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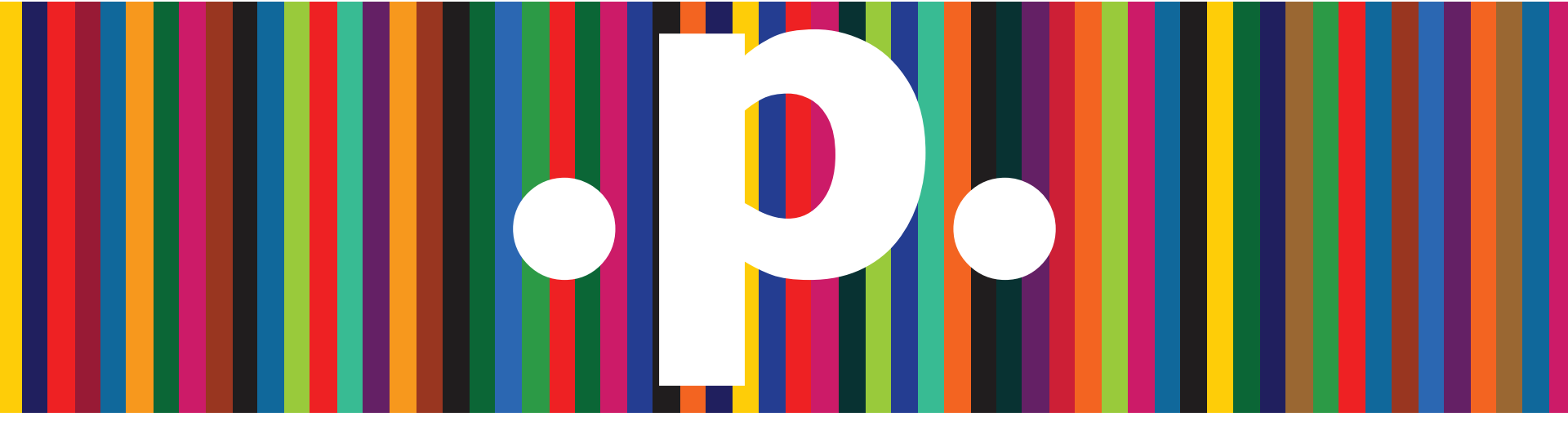

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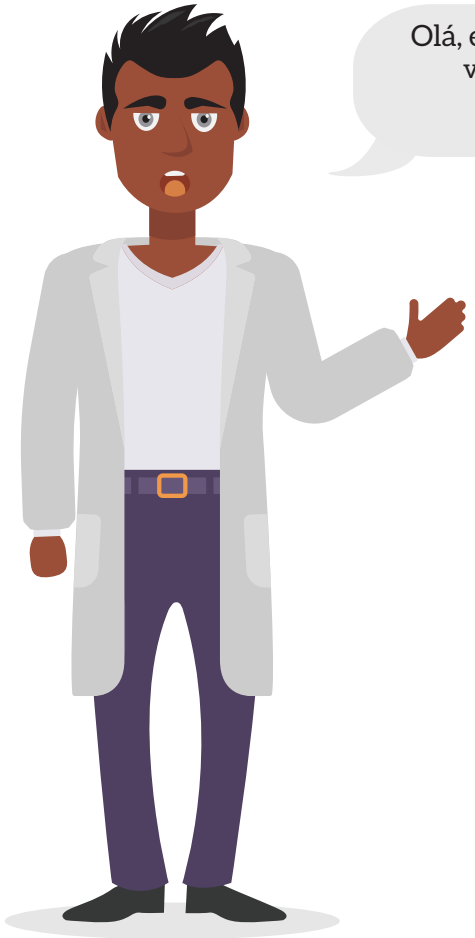

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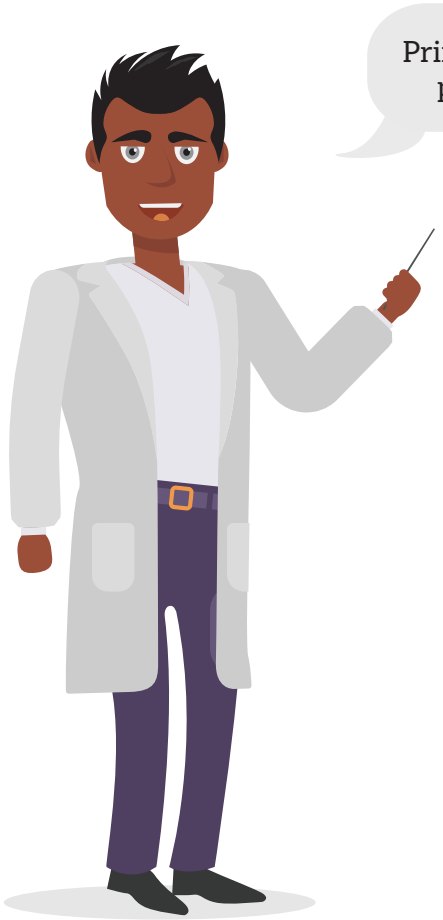

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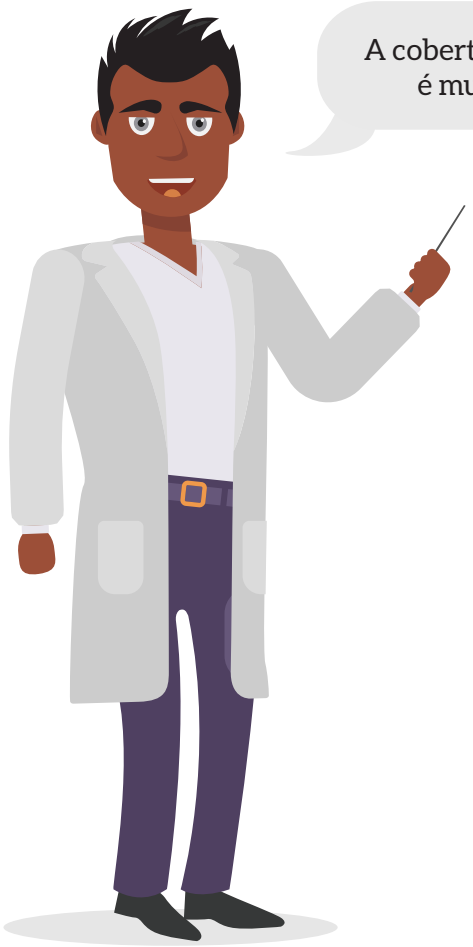

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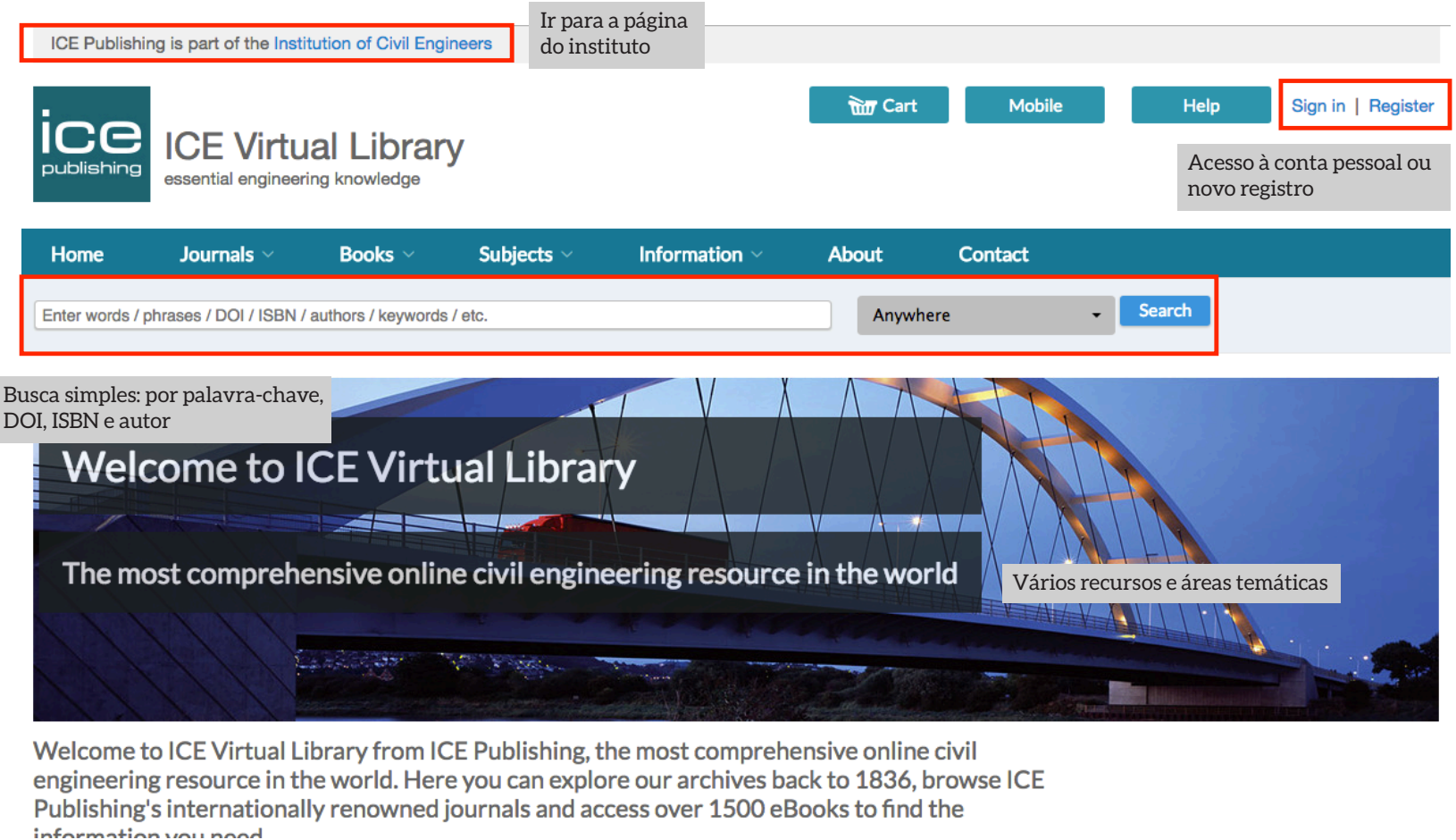

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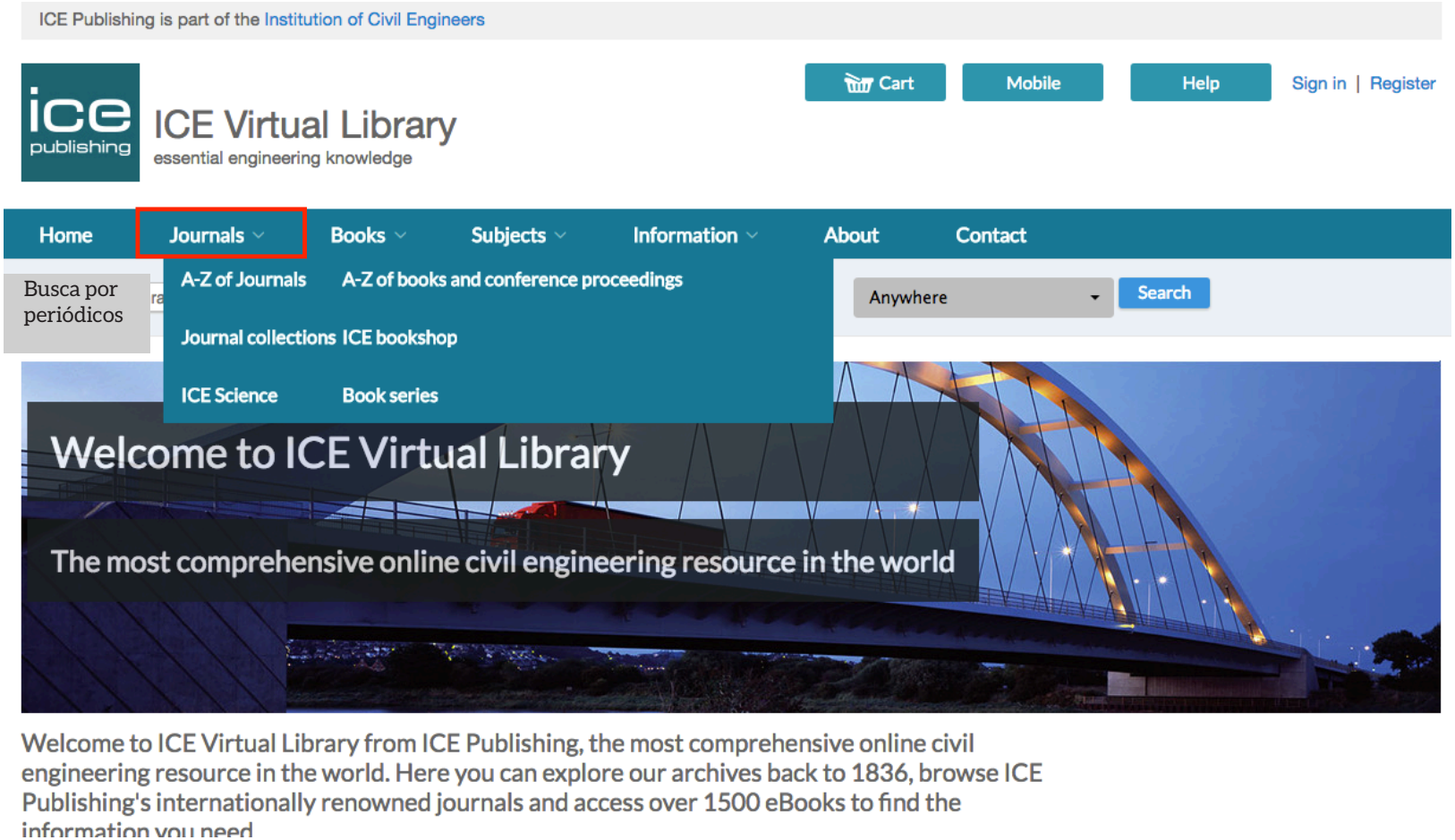

