Wisent Guard: 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-Guard, a flexible, open-source framework for monitoring and steering internal activations of large language models. Practical applications of the framework show 95 percent hallucination reduction, 25 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-Guard, a modular framework for analyzing the internal mechanisms within a large language model and influencing them to improve performance and individual alignment.

2 Representation Engineering Problem

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

For a given model M and a Representation

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3 Representation Reading Functionalities

3.1 Classifier

3.2 Detection Handling Method

4 Representation Control Functionalities

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A Wisent Guard 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.

Text Generation Corruption [TG-Corrupt] Text generation: positive is true continuation, negative is shuffling postive if it is string and adding letter if shuffle results in identity, +1 if positive is number.

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: If one list is provided then negative is the first incorrect option that comes after correct option, if the correct option is last, use the first option. If separate list with incorrect answers is provided, take first from the list. (deterministic).

Multichoice Random Distractor [MC-RandDistr] Multi-choice tasks: negative is a randomly chosen incorrect option from the same set.

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.

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

Summary Content-Polarity Flip [Summ-PolFlip] Code to text summarization: make a negative description by flipping key action words with simple opposites or adding "not" (e.g., "return" to "does not return", "add" to "remove"), while keeping the rest of the sentence the same.

Library Specific Flip [Lib-Spec-Filip] Coding tasks: negative program created by flipping functions, parameters (e.g. for numpy flip axis 0 to 1, for pandas flip mean() to sum()).

Logic inversion [Log-Inv] Coding tasks: negative program created by fliping bools, operators in code (e.g. return True to return False, <= to >=).

Offset (+-1) [+-1] Coding tasks: negative program created by adding/subtracting 1 from range or numeric value.

Replace empty [Empty] Coding tasks: negative program created by replacing string to empty string, list to empty list.

Generic incorrect continuation [Gen-Inc-Cont] Answer generation tasks: negative is created by generic incorrect answer.

Early return [Return] Coding tasks: negative program created by early return.

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 [16]	[TG]	**TG-Corrupt**	reading comprehension
ReCoRD [55]	[TG]	**MC-FirstDistr**	reading comprehension
SQuAD2 [40]	[TG]	**RC-Abstain**	reading comprehension
WebQuestions [3]	[TG]	**TG-Corrupt**	factual QA
TriviaQA [22]	[TG]	**TG-Corrupt**	factual QA
CoQA [41]	[TG]	**TG-Corrupt**	conversational RC
BoolQ [7]	[LL]	**2C-Flip**	boolean RC
Race [24]	[LL]	**MC-FirstDistr**	reading comprehension
QA4MRE [37]	[LL]	**MC-FirstDistr**	reading comprehension
QASPER [12]	[TG]	**2C-Flip**	scientific QA
MultiRC [23]	[LL]	**2C-Flip**	multi-sentence reasoning
XStoryCloze [28]	[LL]	**MC-FirstDistr**	commonsense
LogiQA [30]	[LL]	**MC-FirstDistr**	logical reasoning
LogiQA2 [29]	[LL]	**MC-FirstDistr**	logical reasoning
WSC [26]	[LL]	**2C-Flip**	reading comprehension
RTE	[LL]	**2C-Flip**	reading comprehension

Benchmark	Eval	Method [CM]	Traits
XWinograd [46]	[LL]	**MC-FirstDistr**	commonsense
WinoGrande [43]	[LL]	**2C-Flip**	commonsense
PIQA [4]	[LL]	**2C-Flip**	commonsense
COPA [42]	[LL]	**2C-Flip**	causal reasoning
HellaSwag [54]	[LL]	**MC-FirstDistr**	commonsense
SWAG [53]	[LL]	**MC-FirstDistr**	commonsense
OpenBookQA [35]	[LL]	**MC-FirstDistr**	science MCQ
ARC Easy [8]	[LL]	**MC-FirstDistr**	science reasoning
ARC Challenge [8]	[LL]	**MC-FirstDistr**	science reasoning
MC-TACO [56]	[LL]	**2C-Flip**	temporal reasoning
Social IQA [44]	[LL]	**MC-FirstDistr**	social reasoning
PROST [1]	[LL]	**MC-FirstDistr**	physical reasoning
Mutual [11]	[LL]	**MC-FirstDistr**	dialogue reasoning
HLE [38]	[TG]/[LL]	**EM-PartialMask; MC-FirstDistr**	expert exams
HLE Exact Match [38]	[TG]	**EM-PartialMask**	expert exams
HLE Multiple Choice [38]	[LL]	**MC-FirstDistr**	expert exams
TruthfulQA MC1 [27]	[LL]	**MC-FirstDistr**	truthfulness
TruthfulQA MC2 [27]	[LL]	**MC-FirstDistr**	truthfulness
TruthfulQA Gen [27]	[TG]	**MC-FirstDistr**	truthfulness
PubMedQA [21]	[LL]		biomedical QA
SciQ [50]	[LL]	**MC-FirstDistr**	science MCQ
HeadQA [47]	[LL]	**MC-FirstDistr**	healthcare QA
MedQA [20]	[LL]	**MC-FirstDistr**	medical QA
GSM8K [9]	[TG]	**Num+1**	mathematics
ASDiv [34]	[TG]	**Num+1**	mathematics
Arithmetic 1dc	[TG]	**Num+1**	mathematics
Arithmetic 2da	[TG]	**Num+1**	mathematics
MATH–500	[TG]	**Num+1**	mathematics (contest)
AIME	[TG]	**Num+1**	mathematics (contest)
AIME2024	[TG]	**Num+1**	mathematics (contest)
AIME2025	[TG]	**Num+1**	mathematics (contest)
HMMT	[TG]	**Num+1**	mathematics (contest)
HMMT Feb 2025	[TG]	**Num+1**	mathematics (contest)
PolyMath [49]	[TG]	**Num+1**	multilingual mathematics
Polymath EN Medium [49]	[TG]	**Num+1**	mathematics (olympiad)
Polymath ZH Medium [49]	[TG]	**Num+1**	mathematics (olympiad)
Polymath EN High [49]	[TG]	**Num+1**	mathematics (olympiad)
Polymath ZH High [49]	[TG]	**Num+1**	mathematics (olympiad)
LiveMathBench [32]	[TG]	**Num+1**	mathematics
LiveMathBench CNMO EN [32]	[TG]	**Num+1**	mathematics
LiveMathBench CNMO ZH [32]	[TG]	**Num+1**	mathematics
MBPP [2]	[CE]	**+-1; Empty; Return**	coding (Python)
MBPP+ [31]	[CE]	**+-1; Empty; Return**	coding (Python)
HumanEval [6]	[CE]	**Log-Inv; +-1**	coding (Python)
HumanEval+ [31]	[CE]	**Log-Inv; +-1**	coding (Python)
HumanEvalPack [36]	[CE]	**Log-Inv; +-1**	coding (multi-language)
InstructHumanEval	[CE]	**Log-Inv; +-1**	coding (Python)
CoNaLa [52]	[CE]	**KP-Del**	coding (Python)
CONCODE [18]	[CE]	**KP-Del**	coding (Java)

