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RANDOM WALK OPERATORS ON GROUPS
Autor: UK, Andrzej

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$$(16) \quad a_{n+1} = |S_{n+1}|g^2(n+1) \leq (k-1)|S_n|g^2(n+1) = \left(1 + \frac{k-2}{(k-2)n+k}\right)^2 a_n.$$

We have to show that

$$(17) \quad \frac{\sum_{v \in S_{n+1}} f^2(v)}{\sum_{v \in B_n} f^2(v)} = \frac{a_{n+1}}{a_1 + \dots + a_n} \xrightarrow{n \rightarrow \infty} 0.$$

It is a standard exercise to show that (16) implies (17). \square

Let f_n be the sequence of functions which are restrictions of f to the vertices that are at a distance not greater than n :

$$f_n = f|_{B_n}.$$

By Lemma 6 and Lemma 7 it follows that

$$\limsup_{n \rightarrow +\infty} \frac{\|Pf_n\|_{l^2(X,N)}}{\|f_n\|_{l^2(X,N)}} \geq \frac{2\sqrt{k-1}}{k},$$

which proves Theorem 8. \square

Some examples of upper bounds on the norm of the simple random walk operator on graphs and their comparison with the lower bound from Theorem 8 can be found in [22].

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Andrzej Żuk

CNRS, École Normale Supérieure de Lyon
Unité de Mathématiques Pures et Appliquées
46, allée d'Italie
F-69364 Lyon Cedex 07
France
e-mail: azuk@umpa.ens-lyon.fr