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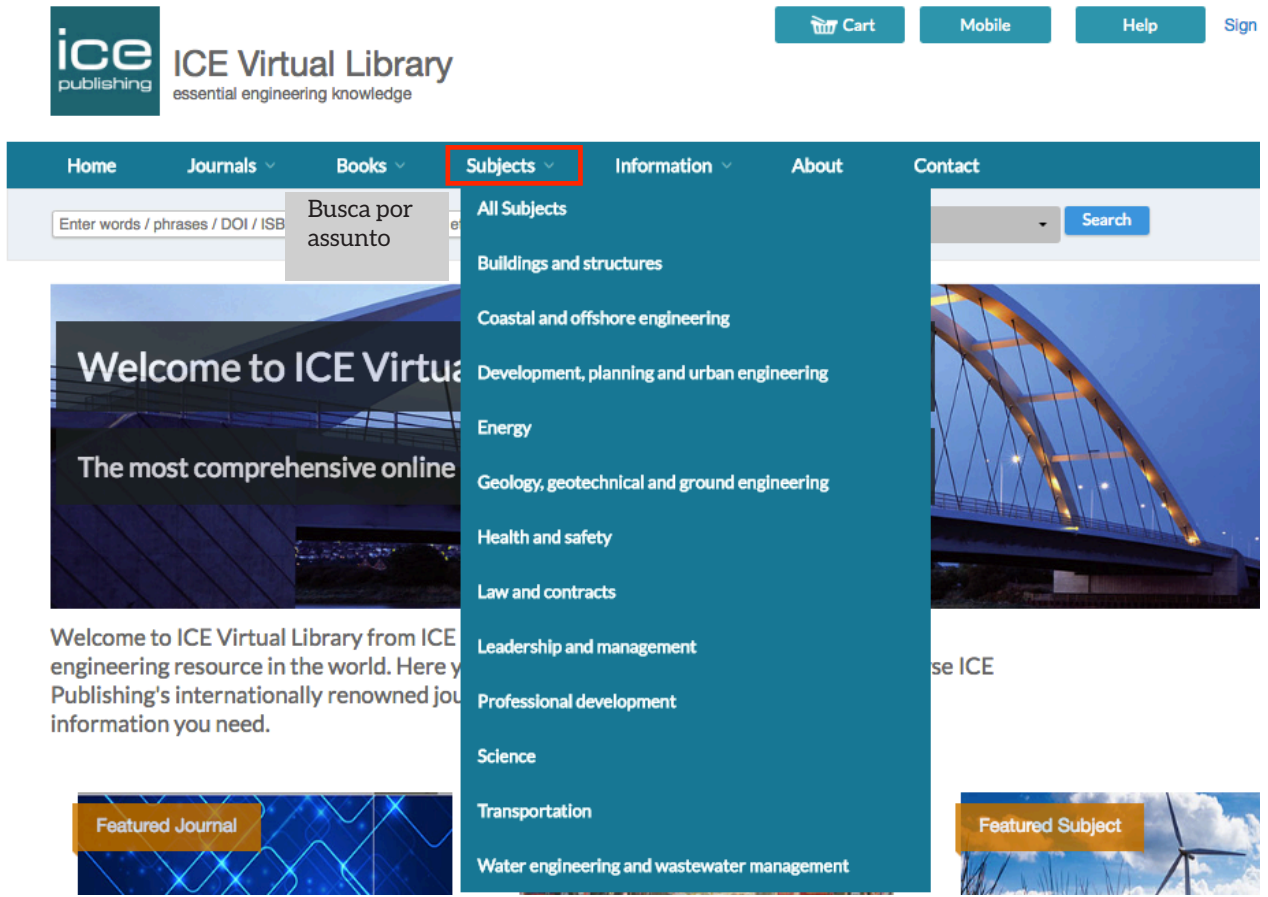

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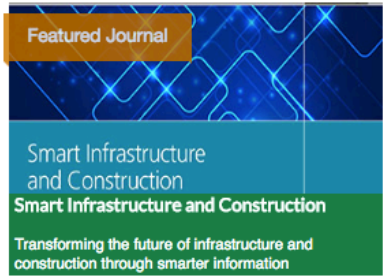

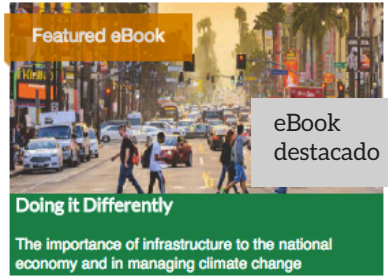

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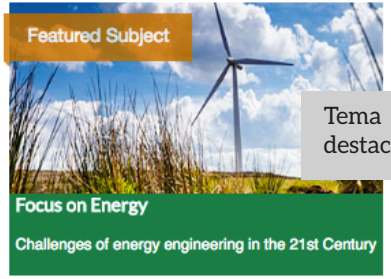

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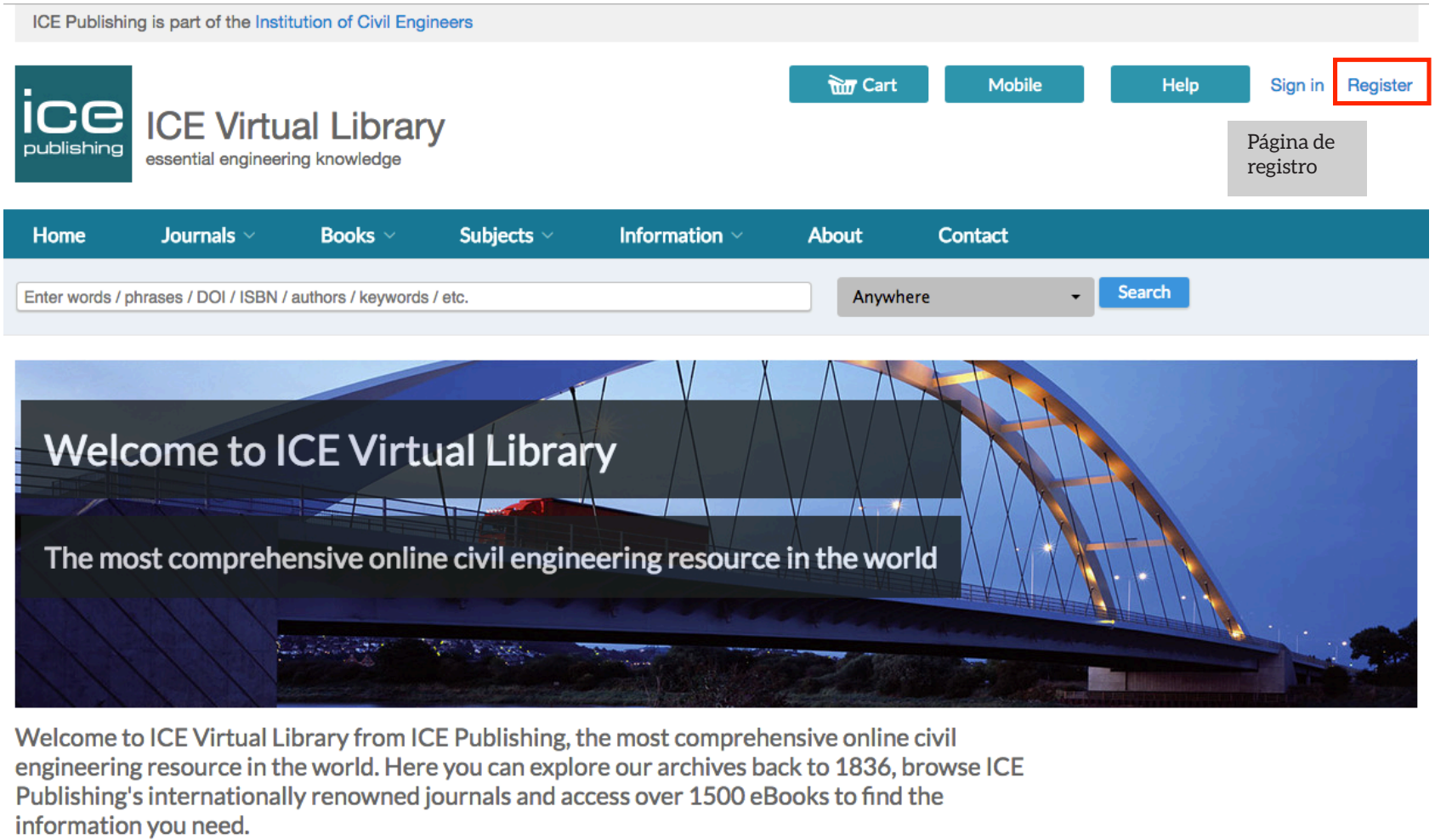

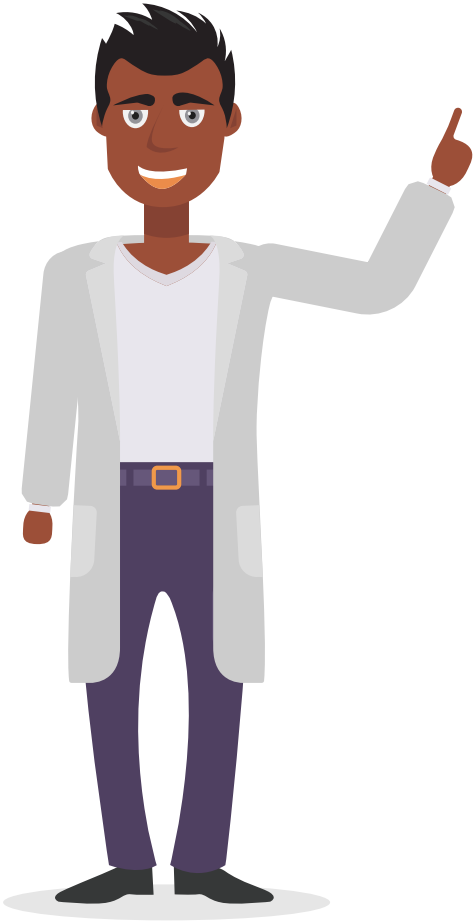

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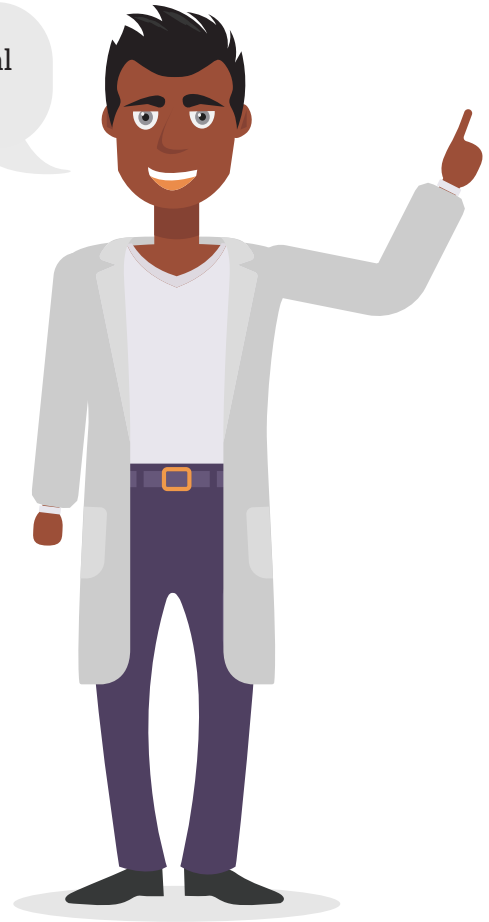

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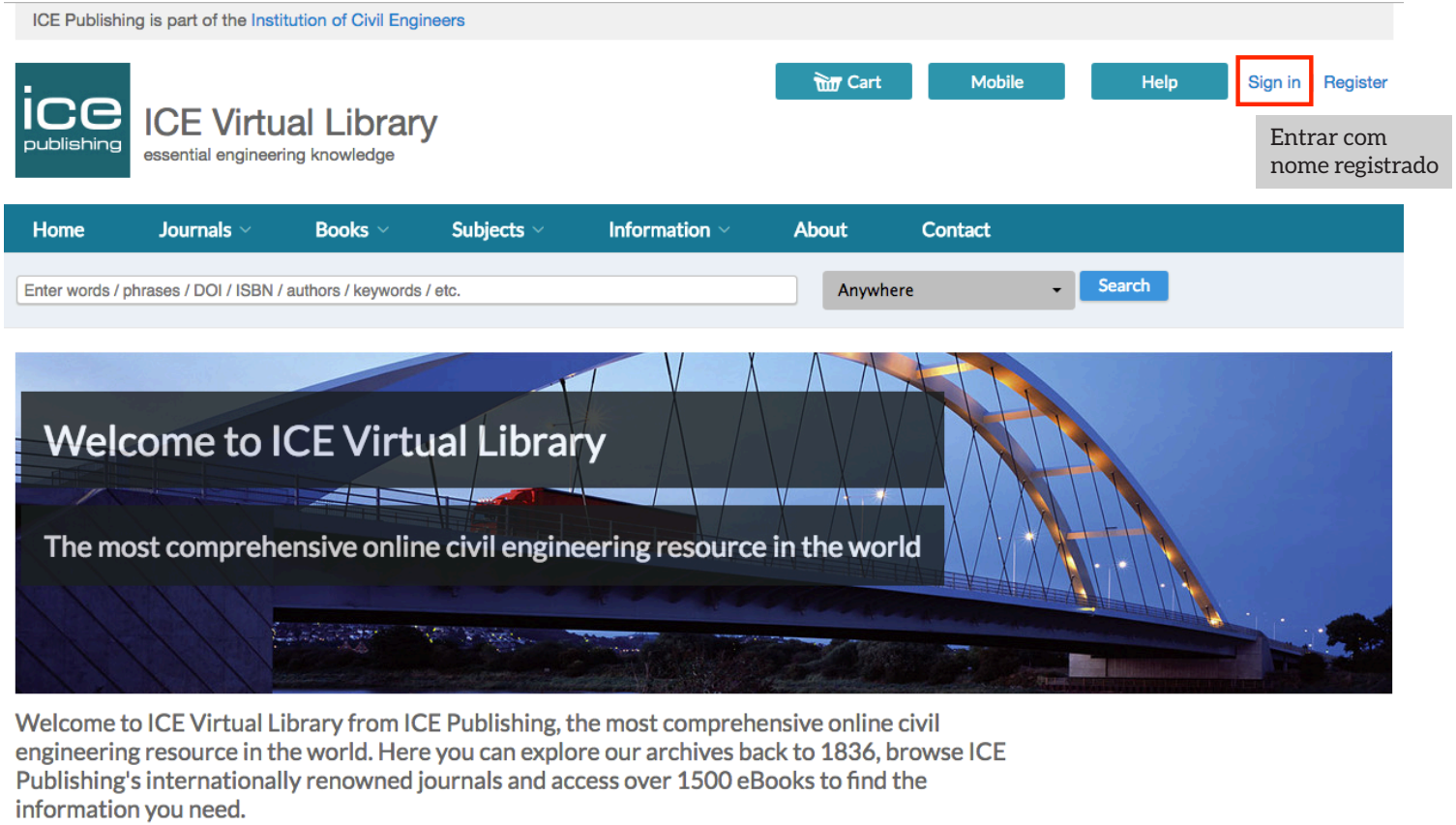

