Dummy title

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Abstract

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2012 ACM Subject Classification Replace ccsdesc macro with valid one

Keywords and phrases Dummy keyword

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1 Typesetting instructions – Summary

For a tournament on $n > 1$ vertices, we can express $n = 2^{k-1} + xk - c$ for some x, k, c where $xk < 2^{k-1}$, $x > 0$ and $0 < c \leq k$. Intuitively, this rewrite makes explicit the largest power of 2 less than n (calling that power $k-1$) and also makes explicit x, the number of times k can be subtracted from n before going below 2^{k-1}. We note that each TT_k fixed by TT-fixing corresponds to adding $\frac{1}{2}k(k-1)$ units, one for each edge in a TT_k. Also, the maximum number of units from TT-fixing is yielded by the greedy strategy of fixing the largest possible subtournaments first.

Proof. Assume for contradiction the existence of a class of tournaments that can be TT-fixed optimally without fixing the largest possible subtournament at each step. Consider in this TT-fixing result F the first transitive subtournament TT_s that is fixed with size s and is smaller than k, the size of the largest possible subtournament that could have been fixed in F at that step. Consider the partial result of TT-fixing up to but not including the insertion of TT_s in F. At this step, continue a new TT-fixing F' with a TT_k instead of TT_s. Now, let $TT_s, TT_{s2}, TT_{s3}, ...TT_{sn}$ be the sequence of transitive tournaments fixed in F defined by TT_{sn} being the first fixed subtournament in F for which the total fixed vertices up to and including TT_{sn} reaches or exceeds the total vertices fixed so far in F'. All tournaments after TT_s in F must have k or fewer vertices, because the maximum tournament size that can be fixed can never increase with any TT-fixing step and this size was k when TT_s was fixed. Therefore, F up to TT_{sn} exceeds the number of fixed vertices of F' by at most $k-1$. **finish this? omit?** ◀

Therefore $units(n) = units(2^{k-1} + xk - c) = \frac{1}{2}xk(k-1) + units(2^{k-1} - c)$.

We now seek to bound $units(2^{k-1} - c)$. $c \leq k$ and $units$ is monotonically non-decreasing (it is always possible to use at least the last fixing of transitive subtournaments via TT-fixing

[1] Optional footnote, e.g. to mark corresponding author

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as n increases), so $units(2^{k-1} - c) \geq units(2^{k-1} - k)$. Here we again rewrite the argument of $units$: $2^{k-1} - k = 2^{k-2} + x_1(k-1) - c_1$ with the analogous properties $x_1(k-1) < 2^{k-2}$, $x_1 > 0$ and $0 < c_1 \leq k-1$. We note that this rewriting procedure can be repeated until the introduction of x_{k-1} **need to somehow mention this only works while $k > 3$?**. In particular,

$$2^{k-i} - (k-i) - 1 = 2^{k-i-1} + x_i(k-i) - c_i \tag{1}$$

Analogously generalizing the number of units produced at "step i" (i.e. when the number of non-fixed vertices exceeds 2^{k-i-1}) gives

$$units(2^{k-i-1} + x_i(k-i) - c_i) = \frac{1}{2}x_i(k-i)(k-i-1) + units(2^{k-i-1} - c_i) \tag{2}$$

with proper restrictions on x_i, c_i.

We can also use the equation that introduces x_i to express it in terms of i, c_i as follows:

$$x_i = \frac{2^{k-i-1} + c_i - (k-i)}{k-i} \tag{3}$$

Therefore, we express

$$units(2^{k-1} - k) = \sum_{i=1}^{k-1} \frac{1}{2}x_i(k-i)(k-i-1) \tag{4}$$

Substituting x_i and cleaning up the summation yields the following:

$$units(2^{k-1} - k) = \sum_{i=1}^{k_1} \frac{1}{2}(2^{k_1-i} + c_i - (k_1 - i + 1))(k_1 - i) \tag{5}$$

where $k_1 = k - 1$. In general each $1 \leq c_i \leq k - i$, and increasing c_i increases $units(...)$, so we set $c_i = 1$ for the lower bound:

$$units(2^{k-1} - k) \geq \sum_{i=1}^{k_1} \frac{1}{2}(2^{k_1-i} - (k_1 - i))(k_1 - i) \tag{6}$$

