Accepted Manuscript

Reduced basis methods for nonlocal diffusion problems with random input data

Qingguang Guan, Max Gunzburger, Clayton G. Webster, Guannan Zhang

PII: S0045-7825(16)30543-6
DOI: http://dx.doi.org/10.1016/j.cma.2016.12.019
Reference: CMA 11265

To appear in: *Comput. Methods Appl. Mech. Engrg.*

Received date: 10 June 2016
Revised date: 8 December 2016
Accepted date: 12 December 2016

Please cite this article as: Q. Guan, M. Gunzburger, C.G. Webster, G. Zhang, Reduced basis methods for nonlocal diffusion problems with random input data, *Comput. Methods Appl. Mech. Engrg.* (2016), http://dx.doi.org/10.1016/j.cma.2016.12.019

This is a PDF file of an unedited manuscript that has been accepted for publication. As a service to our customers we are providing this early version of the manuscript. The manuscript will undergo copyediting, typesetting, and review of the resulting proof before it is published in its final form. Please note that during the production process errors may be discovered which could affect the content, and all legal disclaimers that apply to the journal pertain.

ACCEPTED MANUSCRIPT

Reduced basis methods for nonlocal diffusion problems with random input data☆

Qingguang Guan[a], Max Gunzburger[a], Clayton G. Webster[b,c], Guannan Zhang[b]

[a]Department of Scientific Computing, Florida State University, Tallahassee, FL 32306
[b]Computational and Applied Mathematics, Oak Ridge National Laboratory, Oak Ridge, TN 37831
[c]Department of Mathematics, University of Tennessee, Knoxville, TN 37996

Abstract

The construction, analysis, and application of reduced-basis methods for uncertainty quantification problems involving nonlocal diffusion problems with random input data is the subject of this work. Because of the lack of sparsity of discretized nonlocal models relative to analogous local partial differential equation models, the need for reduced-order modeling is much more acute in the nonlocal setting. In this effort, we develop reduced-basis approximations for nonlocal diffusion equations with affine random coefficients. Efficiency estimates of the proposed greedy reduced-basis methods are provided. Numerical examples are used to illustrate the effect varying various model parameters have on the efficiency and accuracy of the reduced-basis method relative to sparse-grid interpolation using the full finite element method. It is shown that the proposed reduced-basis approach can indeed provide substantial savings over standard sparse-grid methods.

Keywords: reduced-basis methods, nonlocal diffusion, uncertainty quantification, finite element methods

1. Introduction

In classical local models, interactions only occur due to contact and are described by partial differential equations (PDEs). However, in many settings (e.g., continuum mechanics [1, 2], image processing [3–6], fractional dynamics and diffusion [7], machine learning [8], and graph theory [9]), interactions are intrinsically nonlocal. Here, "nonlocal" refers to spatial interactions between points separated by . For example, in solid mechanics, the strain energy density at a point $\mathbf{x}$ can depend on points in a neighborhood of $\mathbf{x}$ having

☆This material is based upon work supported in part by the U.S. Air Force of Scientific Research under grants 1854-V521-12 and FA9550-15-1-0001; the U.S. Defense Advanced Research Projects Agency, Defense Sciences Office under contract and award HR0011619523 and 1868-A017-15; the U.S. Department of Energy, Office of Science, Office of Advanced Scientific Computing Research, Applied Mathematics program under contracts and awards ERKJ259, ERKJE45, DE-SC0009324, and DE-SC0010678; and by the Laboratory Directed Research and Development program at the Oak Ridge National Laboratory, which is operated by UT-Battelle, LLC., for the U.S. Department of Energy under contract DE-AC05-00OR22725.

ACCEPTED MANUSCRIPT

Download English Version:

https://daneshyari.com/en/article/4964126

Download Persian Version:

https://daneshyari.com/article/4964126

Daneshyari.com