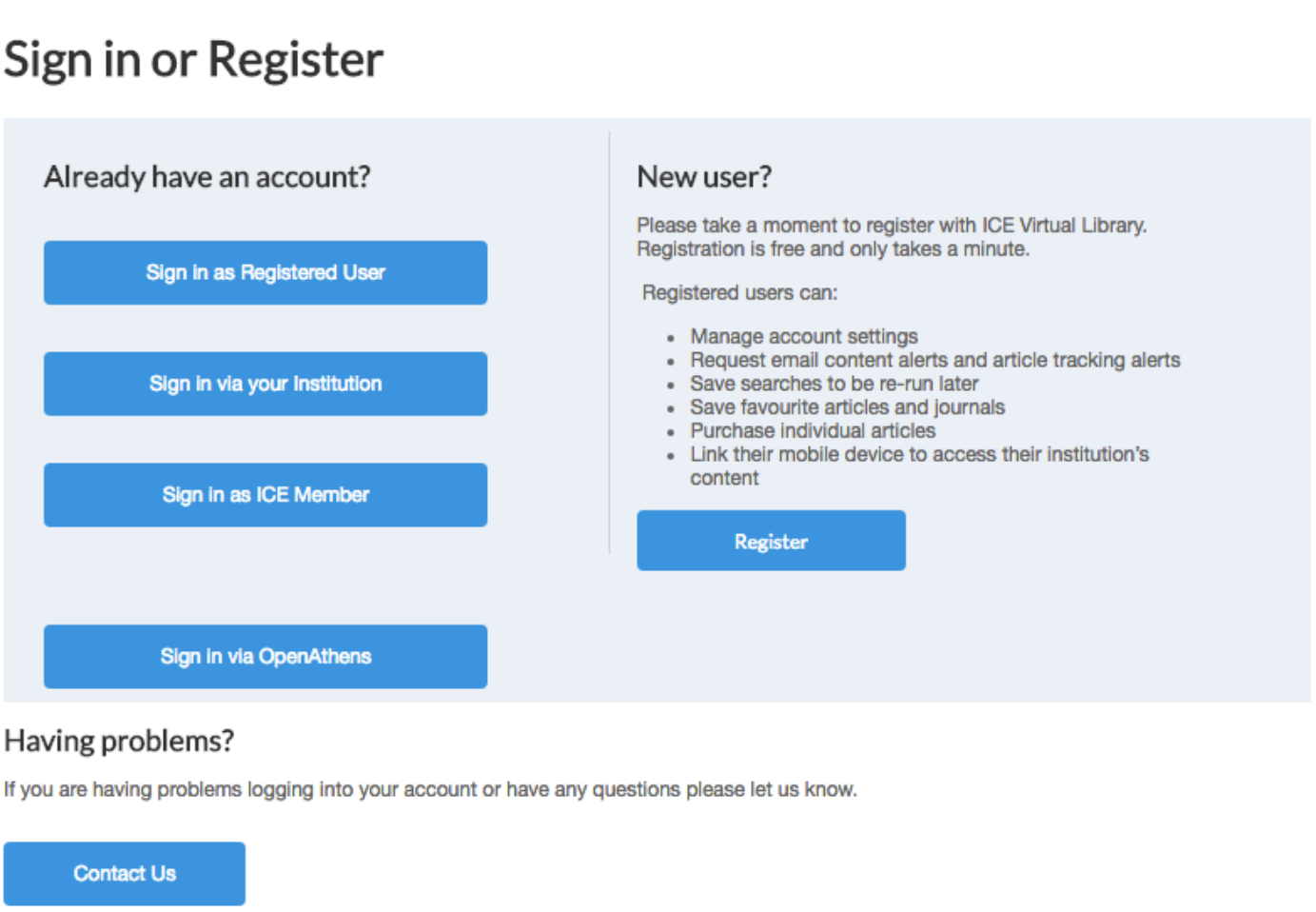
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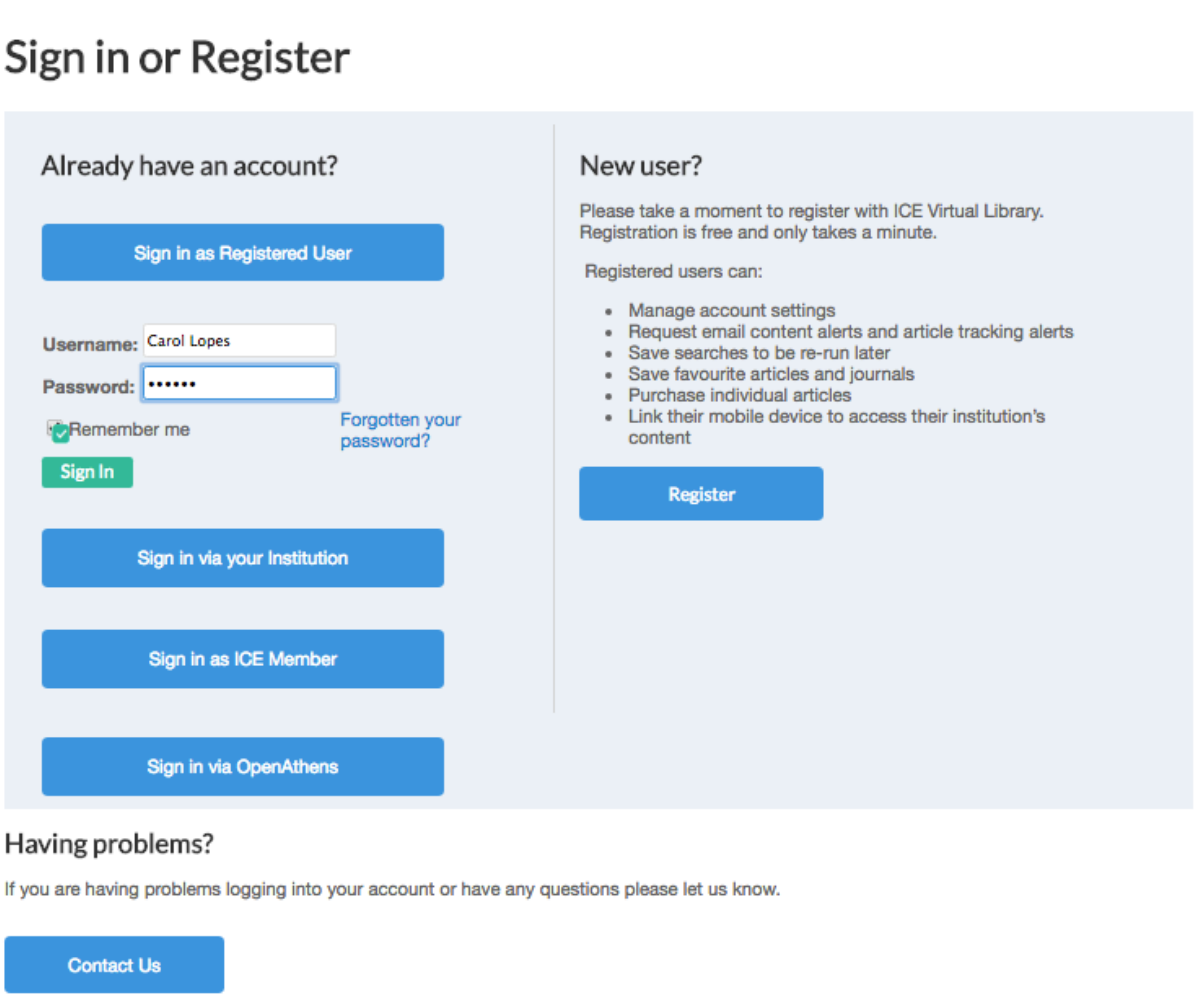
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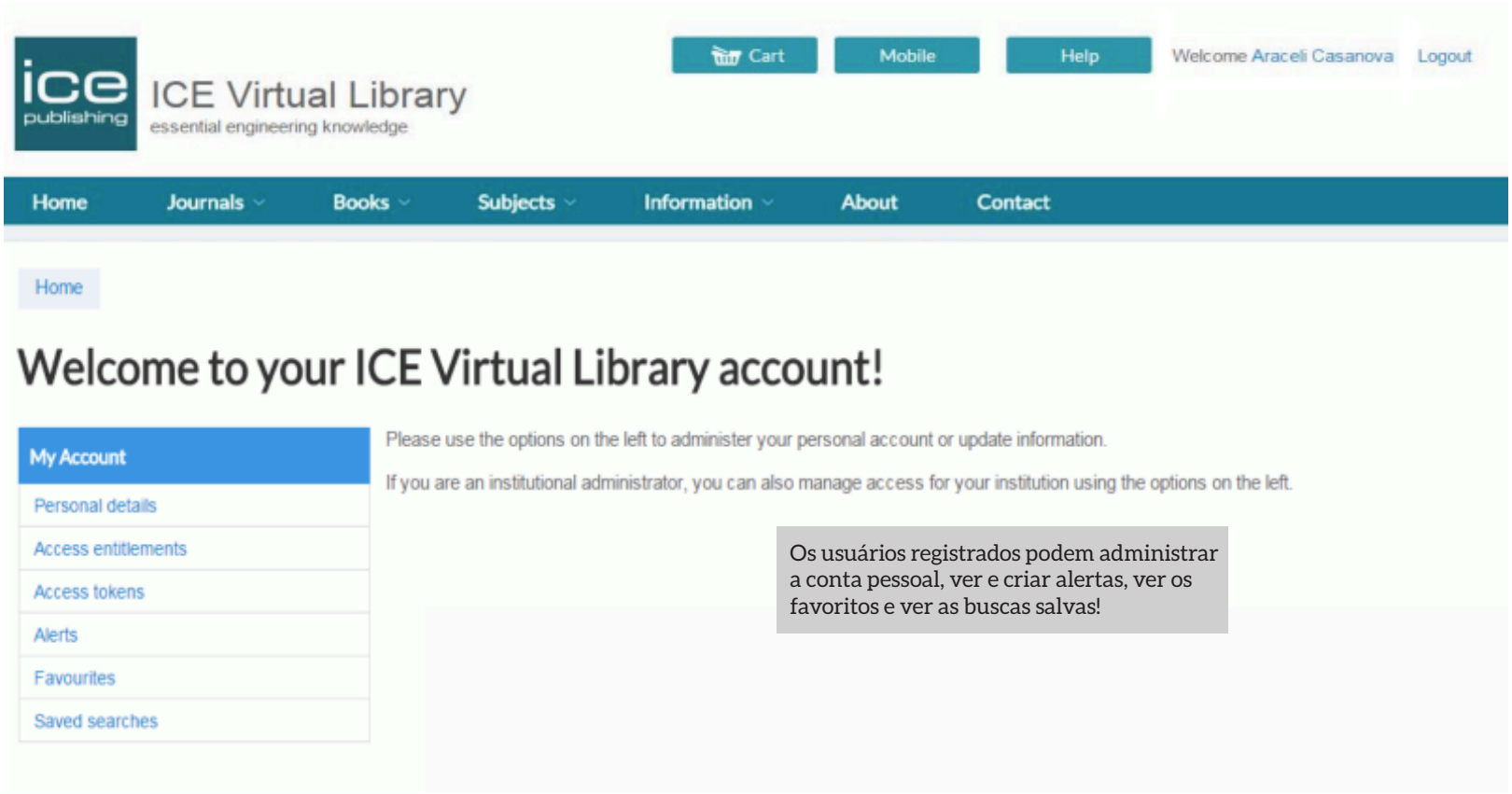

