Wisent: A General Framework for Reliable Representation Identification and Representation Steering

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Abstract

Representation engineering is a powerful method for identifying and modifying high-level concepts within the internal layers of large language models. Despite its potential, real-life deployments of activation steering remain difficult. We present Wisent, a flexible, open-source framework for monitoring and steering internal activations of large language models. Practical applications of the framework show XXX percent hallucination reduction, XXX percent improvement in coding ability and deep personalization capabilities.

1 Introduction

Large language models, with billions of parameters and Internet-scale training dataset, have displayed significant capabilities across a wide range of tasks, such as writing, coding or reasoning.

However, their internal mechanisms of generating the next token cannot be precisely explained, with interactions between layers and parameters increasing in complexity as the size of these models increases.

Experiments with representation engineering (also known as steering or activation steering) have shown activation modification to be a powerful method of identifying and influencing high-level concepts (representations) within the layers of an LLM. Despite strong empirical performance on selected truthfulness, safety or personalization tasks, representation engineering methods lack a universal formulation and a unifying framework for understanding the underlying phenomenon, comparing methods and applying them to new problems.

We propose Wisent, a modular framework for analyzing the internal mechanisms within a large language model and influencing them to improve performance and individual alignment. Wisent surpasses state of the art performance in identifying particular behaviors

2 Representation Engineering Problem

We formulate the **Representation Engineering Problem** as the following:

For a given model M and a Representation

Basic primitives and definitions of key terms are outlined in Appendix A.

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3 Representation Reading

3.1 Classifier

3.2 Detection Handling Method

4 Representation Control

4.1 Classifier

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A Wisent Primitives

A.1 Model

A.2 Contrastive Pair

A.3 Activations

A.4 Activation Collection Method

A.5 Additional Utilities

B Representation Reading Functionalities

B.1 Classifier

B.2 Detection Handling Method

C Representation Control Functionalities

D Ablation

A All supported benchmarks

This section enumerates all benchmarks used in our study, the task traits, the evaluation protocol, and the contrastive pair generation method applied to produce minimally perturbed negative targets. We first merged the *coding* and *mathematics* benchmark lists you provided and then appended them to the original master list.

Contrastive pair generation methods (definitions)

Reading Comprehension Abstention Swap [RC-Abstain] For extractive/open-domain RC: positive is the gold span; negative is an abstention (e.g., "Not provided in the text."). If gold is *No answer*, the negative is a confident but wrong claim.

Conversational Reading Comprehension Abstention [ConvRC-Abstain] As RC-Abstain, but with dialogue context (CoQA). Negatives are generic abstentions; yes/no items are flipped when applicable.

Language Modeling Corrupted Continuation [LM-CorruptCont] Language modeling: positive is the true continuation; negative is a corrupted continuation (local shuffles/randomization) to break coherence.

Two-Choice Flip [2C-Flip] Two-option tasks (PIQA, COPA, WinoGrande, CB): negative is simply the other option.

Multichoice First Distractor [MC-FirstDistr] Multi-choice tasks: negative = the first incorrect option in the provided order (deterministic).

Multichoice Random Distractor [MC-RandDistr] Multi-choice tasks: negative = a randomly chosen incorrect option from the same set (used for GPQA).

Multichoice Letter Swap [MC-LetterSwap] Multi-choice tasks scored over option letters (TruthfulQA MC1/MC2): negative = the first incorrect letter.

Boolean Flip [Bool-Flip] Binary tasks (BoolQ): negative is the opposite boolean label.

Exact Match Partial Mask [EM-PartialMask] Exact-match free-form answers (HLE-EM): negative is the gold text with partial token masking (approximately 1/3 words, or partial masking for single-word answers).

Keyword-Preserving Token Deletion [KP-Del] Coding tasks: negative program created by deleting non-keyword tokens while preserving syntax-critical keywords; aims to remain plausible but fail unit tests.

Summary Content-Word Drop [Summ-WordDrop] Code-to-text summarization: negative description formed by dropping content words (nouns/verbs) while keeping scaffolding words to preserve superficial form.

Numeric Offset (+1) Perturbation [Num+1] Math QA: negative is the correct numeric answer offset by a small integer (typically +1); for non-integer answers, apply the minimal unit offset.

Evaluation types (definitions)

Log-likelihood option scoring [LL] The model scores each provided option/target by conditional log-probability given the prompt. Metrics typically compute accuracy over the highest-likelihood choice (MC tasks) or compare likelihoods of gold vs. negative targets.

Text generation string matching [TG] The model generates free-form text (or a number), which is then judged by task-specific metrics (e.g., exact match on numerical value for GSM8K/MATH; span/string matching for RC tasks; structured checks for DROP). Used also for CoT/generative GPQA variants and HLE-Exact-Match.

Perplexity (language modeling) [PPL] The model's next-token distribution is evaluated over a reference text to compute Perplexity (lower is better). Used for language-modeling corpora like WikiText.

Code execution against unit tests [CE] The model generates code, which is executed in a sandbox against unit tests provided by a dataset (e.g., pass@1). Applies to HumanEval/MBPP/APPS, MultiPL-E, DS-1000, LiveCodeBench, etc.

