

[Home](#) \* [Engines](#) \* **Winter**



[Winter](#) in [Zurich](#), [ETH Zurich](#)  
view <sup>[5]</sup>

## Winter,

an [UCI](#) compliant [open source](#) [chess engine](#) by [Jonathan Rosenthal](#), written in [C++](#), released on January 08, 2018 under the terms of [GPL Version 3](#). Winter is inspired by [machine learning](#) techniques, as applied in [move ordering](#) and in particular in [evaluation](#), and heavily relies on [C++ templates](#) but not on any library aside from [STL](#) as it comes with its own implementations for [statistics](#) <sup>[1]</sup> and [linear algebra](#) <sup>[2]</sup>. Winter started its life in 2016 as a group project at [ETH Zurich](#) in a course on parallel computing along with Jonas Kuratli and Jonathan Maurer - the current release with Jonathan Rosenthal as sole author has removed the parallel portion of the code <sup>[3]</sup>. It started to play on-line at [HGM's Online Engine Blitz Tournaments](#) in April 2017 <sup>[4]</sup>.

## Table of Contents

[Selected Features](#)

[Board Representation](#)

[Search](#)

[Evaluation](#)

[Misc](#)

[Forum Posts](#)

[External Links](#)

[Chess Engine](#)

[Misc](#)

[References](#)

[What links here?](#)

## Selected Features

[6]

### [Board Representation](#)

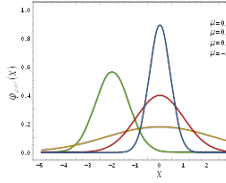
- [Bitboards](#)
- [8x8 Board](#)
- [Fancy Magic Bitboards](#)  
[BMI2 - PEXT Bitboards](#)

### [Search](#)

- [Fail-Hard Iterative Deepening](#)
- [Alpha-Beta Principal Variation Search](#)
- [Transposition Table](#)
- [Move Ordering](#) is based on the linear part of a [Logistic Regression classifier](#) aka [cluster analysis](#)
  - The classifier is trained via [temporal difference learning](#) to predict whether a [move](#) will return [beta](#)
  - Classifier considers [TT move](#), [killers](#), [move type](#), [from square](#), [target square](#), [capture target](#), [SEE](#), target square of last move, [check](#) and changes between forcing and unforcing moves (a capture is more likely after another capture)
- [Selectivity](#)
  - [Null Move Reductions](#)
  - [Static Null Move Pruning](#)
  - [Late Move Reductions](#)
  - [Futility Pruning](#)
  - [Quiescence Search](#)
  - [Static Exchange Evaluation](#)

### [Evaluation](#)

- Non standard approach relies on a [mixture model](#) <sup>[7]</sup>
  - Assumes [positions](#) encountered in search come from some set of k [Gaussians](#) <sup>[8] [9]</sup>



A set  
of Gau  
ssians

- Mixture model is trained via [EM algorithm](#) <sup>[10] [11]</sup> either on [database games](#) or positions sampled from search
- For each Gaussian a separate evaluation function is trained. When the evaluation function is called the relative probability a position stems from each Gaussian is estimated, the evaluation functions are computed and the final score is returned as the weighted average - a generalization of [tapered eval](#) with [game phases](#) <sup>[12]</sup>
- Parameter weights are trained via a mixture of [reinforcement](#) ([temporal difference](#)) learning and [supervised learning](#)
  - Minimizing the [cross entropy](#) loss of a [Logistic Regression](#) model for each of the k Gaussians
  - Training converges fast due to [linear model](#) at the heart

## Misc

- [Perft](#)
- Print pretty [Unicode chess boards](#)

## Forum Posts

- [Re: Tapered Eval between 4 phases](#) by [Jonathan Rosenthal](#), [CCC](#), October 16, 2017 » [Tapered Eval](#)
- [Winter Released](#) by [Jonathan Rosenthal](#), [CCC](#), January 08, 2018
- [Re: Winter Released](#) by [Jonathan Rosenthal](#), [CCC](#), January 09, 2018
- [Windows version released](#) by [Jonathan Rosenthal](#), [CCC](#), January 23, 2018

## External Links

## Chess Engine

- [GitHub - rosenthj/Winter: UCI Chess Engine](#)

## Misc

- [Winter from Wikipedia](#)
- [Winter - Wiktionary](#)
- [winter - Wiktionary](#)

- [Winter \(disambiguation\)](#) from Wikipedia
- [Summer and Winter Schools](#) | [ETH Zurich](#)
- [Wintel](#) from Wikipedia
- [AI winter](#) from Wikipedia
- [Winter \(surname\)](#) from Wikipedia
- [Edward Winter \(chess historian\)](#) from Wikipedia
- [Johnny Winter](#) - Winter Ballade, [ina.fr](#) 1970, [YouTube](#) Video  
feat. [Tommy Shannon](#) on bass and [Uncle John Turner](#) on drums

## References

1. [^](#) [Winter/statistics.h at master · rosenthj/Winter · GitHub](#)
2. [^](#) [Winter/linear\\_algebra.h at master · rosenthj/Winter · GitHub](#)
3. [^](#) [Winter Released](#) by [Jonathan Rosenthal](#), [CCC](#), January 08, 2018
4. [^](#) [Re: On-line engine blitz tourney April](#) by [Harm Geert Muller](#), [CCC](#), April 22, 2017
5. [^](#) Image clipped from [Winter views from our floor](#) by [Bertrand Meyer](#), [ETH Zurich](#), [Gray moment](#) with [Zentralbibliothek](#) and [Predigerkirche](#) in the foreground, [Lake Zurich](#), [Grossmünster](#), [Fraumünster](#) and [St. Peter](#) behind, in the background foothill of [Uetliberg](#), from [Bertrand Meyer's ETH home page](#)
6. [^](#) based on [Winter Released](#) by [Jonathan Rosenthal](#), [CCC](#), January 08, 2018
7. [^](#) [Re: Winter Released](#) by [Jonathan Rosenthal](#), [CCC](#), January 09, 2018
8. [^](#) [k-means clustering](#) from Wikipedia
9. [^](#) [K Means](#) by [Chris Piech](#)
10. [^](#) [The EM Algorithm for Gaussian Mixtures - Probabilistic Learning: Theory and Algorithms, CS 274A](#) (pdf) [University of California, Irvine](#)
11. [^](#) [Mixture Models & EM algorithm Lecture 21](#) (pdf) by [David Sontag](#), [New York University](#)
12. [^](#) [Re: Tapered Eval between 4 phases](#) by [Jonathan Rosenthal](#), [CCC](#), October 16, 2017

## What links here?

Page	Date Edited
<a href="#">Automated Tuning</a>	Feb 27, 2018
<a href="#">Engine releases</a>	Apr 23, 2018
<a href="#">Engines</a>	Mar 10, 2018
<a href="#">ETH Zurich</a>	Jan 9, 2018
<a href="#">Jonathan Rosenthal</a>	Jan 9, 2018
<a href="#">Learning</a>	Feb 20, 2018
<a href="#">Tapered Eval</a>	Jan 9, 2018
<a href="#">Winter</a>	Jan 23, 2018

[Up one Level](#)