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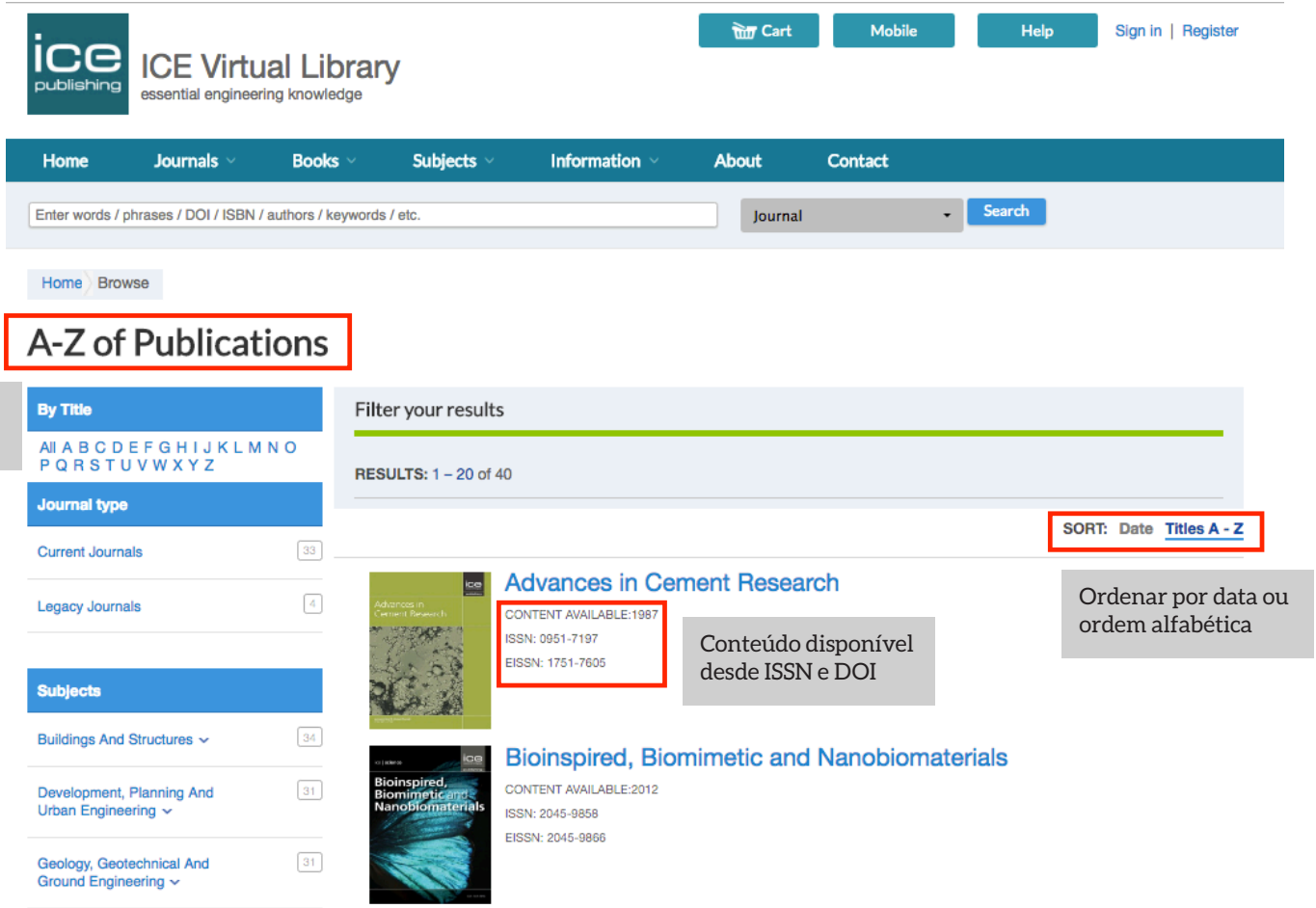

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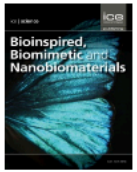

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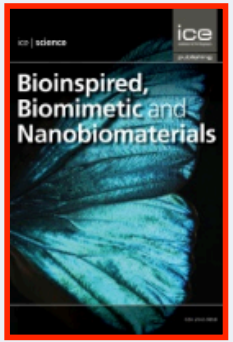

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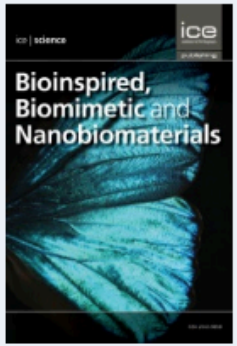

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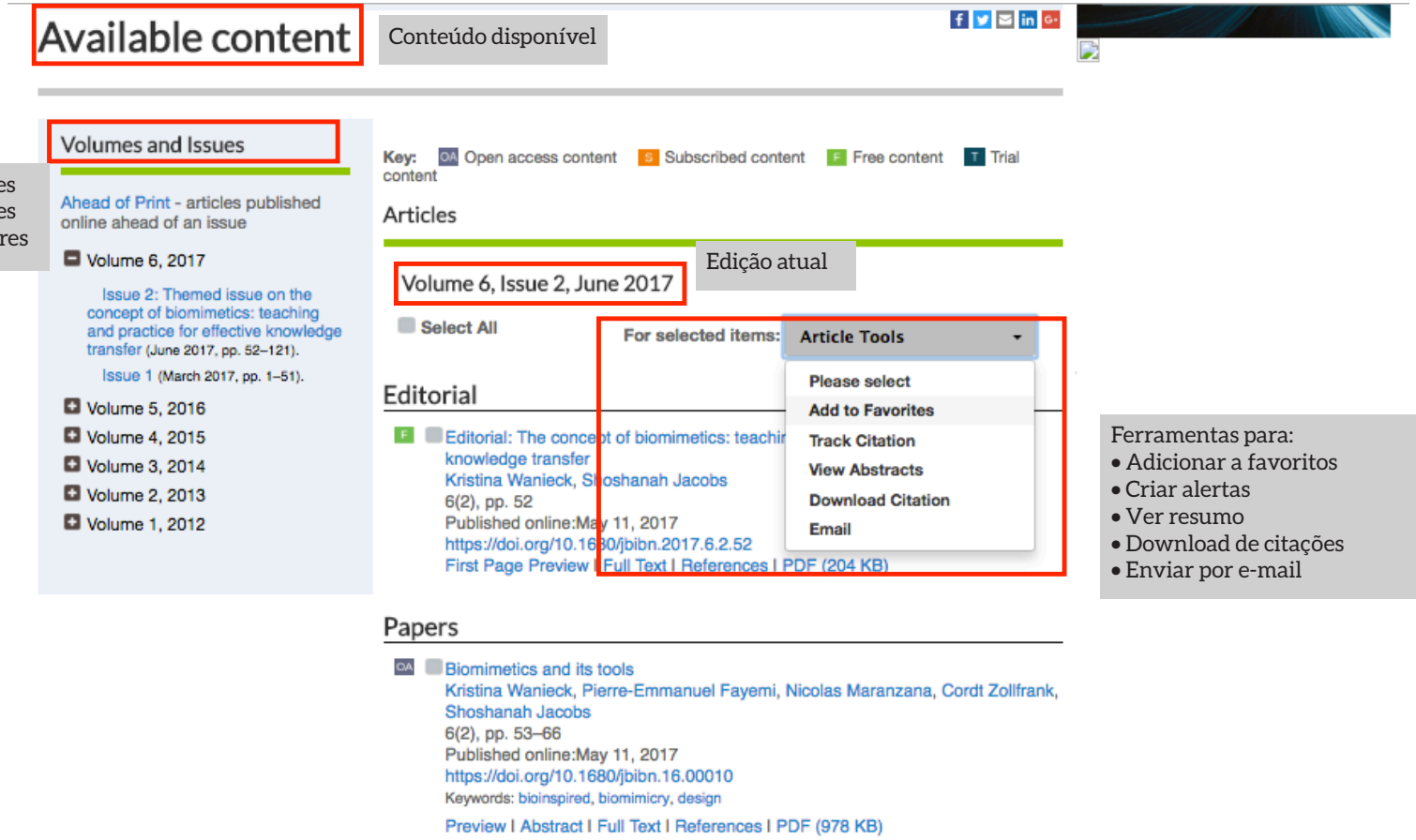

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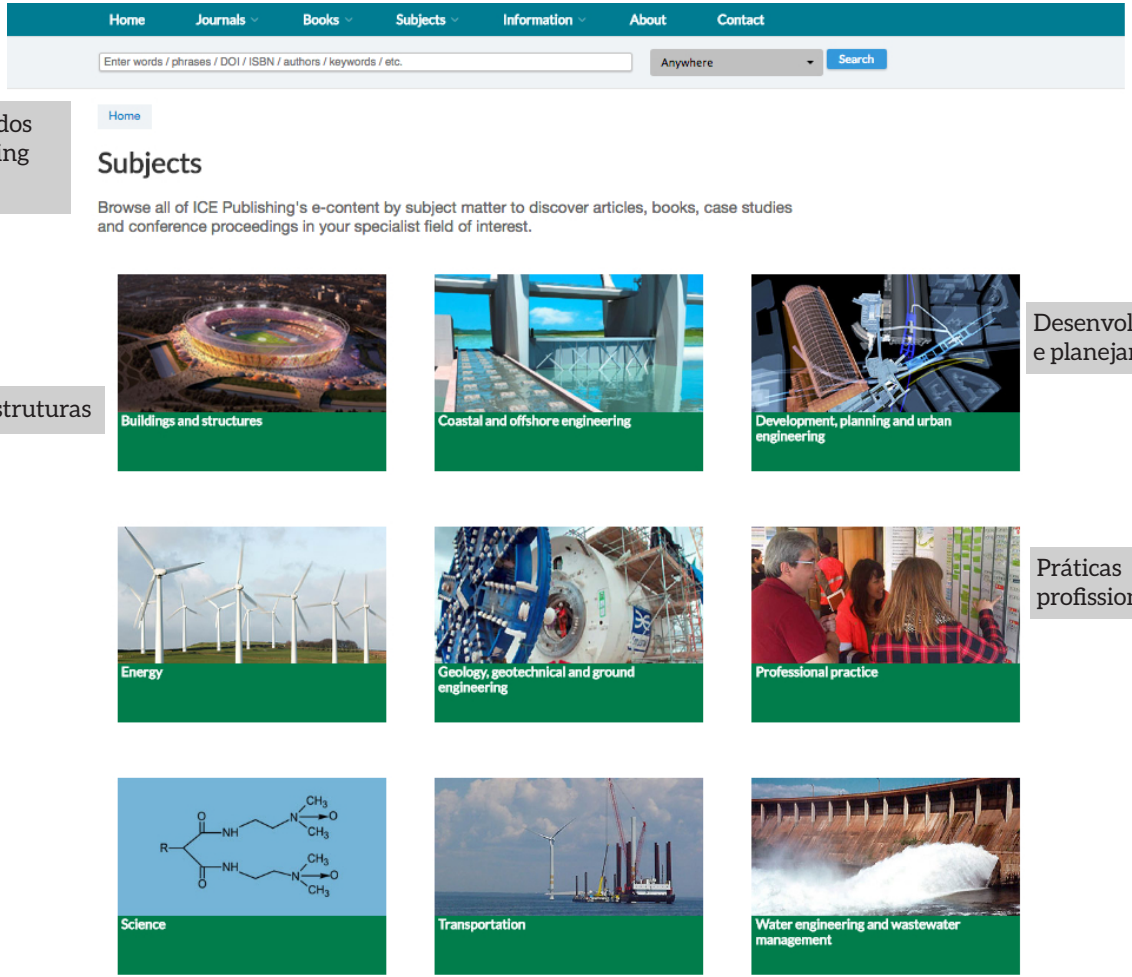

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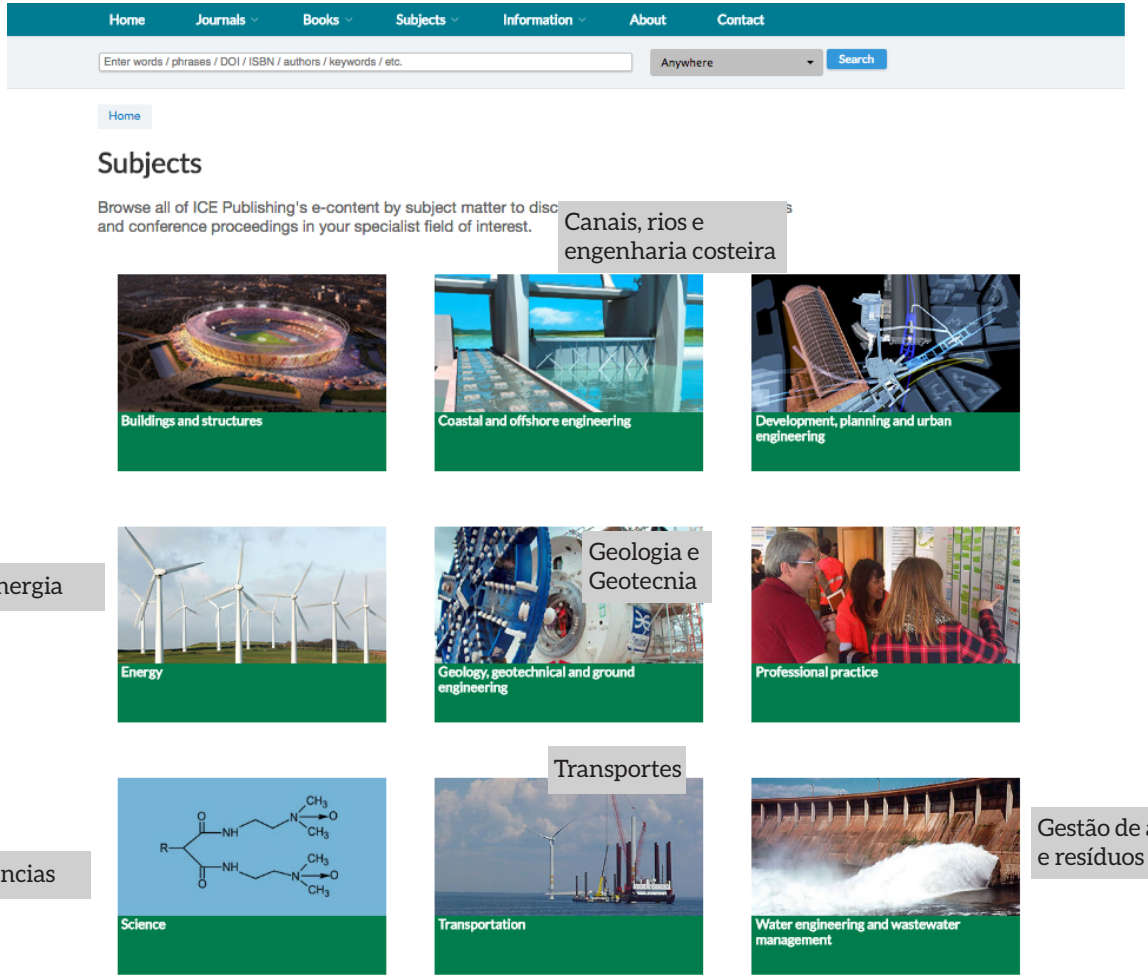

