of Single-Step EBVs to female phenotypes

• Results are reassuring for industry partners
• Easier to interpret than correlations
• Animal discrimination as good or better than with genomic GEBVs

▶ Done in all 8 dairy breeds, for several traits

Co-validation of Single-Step – Step 4

▶ Talking, training and a bit more talking

▶ Regular communication to industry through common meetings

▶ Training for every breeding company!

▶ Make sure everyone understands the main principles

▶ Answer all questions asked

Co-validation of Single-Step – The end

▶Final Single-Step GEBVs accepted and validated by all breeding companies and breed societies!

Now, that's what I call R&D!

▶ Very strong links between UMT (research, validation, software development) – GenEval (Single-Step EBV routine estimation) – Idele (diffusion of EBVs)

▶ Constant feedback from one structure to another

▶ High reactivity on issues encountered along the way

▶ Approach validated by all partners (research, industry, breeding companies and breed societies)

▶ National-scale implementation (almost) on time!