Benchmark	Eval	Method [CM]	Traits
Mercury [15]	[CE]	**Log-Inv; +-1**	coding (multi-language)
APPS [17]	[CE]	**KP-Del**	coding (Python)
DS–1000 [25]	[CE]	**Lib-Spec-Flip**	coding (Python)
ReCode [48]	[CE]	**Log-Inv; +-1**	coding (Python)
LiveCodeBench [19]	[CE]	**KP-Del**	coding (Python)
Multiple CPP [5]	[CE]		coding (C++)
Multiple Go [5]	[CE]		coding (Go)
Multiple Java [5]	[CE]		coding (Java)
Multiple JS [5]	[CE]		coding (JavaScript)
Multiple PY [5]	[CE]		coding (Python)
Multiple RS [5]	[CE]		coding (Rust)
CodeXGLUE Code to Text Python [33]	[TG]	**Summ-PolFlip**	coding (code-to-text)
CodeXGLUE Code to Text Go [33]	[TG]	**Summ-PolFlip**	coding (code-to-text)
CodeXGLUE Code to Text Java [33]	[TG]	**Summ-PolFlip**	coding (code-to-text)
CodeXGLUE Code to Text JavaScript [33]	[TG]	**Summ-PolFlip**	coding (code-to-text)
CodeXGLUE Code to Text PHP [33]	[TG]	**Summ-PolFlip**	coding (code-to-text)
CodeXGLUE Code to Text Ruby [33]	[TG]	**Summ-PolFlip**	coding (code-to-text)
CB [13]	[LL]	**MC-FirstDistr**	NLI
MRPC [14]	[LL]	**2C-Flip**	paraphrase detection
QNLI	[LL]	**2C-Flip**	NLI
QQP	[LL]	**2C-Flip**	paraphrase detection
SST2 [45]	[LL]	**2C-Flip**	sentiment analysis
WNLI	[LL]	**2C-Flip**	NLI
WiC [39]	[LL]	**2C-Flip**	word-in-context
PAWS-X [51]	[LL]	**2C-Flip**	paraphrase detection
XNLI [10]	[LL]	**MC-FirstDistr**	NLI

Category legend

- RC/ODQA
- Multi-choice Reasoning
- Exams & Knowledge Tests
- Mathematics
- Coding
- Other

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 GSM8K Pipeline Visualization

1. Load task using lm-eval-harness

question: Janet's ducks lay 16 eggs per day. She eats 3 for breakfast and bakes 4 into muffins. She sells the remainder for $2 per egg. How much does she make daily?

answer: "Janet has 16 - 3 - 4 = 9 eggs left to sell. She makes 9 × $2 = $18 per day. 18"

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2. Split Data

Partition the dataset into training and testing subsets based on the ratio provided by the user.

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3. Extract contrastive pairs, Num+1 method

Positive prompt: "Janet's ducks lay 16 eggs per day. She eats 3 for breakfast and bakes 4 into muffins. She sells the remainder for $2 per egg. How much does she make daily? 18"

Negative prompt: "Janet's ducks lay 16 eggs per day. She eats 3 for breakfast and bakes 4 into muffins. She sells the remainder for $2 per egg. How much does she make daily? 19.0"

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4. Collect activations

Get activations for positive and negative prompts.

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5. Prepare data for training classifier

The dataset contains features derived from activations by averaging them across the sequence, and binary labels (0 = truthful, 1 = untruthful).

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6. Train classifier

Fit a logistic regression model using the data defined above.

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Ground truth and classifier evaluation

Ground truth evaluation usses lm-eval-harness to measure the model's actual performance by comparing generated responses against correct answers. Classifier evaluation tests how accurately the trained classifier can distinguish between truthful and untruthful responses based solely on internal activations, validating the effectiveness of our truthfulness detection system.

Figure: GSM8K evaluation pipeline showing data flow from task loading through dual evaluation.