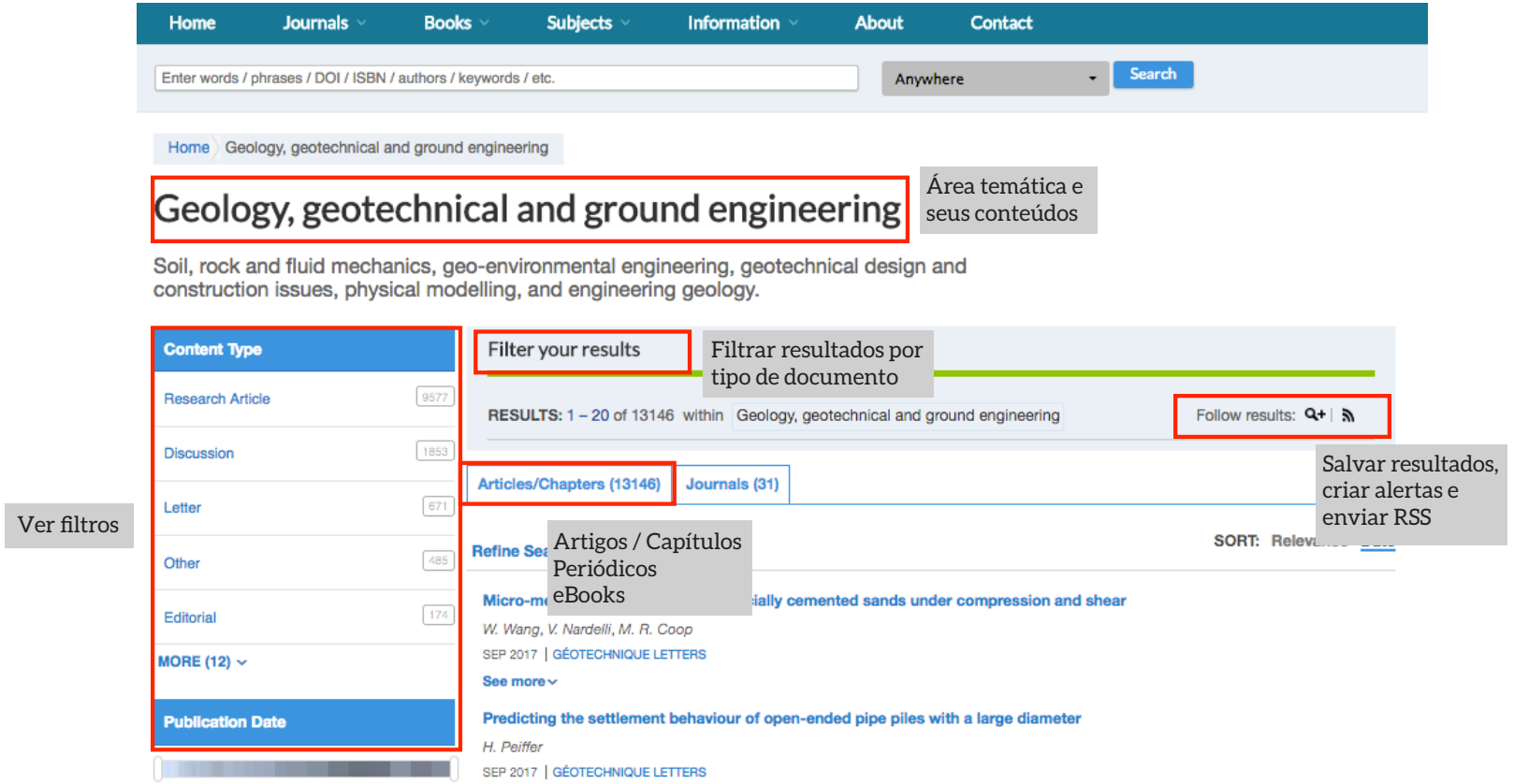
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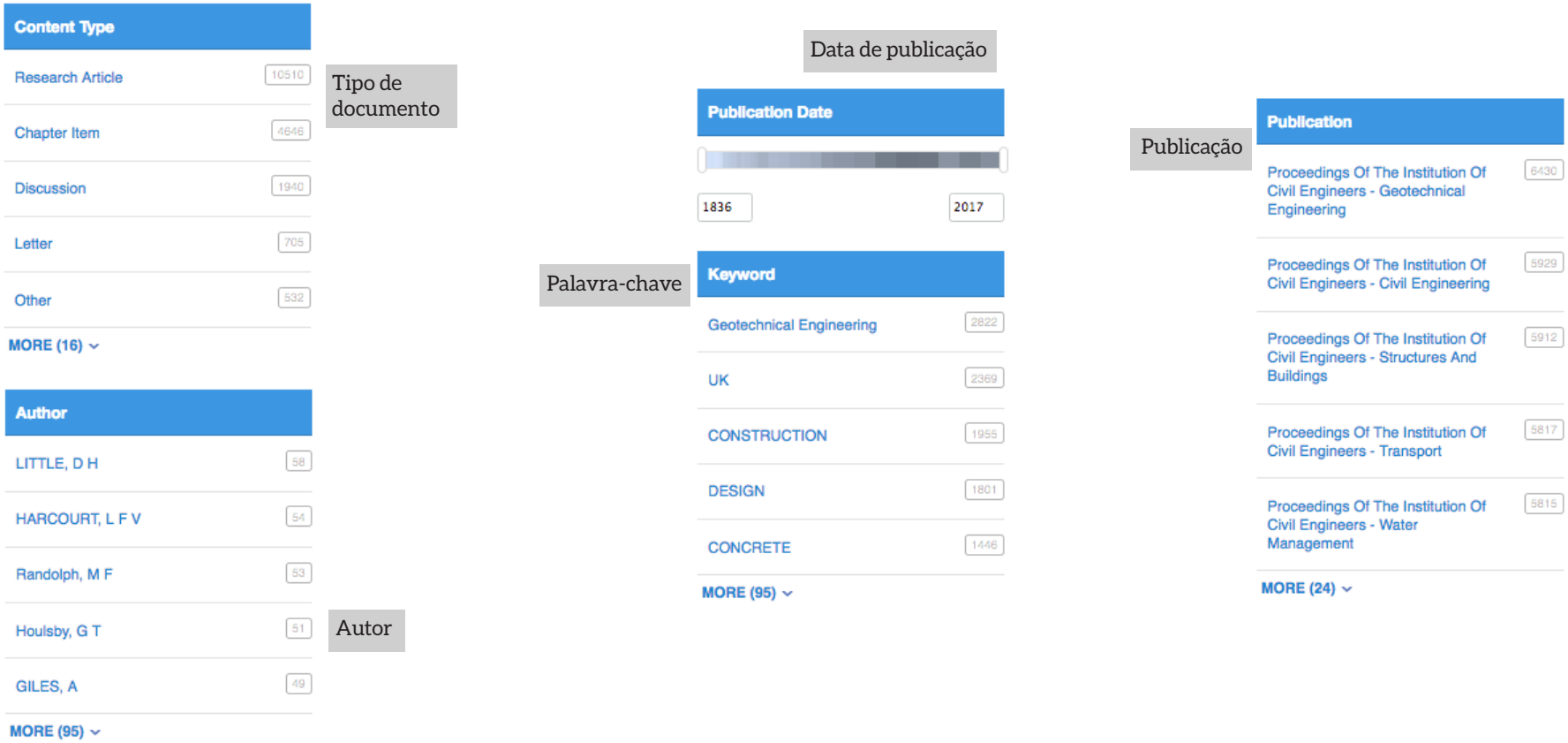
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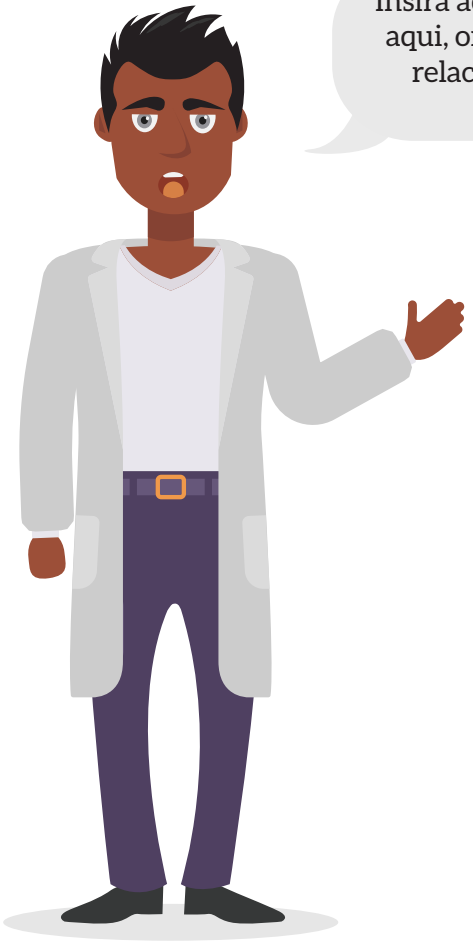

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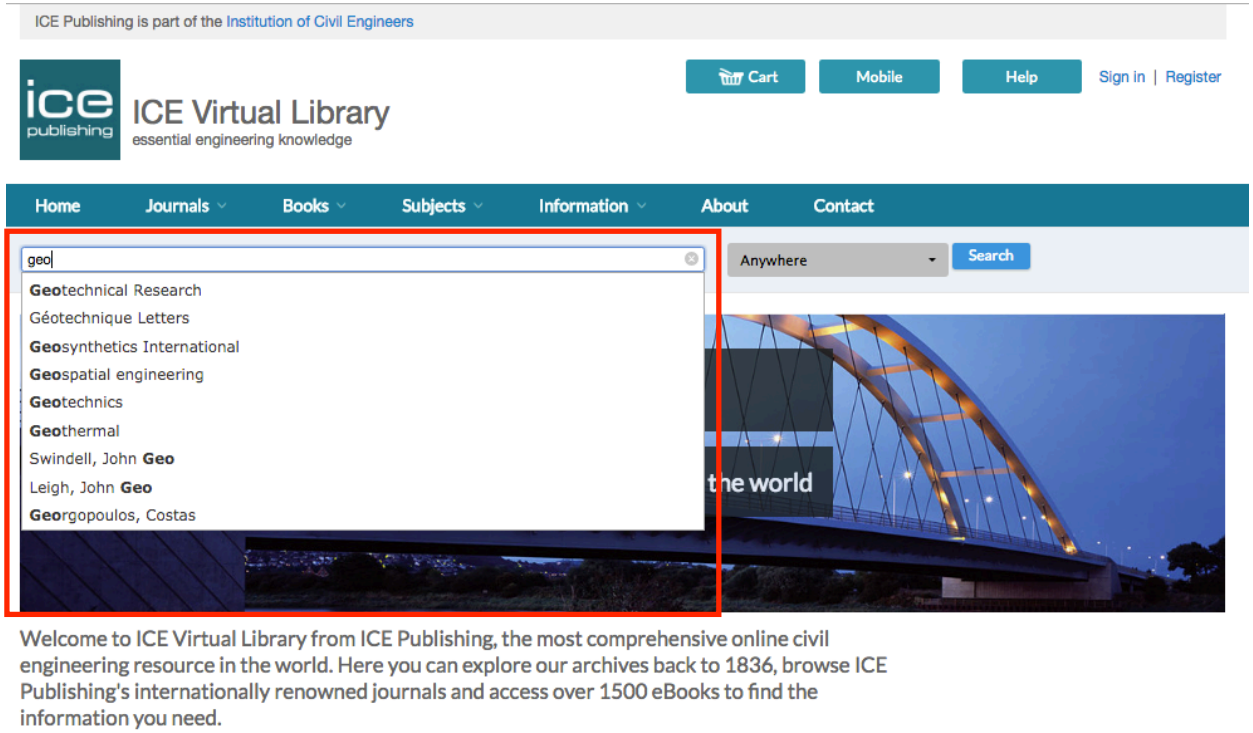

