

Assume that CricketBowlingFigures is context free. For any context-free language, the non empty words in that language can be generated by a grammar in Chomsky Normal Form. Let G be the Chomsky Normal Form version of CricketBowlingFigures. The words produced by CricketBowlingFigures is in the form (O,M,R,W) .

G will have k non-terminal symbols. Let w be any word generated by G with length greater than 2^{k-1} . By the Pumping Lemma for Context Free Grammar's, there exists u,v,y and z such that $w = uvxyz$, v and y are not both empty, $|vxy| \leq 2^k$ and for all $i \geq 0$, uv^ixy^iz is generated by G if CricketBowlingFigures is context free.

Let $w = (1^{2^k}, 1^{2^k}, 1^{6 \times 2^k})$. There are 6 cases for what v and y can be and this proof will show that in each of the 6 cases, uv^ixy^iz is not produced by G for all $i \geq 0$.

Case 1: v and/or y include a comma or the left bracket or right bracket.

Case 2: v and/or y would include some amount of 1s that represent O and uxy represents some amount or the whole amount of O . This will be the 1s before the first comma.

Case 3: v and/or y have some of the 1s that represent M and uxy represents some amount or the whole amount of M .

Case 4: v represents some amount of 1s in O , x represents the comma between O and M and can also represent some amount of 1s in O and/or M , and y represents some amount of 1s in M .

Case 5: v and/or y have some of the 1s in W and uxy represents some amount or the whole amount of W .

Case 6: v represents some amount of 1s in M and y represents some amount of 1s in W .

Disproving Case 1

Let $i = 2$ so the word would become uv^2xy^2z . Based on the definition of this case, the new word would either include 2 left brackets or 2 right brackets or 4 commas. G only accepts words with 1 left bracket at the start and 1 right bracket at the end of the word so multiple left or right brackets would not be accepted. G only accepts words with 3 commas so it would reject words with 4 comma. As G does not accept the new word produced for all $i \geq 0$, this case for v and y has been disproven.

Disproving Case 2

Let $i = 0$ so the word would become uxz . As v and y have been removed, that means some amount of 1s have been removed from the O part of the word. Therefore O would be less than M which breaks the rule of CricketBowlingFigures where M is less than or equal to O . This new word would not be produced by G .

Disproving Case 3

Let $i = 3$ so that xyz would increase the amount of 1s in the M part of the word to be greater than 1^{2^k} while the O part would remain at 1^{2^k} . This would not be accepted by CricketBowlingFigures as the M in the word must be less than or equal to the O . Therefore, this new word would not be produced by G .

Disproving Case 4

Let $i = 0$ so that both O and M would lose some amount of 1s depending on the definition of v and y. W was originally defined in such a way that wickets was equal to 6 times the number of O. By removing some amount of 1s from O and keeping the same amount of W, W is now greater than 6 times the number of O and the new word would not be produced by G as it is not in CricketBowlingFigures.

Disproving Case 5

Let $i = 2$ so that the number of W would increase while the amount of O would stay the same. W was defined in w such that it was equal to 6 times the number of O. By adding more W but keeping the same amount of O, now W is greater than 6 times the number of O and therefore the new word would not be produced by G as it is not in CricketBowlingFigures.

Disproving Case 6

Let $i = 2$ so that the number of M and W have increased. w was defined so that O is equal to M. In the new word, M has increased but O has not changed so now M is greater than O. This would not be produced by G as M must be less than or equal to O.

In every case for what v and y could be, uv^ixy^jz was not produced by G for all $i \geq 0$. This is a contradiction as the pumping lemma for Context Free Grammars requires that there must be a way for uvxyz to be selected such that the language accepts all words produced by uv^ixy^jz for all $i \geq 0$. Due to this contradiction, G must not be a context free language and therefore CricketBowlingFigures must not be a context free language.