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[Samuel Bak](#) - Other Rules ^[3]

Late Move Reductions (LMR), or its version known as **History Pruning** and **History Reductions** ^[1], save search by reducing [moves](#) that are [ordered](#) closer to the end of likely [fail-low nodes](#). Typically, most schemes search the first few moves (say 3-4) at full [depth](#), then if no move [fails high](#), many of the remaining moves are reduced in search [depth](#). The technique has been used for many years in various forms, but it became very popular in 2005 after [Fruit](#) and [Glaurung](#) ^[2] used open source implementations based on the [History Heuristic](#). LMR can often reduce the [effective branching factor](#) to less than 2, depending on the reduction conditions.

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Common Conditions

Most programs do not reduce these types of [moves](#):

- [Tactical moves](#) ([captures](#) and [promotions](#))
- Moves while in [check](#)
- Moves which give check
- Moves that cause a search [extension](#)
- Anytime in a [PV-Node](#) in a [PVS](#) search
- [Depth](#)

Less Common Conditions

Less common conditions on moves not to reduce:

- [Passed Pawn](#) Moves
- [Killer Moves](#)
- Moves threatening the King area
- [Tactically](#) threatening moves
- Moves with good past [relative history](#) ^[4]
- Any [Pawn Moves](#)
- Allowing reductions of "bad" [captures](#) ([SEE](#)
- Moves of a [threatened piece](#) to safety (often detected via a [Null Move search](#))

Reduction Depth

Classical implementation reduces by one [ply](#) only. Yet modern programs, most notably [Stockfish](#), allow

reductions of more than one ply and increase them for later moves. Reduction depth changes according to expected [node type](#) (being typically smaller in pv nodes), [depth](#) and move number. Here some sample formulas can be viewed:

- [Senpai](#) reduces by one ply for the first 6 moves and by $\text{depth} / 3$ for remaining moves.
- [Fruit Reloaded](#) uses formula: $\text{uint8}(\sqrt{\text{double}(\text{depth}-1)} + \sqrt{\text{double}(\text{moves}-1)})$; for non-PV nodes. In PV-nodes it reduces by 2/3 of this value.

Re-searches

Classical implementation assumes a re-search at full depth if the reduced depth search returns a score above alpha.

Test Results

Some test results related to LMR can be found on

- [Late Move Reduction Test Results](#)

See also

- [Parallelism and Selectivity in Game Tree Search | Video](#), Talk by [Tord Romstad](#)
- [Bobby's Strategic Quiescence Search](#)
- [History Heuristic](#)
- [History Leaf Pruning](#)
- [Move Count Based Pruning](#) (Late Move Pruning)
- [Null Move Pruning](#)
- [Relative History Heuristic](#)
- [SEX Algorithm](#)

Publications

- [David Levy](#), [David Broughton](#), [Mark Taylor](#) (1989). *The SEX Algorithm in Computer Chess*. [ICCA Journal](#), Vol. 12, No. 1
- [Daniel S. Abdi](#) (2013). *Analysis of pruned minimax trees*. [pdf](#) » [Alpha-Beta](#), [Null Move Pruning](#)

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- [Forward pruning and some related techniques](#) by [Sergei Markoff](#), [CCC](#), March 02, 2004

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- [Reductions and null move refutations](#) by [Tord Romstad](#), [Winboard Forum](#), April 18, 2005 » [Null Move Pruning](#)
- [What is History Pruning?](#) by [David Dahlem](#), [CCC](#), July 03, 2005
- [History based pruning question](#) by [Alvaro Jose Pova Cardoso](#), [CCC](#), August 26, 2005
- [About history pruning...](#) by [Svein Bjørnar Myrvang](#), [CCC](#), October 26, 2005
- [What is "history pruning"?](#) by [Vladimir Medvedev](#), [Winboard Forum](#), November 07, 2005

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- [late move reductions](#) by [Robert Hyatt](#), [CCC](#), March 01, 2006
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- [Adaptative LMR and TT](#) by [Fermin Serrano](#), [CCC](#), December 23, 2008

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- [About LMR & History reductions](#) by [Joona Kiiski](#), [CCC](#), February 24, 2009
- [LMR](#) by [Robert Hyatt](#), [CCC](#), March 05, 2009
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- [Researching if LMR-affected search improves Alpha?](#) by [John Merlino](#), [CCC](#), January 22, 2010
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- [Should reduction depend on depth?](#) by [Larry Kaufman](#), [CCC](#), January 14, 2012 » [Komodo](#)
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- [Adjustable search pruning depending on time control](#) by [Jerry Donald](#), [CCC](#), December 20, 2012 » [Time Management](#)

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- [ROC analysis of Late Move Reductions](#) by Gerard van Ewijk, [CCC](#), March 22, 2013 ^[5]
- [Is LMR Sound](#) by [Henk van den Belt](#), [CCC](#), May 29, 2013
- [Is LMR safe within NULL move reduction](#) by [Henk van den Belt](#), [CCC](#), May 30, 2013
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- [LMR tuning](#) by [Shawn Chidester](#), [CCC](#), May 11, 2015
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- [LMR by another name](#) by [Steven Edwards](#), [CCC](#), September 02, 2015 » [Spector](#)
- [Ratio reduction](#) by [Steven Edwards](#), [CCC](#), September 20, 2015 » [Symbolic](#)

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- [Extensions in the days of LMR?](#) by [Martin Fierz](#), [CCC](#), March 22, 2016 » [Extensions](#)
- [LMR problems](#) by [Alvaro Cardoso](#), [CCC](#), May 16, 2016
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- [Check extension vs LMR](#) by [Harm Geert Muller](#), [CCC](#), April 04, 2017 » [Check Extensions](#)
- [LMR - \[for starters\] - \[Advance\] and \[Expert\]](#) by [Ed Schroder](#), [CCC](#), May 01, 2017
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- [LMR prescription](#) by [Evert Glebbeek](#), [CCC](#), September 24, 2017

External Links

Late Move Reductions

- [Late Move Reductions from Wikipedia](#)

- [An Introduction to Late Move Reductions](#) by [Tord Romstad](#) (dead link)
- [Mediocre Chess: \[Guide\] Late move reduction \(LMR\)](#) by [Jonatan Pettersson](#), March 26, 2007 » [Mediocre](#)
- [History Reductions in Pro Deo](#) by [Ed Schröder](#) » [Pro Deo](#)
- [LMR advanced](#) from [Rebel 13](#) by [Ed Schroder](#) ^[6] » [Rebel](#)

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- [Wolfgang Schmid](#) - The Latest Kick, [Bix Jazzclub Stuttgart](#), Summer 2010, [YouTube](#) Video

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5. [^] [Receiver operating characteristic \(ROC\) from Wikipedia](#)
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