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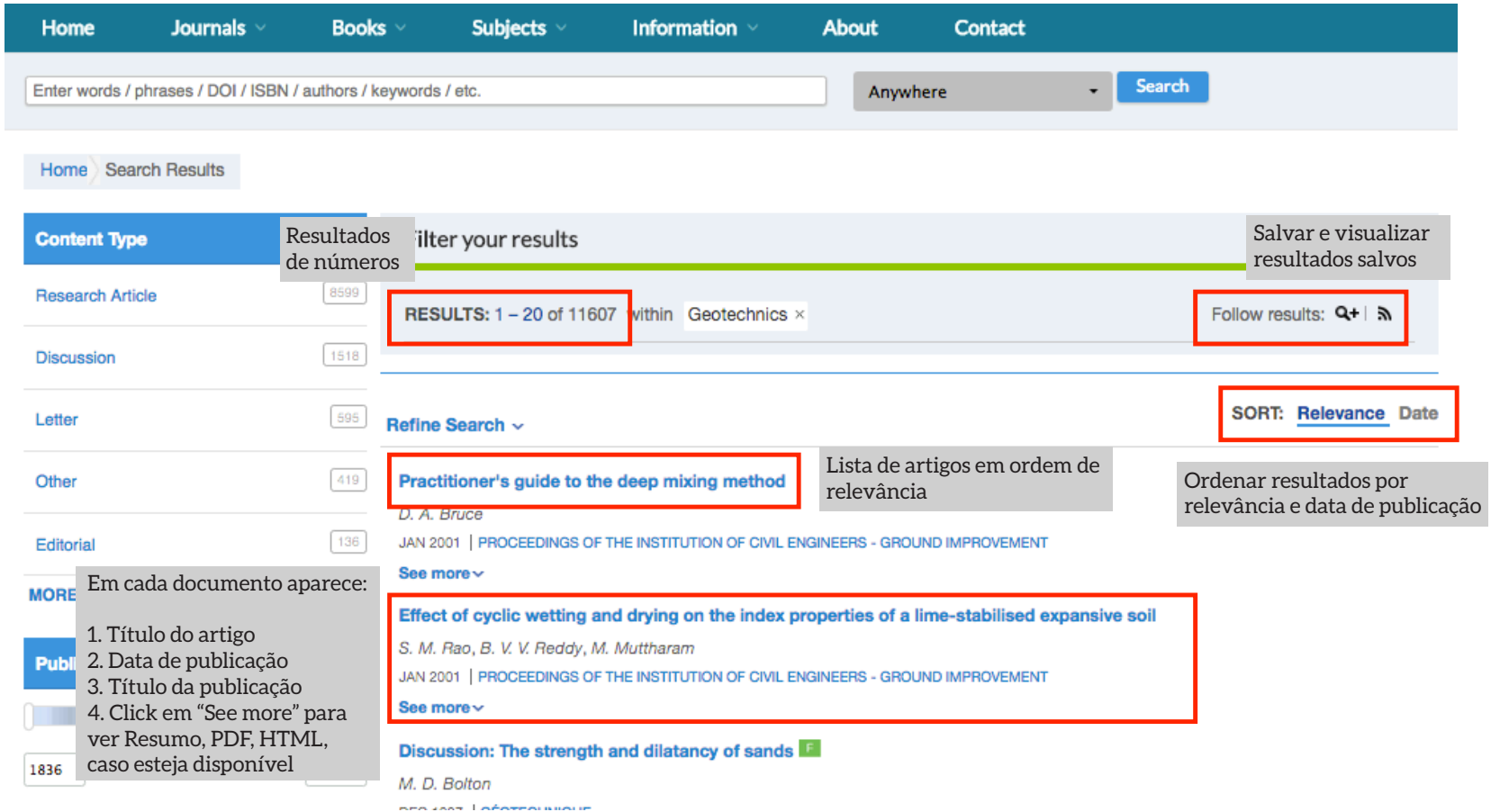

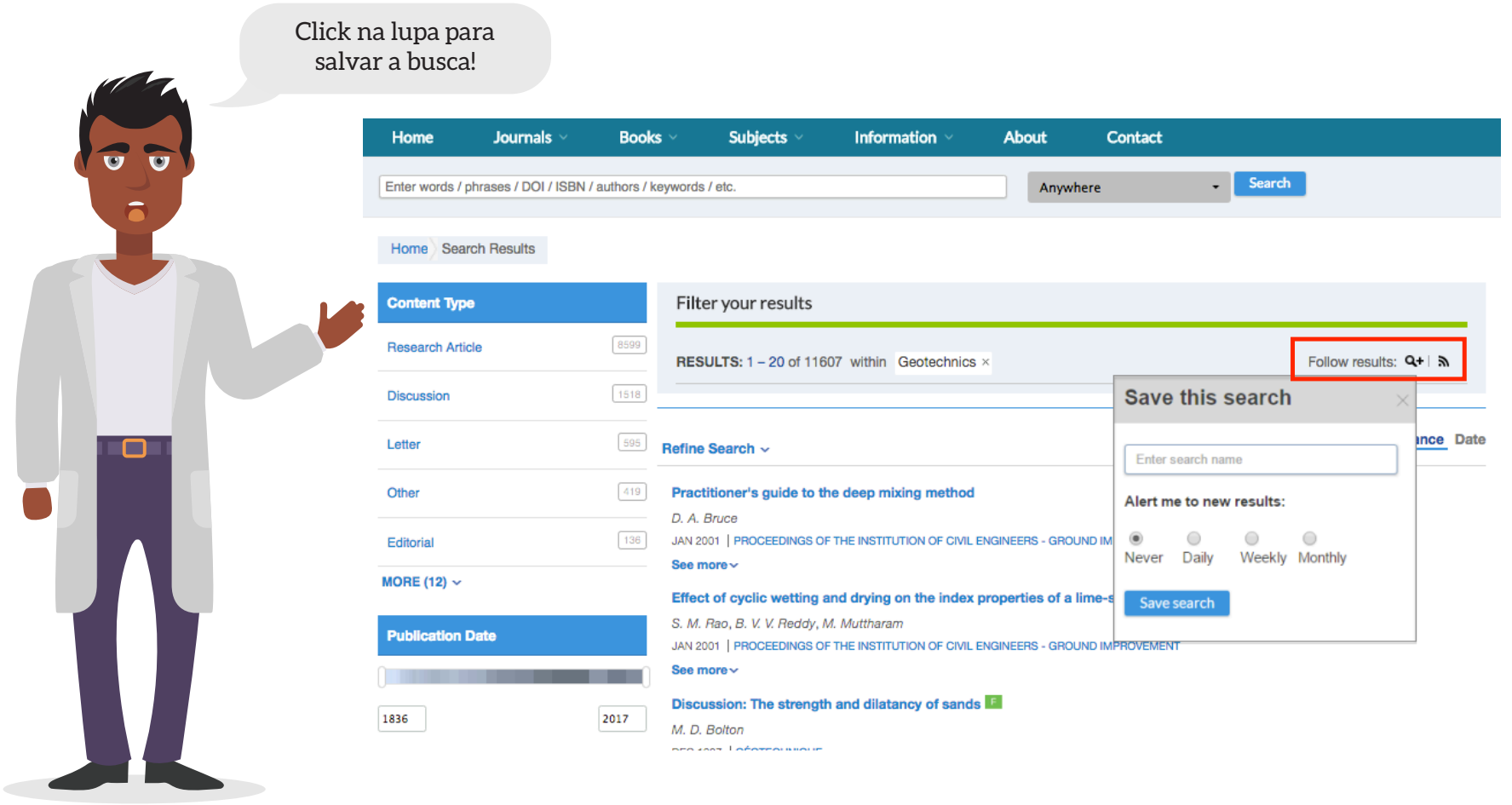
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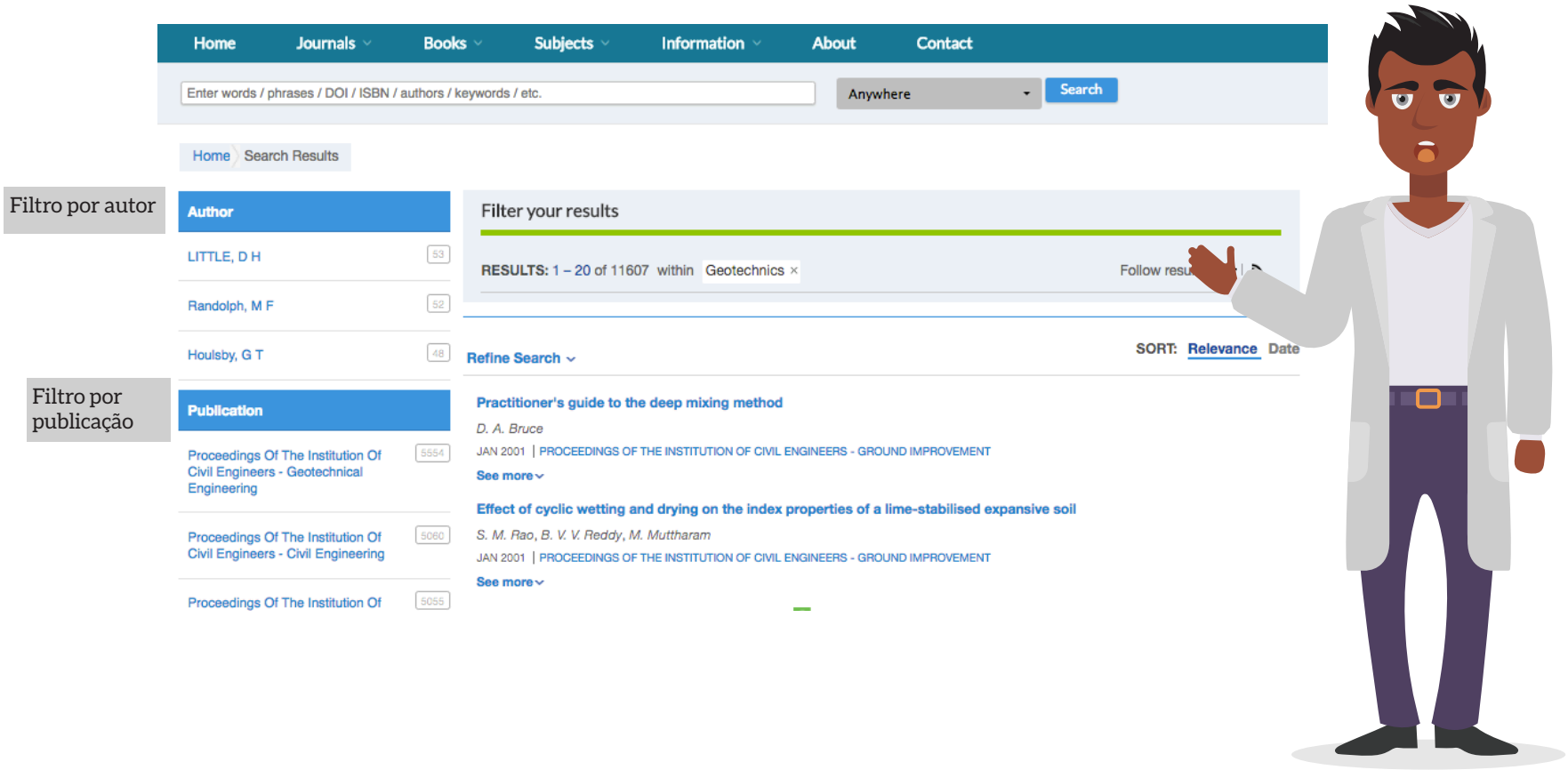
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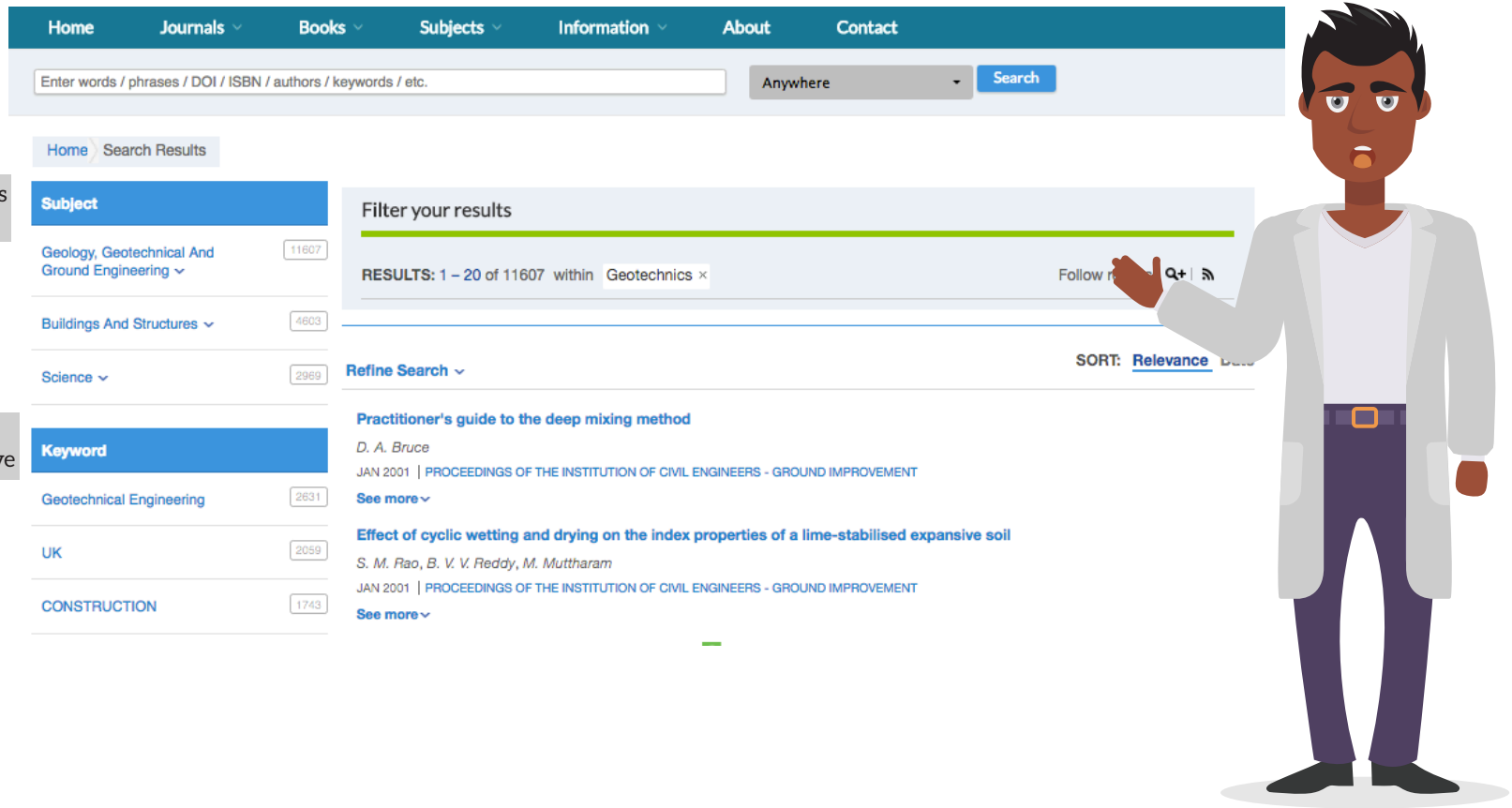