This summation can be split as follows:

$$units(2^{k-1} - k) \geq \frac{1}{2}\sum_{i=1}^{k_1}(2^{k_1-i})(k_1 - i) - \frac{1}{2}\sum_{i=1}^{k_1}(k_1 - i)^2 \tag{7}$$

And further rewritten for simplicity:

$$units(2^{k-1} - k) \geq \frac{1}{2}\sum_{j=1}^{k-2} j(2^j) - \frac{1}{2}\sum_{j=1}^{k-2} j^2 \tag{8}$$

At which point, it becomes clear that the sums have the following closed form:

$$units(2^{k-1} - k) \geq (k-3)2^{k-2} + 1 - \frac{1}{12}(k-2)(k-1)(2k-3) \tag{9}$$

From here on out I use my highly suspect understanding of complexity theory...

Because we expressed $n = 2^{k-1} + xk + c$, we have $(k-3)2^{k-2} \in \Theta(n\log(n))$ and $\frac{1}{12}(k-2)(k-1)(2k-3) \in \Theta(\log(n)^3)$. Also, $units(n) \geq units(2^{k-1}-k)$ because $n \geq 2^{k-1}-k$. We conclude that an asymptotic lower bound on $units(n)$ is therefore $units(n) \in \Omega(n\log(n))$

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▶ **Lemma 1** (Lorem ipsum). *Vestibulum sodales dolor et dui cursus iaculis. Nullam ullamcorper purus vel turpis lobortis eu tempus lorem semper. Proin facilisis gravida rutrum. Etiam sed sollicitudin lorem. Proin pellentesque risus at elit hendrerit pharetra. Integer at turpis varius libero rhoncus fermentum vitae vitae metus.*

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▷ Claim 2. content...

Proof. content...

Listing 1 Useless code.

```
for i:=maxint to 0 do
begin
    j:=square(root(i));
end;
```

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◀

▶ **Corollary 3** (Curabitur pulvinar, [?]). *Nam liber tempor cum soluta nobis eleifend option congue nihil imperdiet doming id quod mazim placerat facer possim assum. Lorem ipsum dolor sit amet, consectetuer adipiscing elit, sed diam nonummy nibh euismod tincidunt ut laoreet dolore magna aliquam erat volutpat.*

▶ **Proposition 4.** *This is a proposition*

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▶ **Lemma 6** (Quisque blandit tempus nunc)**.** *Sed interdum nisl pretium non. Mauris sodales consequat risus vel consectetur. Aliquam erat volutpat. Nunc sed sapien ligula. Proin faucibus sapien luctus nisl feugiat convallis faucibus elit cursus. Nunc vestibulum nunc ac massa pretium pharetra. Nulla facilisis turpis id augue venenatis blandit. Cum sociis natoque penatibus et magnis dis parturient montes, nascetur ridiculus mus.*

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A Styles of lists, enumerations, and descriptions

List of different predefined enumeration styles:

- `\begin{itemize}...\end{itemize}`
- ...
- ...

1. `\begin{enumerate}...\end{enumerate}`
2. ...
3. ...

(a) `\begin{alphaenumerate}...\end{alphaenumerate}`
(b) ...
(c) ...

(i) `\begin{romanenumerate}...\end{romanenumerate}`
(ii) ...
(iii) ...

(1) `\begin{bracketenumerate}...\end{bracketenumerate}`
(2) ...
(3) ...

Description 1 \begin{description} \item[Description 1] ...\end{description}

Description 2 Fusce eu leo nisi. Cras eget orci neque, eleifend dapibus felis. Duis et leo dui. Nam vulputate, velit et laoreet porttitor, quam arcu facilisis dui, sed malesuada risus massa sit amet neque.

Description 3 ...

?? and ?? ...