Table 1: Benchmarks (short names), evaluation abbreviations, contrastive method (short), and traits. Versions merged where applicable.

Benchmark	**Eval**	**Method [CM]**	**Traits**
DROP **?**	[TG]	**RC-Abstain**	reading comprehension
ReCoRD **?**	[TG]	**RC-Abstain**	reading comprehension
SQuAD2 **?**	[TG]	**RC-Abstain**	reading comprehension
WebQuestions **?**	[TG]	**RC-Abstain**	factual QA
Natural Questions **?**	[TG]	**RC-Abstain**	factual QA
TriviaQA **?**	[TG]	**RC-Abstain**	factual QA
CoQA **?**	[TG]	**ConvRC-Abstain**	conversational RC
BoolQ **?**	[LL]	**Bool-Flip**	boolean RC
WinoGrande **?**	[LL]	**2C-Flip**	commonsense
PIQA **?**	[LL]	**2C-Flip**	commonsense
COPA **?**	[LL]	**2C-Flip**	causal reasoning
HellaSwag **?**	[LL]	**MC-FirstDistr**	commonsense
SWAG **?**	[LL]	**MC-FirstDistr**	commonsense
OpenBookQA **?**	[LL]	**MC-FirstDistr**	science MCQ
ARC **?**	[LL]	**MC-FirstDistr**	science MCQ
RACE **?**	[LL]	**MC-FirstDistr**	RC (MC)
MMLU **?**	[LL]	**MC-FirstDistr**	multi-subject exams
GPQA **?**	[LL]/[TG]	**MC-RandDistr**	expert STEM exams
SuperGPQA **?**	[LL]	**MC-FirstDistr**	expert STEM exams
HLE **?**	[TG]/[LL]	**EM-PartialMask; MC-FirstDistr**	expert exams
GSM8K **?**	[TG]	**Num+1**	mathematics
ASDiv **?**	[TG]	**Num+1**	mathematics
Arithmetic **?**	[TG]	**Num+1**	mathematics

Benchmark	Eval	Method [CM]	Traits
MATH **?**	[TG]	**Num+1**	mathematics (contest)
MATH–500 **?**	[TG]	**Num+1**	mathematics (contest)
AIME **??**	[TG]	**Num+1**	mathematics (contest)
HMMT **?**	[TG]	**Num+1**	mathematics (contest)
PolyMath **?**	[TG]	**Num+1**	mathematics (multiling.)
LiveMathBench **?**	[TG]	**Num+1**	mathematics (EN/ZH)
MBPP **?**	[CE]	**KP-Del**	coding (Python)
HumanEval **?**	[CE]	**KP-Del**	coding (Python)
CoNaLa **?**	[CE]	**KP-Del**	coding (Python)
CONCODE **?**	[CE]	**KP-Del**	coding (Java)
Mercury **?**	[CE]	**KP-Del**	coding (multi-language)
HumanEval+ **?**	[CE]	**KP-Del**	coding (Python)
InstructHumanEval **?**	[CE]	**KP-Del**	coding (Python)
MBPP+ **?**	[CE]	**KP-Del**	coding (Python)
APPS **?**	[CE]	**KP-Del**	coding (Python)
DS–1000 **?**	[CE]	**KP-Del**	coding (Python)
MultiPL–E **?**	[CE]	**KP-Del**	coding (multi-language)
CodeXGLUE **?**	[TG]	**Summ-WordDrop**	coding (code-to-text)
ReCode **?**	[CE]	**KP-Del**	coding (Python)
LiveCodeBench **?**	[CE]	**KP-Del**	coding (Python)
TruthfulQA **?**	[LL]	**MC-LetterSwap**	truthfulness
CB **?**	[LL]	**2C-Flip**	NLI
WikiText (2/103) **?**	[PPL]	**LM-CorruptCont**	language modeling

Category legend

🟦 RC/ODQA
🟦 Multi-choice Reasoning
🟧 Exams & Knowledge Tests
🟩 Mathematics
🟪 Coding
⬜ Other (Truthfulness/NLI/LM)

Abbreviation legend

`[LL]`	Log-likelihood option scoring
`[TG]`	Text generation (string match)
`[PPL]`	Perplexity (LM)
`[CE]`	Code execution vs. unit tests

Method [CM] codes

RC-Abstain	RC abstention swap
ConvRC-Abstain	Conversational RC abstention
LM-CorruptCont	LM corrupted continuation
2C-Flip	Two-choice flip
MC-FirstDistr	First distractor (MC)
MC-RandDistr	Random distractor (MC)
MC-LetterSwap	Letter swap (MC)
Bool-Flip	Boolean flip
EM-PartialMask	Exact-match partial mask
KP-Del	Keyword-preserving deletion
Summ-WordDrop	Summary word drop
Num+1	Numeric offset (+1)

B Per-Task Results

C Detailed Classification Results

D Benchmark-Aided Steering Results

E Optimal Sample Size Calculations

F Fully Synthethic Generation

G Agentic Capabilities