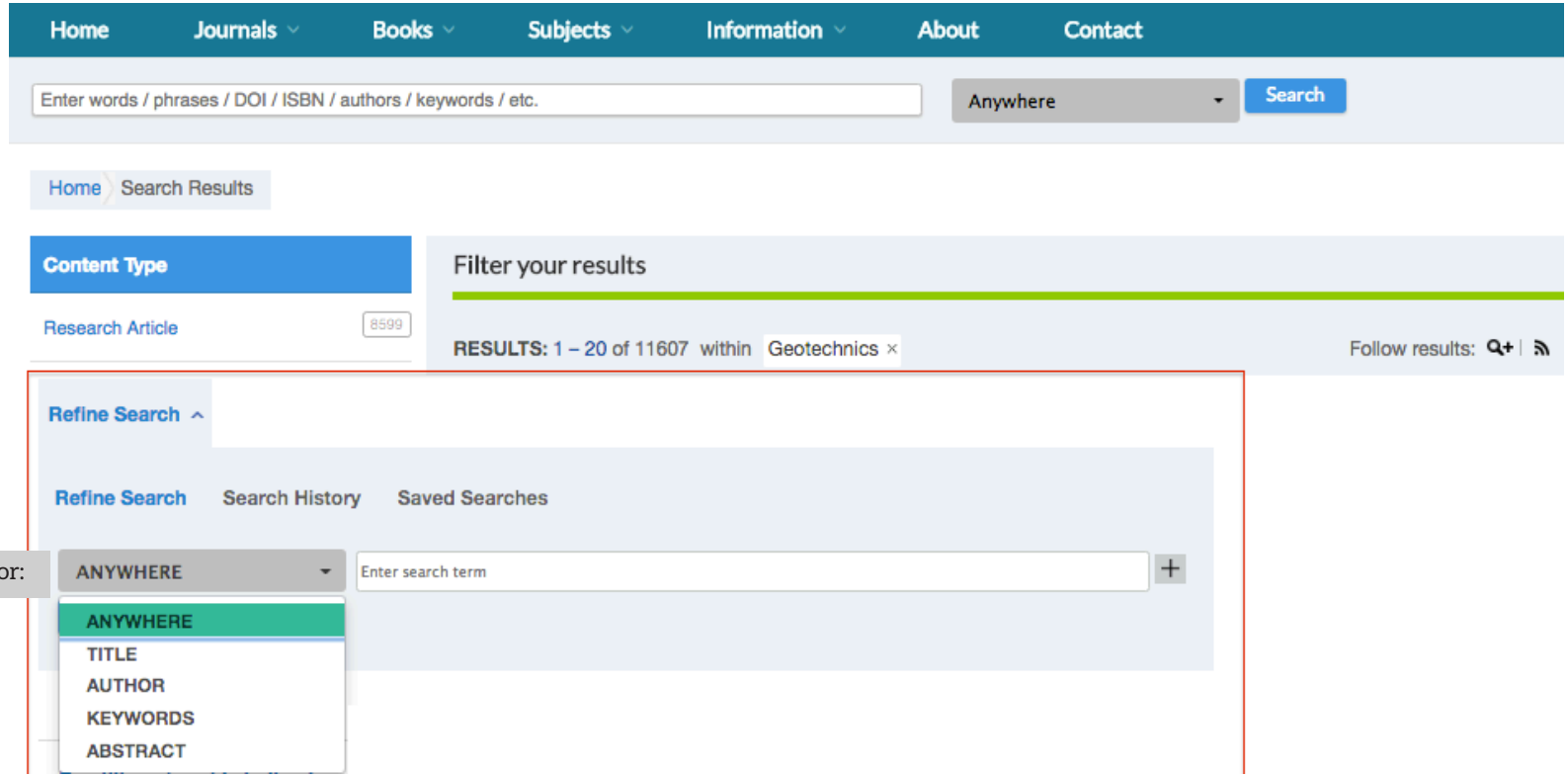
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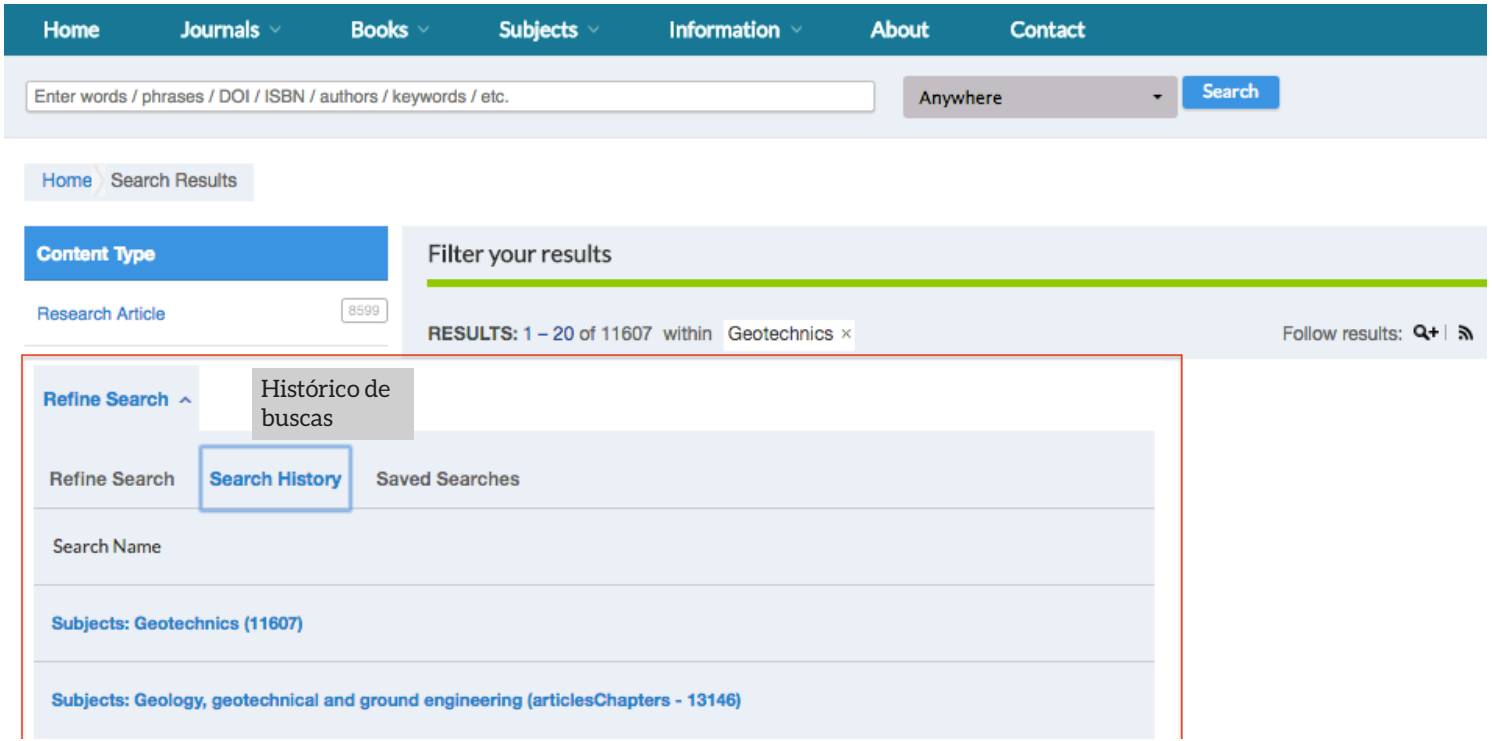
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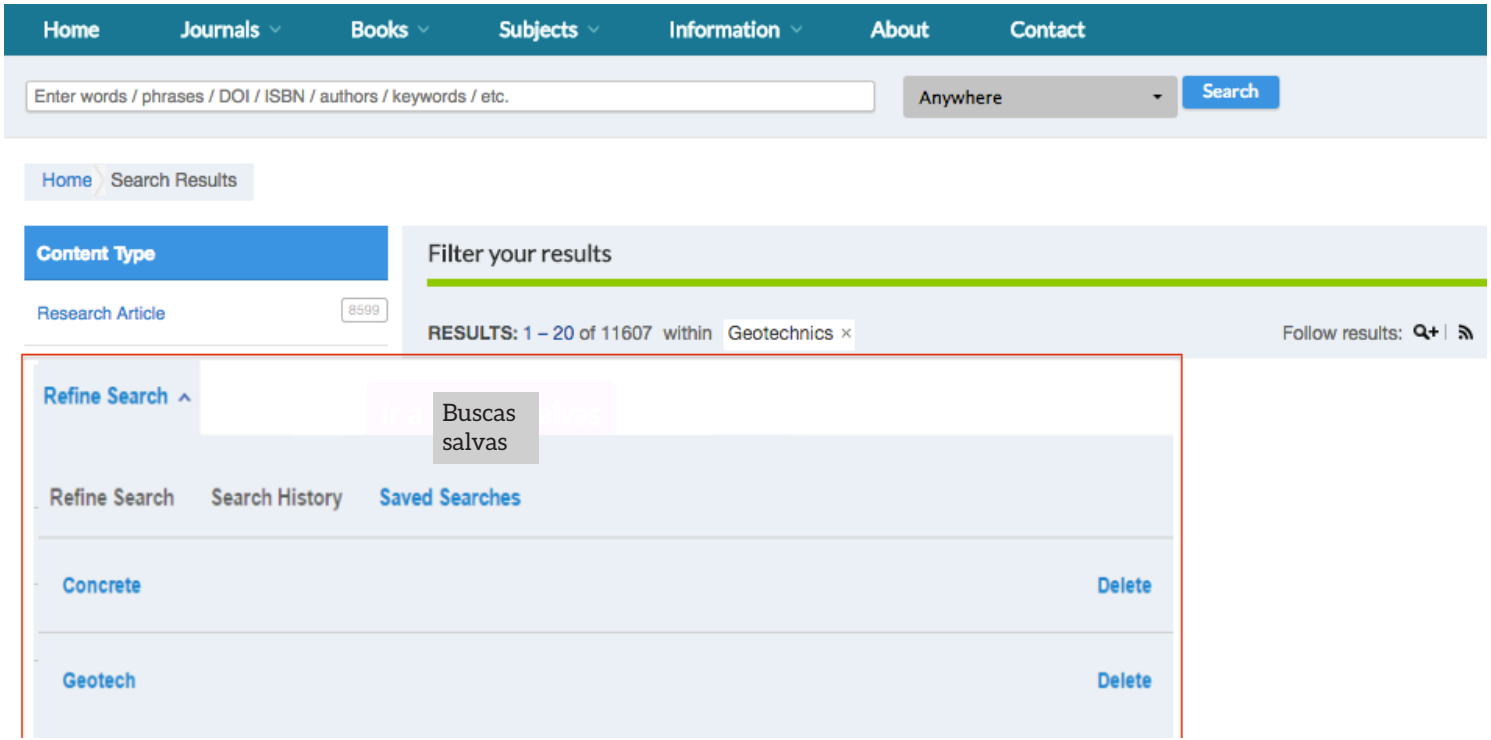
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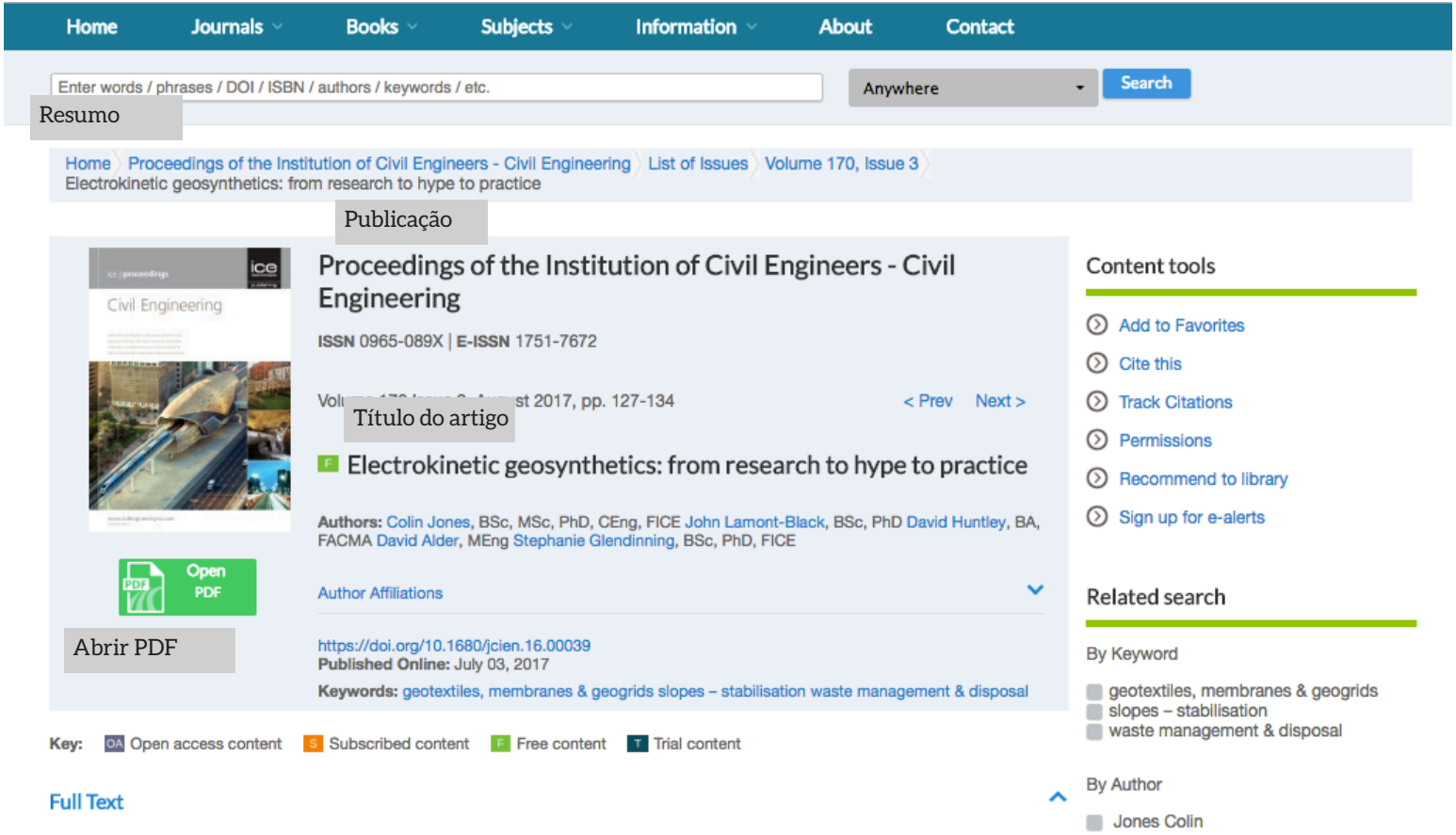
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Authors: Colin Jones, BSc, MSc, PhD, CEng, FICE John Lamont-Black, BSc, PhD David Huntley, BA, FACMA David Alder, MEng Stephanie Glendinning, BSc, PhD, FICE
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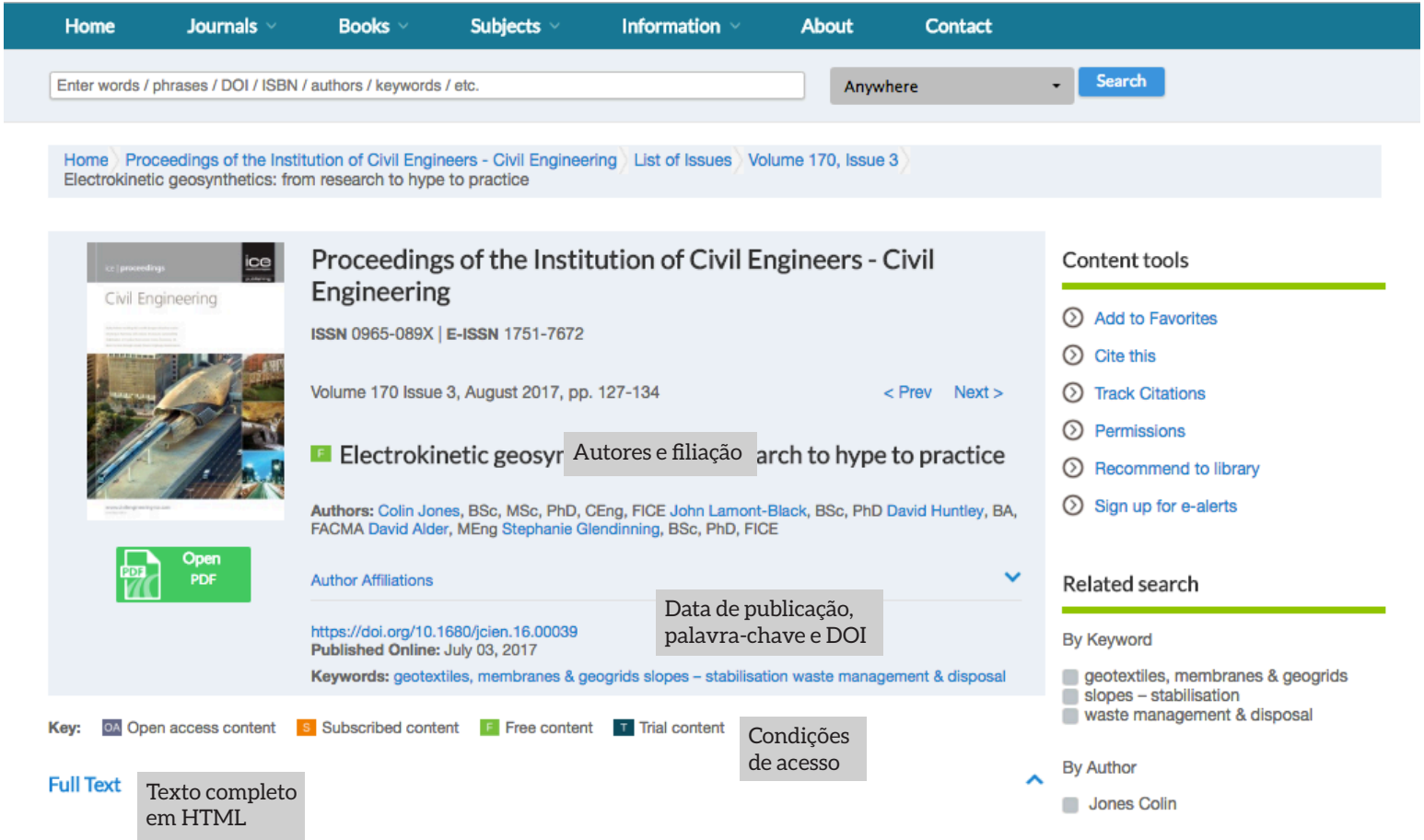
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Abstract Resumo