B Theorem-like environments

List of different predefined enumeration styles:

▶ **Theorem 7.** *Fusce eu leo nisi. Cras eget orci neque, eleifend dapibus felis. Duis et leo dui. Nam vulputate, velit et laoreet porttitor, quam arcu facilisis dui, sed malesuada risus massa sit amet neque.*

▶ **Lemma 8.** *Fusce eu leo nisi. Cras eget orci neque, eleifend dapibus felis. Duis et leo dui. Nam vulputate, velit et laoreet porttitor, quam arcu facilisis dui, sed malesuada risus massa sit amet neque.*

▶ **Corollary 9.** *Fusce eu leo nisi. Cras eget orci neque, eleifend dapibus felis. Duis et leo dui. Nam vulputate, velit et laoreet porttitor, quam arcu facilisis dui, sed malesuada risus massa sit amet neque.*

▶ **Proposition 10.** *Fusce eu leo nisi. Cras eget orci neque, eleifend dapibus felis. Duis et leo dui. Nam vulputate, velit et laoreet porttitor, quam arcu facilisis dui, sed malesuada risus massa sit amet neque.*

▶ **Conjecture 11.** *Fusce eu leo nisi. Cras eget orci neque, eleifend dapibus felis. Duis et leo dui. Nam vulputate, velit et laoreet porttitor, quam arcu facilisis dui, sed malesuada risus massa sit amet neque.*

▶ **Observation 12.** *Fusce eu leo nisi. Cras eget orci neque, eleifend dapibus felis. Duis et leo dui. Nam vulputate, velit et laoreet porttitor, quam arcu facilisis dui, sed malesuada risus massa sit amet neque.*

▶ **Exercise 13.** *Fusce eu leo nisi. Cras eget orci neque, eleifend dapibus felis. Duis et leo dui. Nam vulputate, velit et laoreet porttitor, quam arcu facilisis dui, sed malesuada risus massa sit amet neque.*

▶ **Definition 14.** *Fusce eu leo nisi. Cras eget orci neque, eleifend dapibus felis. Duis et leo dui. Nam vulputate, velit et laoreet porttitor, quam arcu facilisis dui, sed malesuada risus massa sit amet neque.*

▶ **Example 15.** Fusce eu leo nisi. Cras eget orci neque, eleifend dapibus felis. Duis et leo dui. Nam vulputate, velit et laoreet porttitor, quam arcu facilisis dui, sed malesuada risus massa sit amet neque.

▶ Note 16. Fusce eu leo nisi. Cras eget orci neque, eleifend dapibus felis. Duis et leo dui. Nam vulputate, velit et laoreet porttitor, quam arcu facilisis dui, sed malesuada risus massa sit amet neque.

▶ Note. Fusce eu leo nisi. Cras eget orci neque, eleifend dapibus felis. Duis et leo dui. Nam vulputate, velit et laoreet porttitor, quam arcu facilisis dui, sed malesuada risus massa sit amet neque.

▶ Remark 17. Fusce eu leo nisi. Cras eget orci neque, eleifend dapibus felis. Duis et leo dui. Nam vulputate, velit et laoreet porttitor, quam arcu facilisis dui, sed malesuada risus massa sit amet neque.

▶ Remark. Fusce eu leo nisi. Cras eget orci neque, eleifend dapibus felis. Duis et leo dui. Nam vulputate, velit et laoreet porttitor, quam arcu facilisis dui, sed malesuada risus massa sit amet neque.

▷ Claim 18. Fusce eu leo nisi. Cras eget orci neque, eleifend dapibus felis. Duis et leo dui. Nam vulputate, velit et laoreet porttitor, quam arcu facilisis dui, sed malesuada risus massa sit amet neque.

▷ Claim. Fusce eu leo nisi. Cras eget orci neque, eleifend dapibus felis. Duis et leo dui. Nam vulputate, velit et laoreet porttitor, quam arcu facilisis dui, sed malesuada risus massa sit amet neque.

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Proof. Fusce eu leo nisi. Cras eget orci neque, eleifend dapibus felis. Duis et leo dui. Nam vulputate, velit et laoreet porttitor, quam arcu facilisis dui, sed malesuada risus massa sit amet neque. ◁