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Electrokinetic geosynthetics enable civil engineers to put electrical energy into the ground to stiffen it and control groundwater flows. This paper summarises the evolution of the technology over the past 25 years, from research by way of hype and into practice. It was conceived in 1993 at Newcastle University in the UK, combining established knowledge of geotextiles with historical studies of electrokinetics. A series of UK government-funded research programmes helped to generate global interest in its possible applications, leading to a technology spin-off company being incorporated in 2001 to attract private venture capital investment and further development funding. This eventually narrowed down the practical applications to slope stabilisation and dewatering, which now form the company's main revenue streams.

1 Introduction

Section: Choose

Geosynthetics are widely used in the civil engineering, waste, water and mining industries. They normally play a passive or reactive role. For example, geosynthetic reinforcement provides tensile resistance but only after an initial strain has occurred, while a geosynthetic filter or drain provides a passage for water but only after water flows towards it.

In 1994 it was postulated that an entirely new spectrum of applications for geosynthetics was possible if they could provide an active role – initiating biological, chemical or physical change to the matrix in which they were installed as well as providing the established functions (EPSRC, 1994).

It was suggested that geosynthetic inclusions in soil could be transformed into having an active role by making the material electrically conductive. Filtration, drainage, containment and reinforcement functions could be enhanced by electrokinetic techniques that stiffened the soil, improved the soil–reinforcement bond and enabled rapid transport of water and chemicals within fine-grained low-permeability materials. Increasing soil strength is a function of electrokinetic drainage and ion migration. Electrokinetically enhanced water flow through normally impermeable materials also permits the introduction of conditioning fluids.

3 UK government-funded studies

Section: Choose

Ir de uma seção à outra

A second EPSRC award was granted in 1997 to study the use and application of electrokinetic geosynthetics in the construction industry (EPSRC, 1997). The objectives of the research were to undertake field trials covering electro-osmotic consolidation, the strengthening of cohesive soil, volumetric control of clay embankments and to identify design methodologies. The research was undertaken with industrial collaborators from UK, Germany, Japan and Sweden.

The study identified acceptability criteria for the assessment of the suitability of a soil for treatment by electrokinetics based upon standard soil-mechanics laboratory tests enhanced by electro-osmosis (Table 3). Characterisation of the effectiveness of dissimilar electrode installation arrays was also developed based on finite-difference and resistance-path techniques.

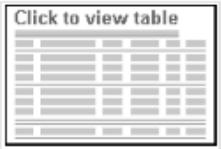

Table 3 Utility of soil tests for assessing acceptability for electrokinetic treatment

A field study of electro-osmotic consolidation of a soft soil was undertaken at Newburn in Newcastle, UK (Pugh *et al.*, 2000). From the trial, a method for predicting the quantity of consolidation that can be achieved using electrokinetic geosynthetic technology was developed. The method is based upon a linearly equivalent surcharge varying from 0 kPa at the cathode to a maximum of 100 kPa at the anode. The method was confirmed by laboratory testing on horizontal electrodes located in a block of London Clay together with the back-analysis of published case studies.

The study also included the first ever field application of electro-osmosis to cohesive reinforced soil (Glendinning *et al.*, 2005a; Jones and Pugh, 2001). The trial was unique in that a vertical 5 m reinforced soil wall was constructed using liquid fill (Figure 1). The fill was strengthened between lifts 300 mm high by electro-osmosis provided by the top two layers of reinforcement at each lift acting as electrodes. The lower electrode acted as an anode and the upper as a cathode; hence drainage was upwards towards the surface of the fill.

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Figure 1 of 7

Descrição

Figure 1 Construction of a 5 m tall reinforced soil wall using liquid cohesive soil – each 300 mm lift was consolidated using electro-osmosis (after Jones and Pugh, 2001)

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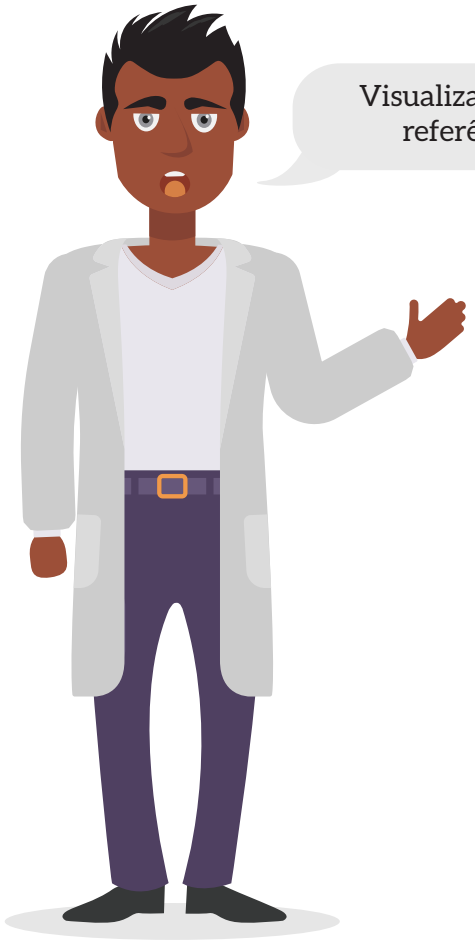

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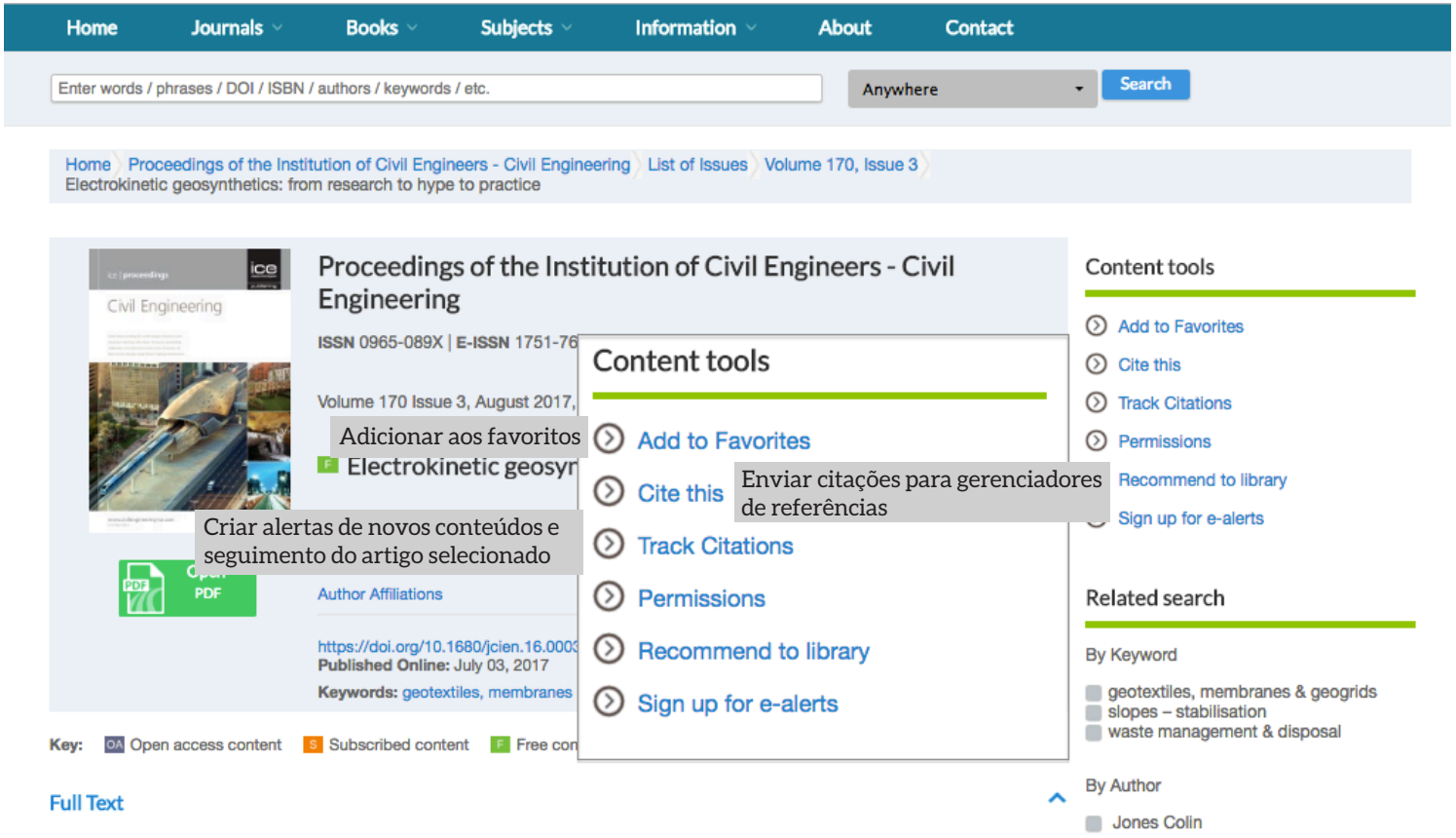

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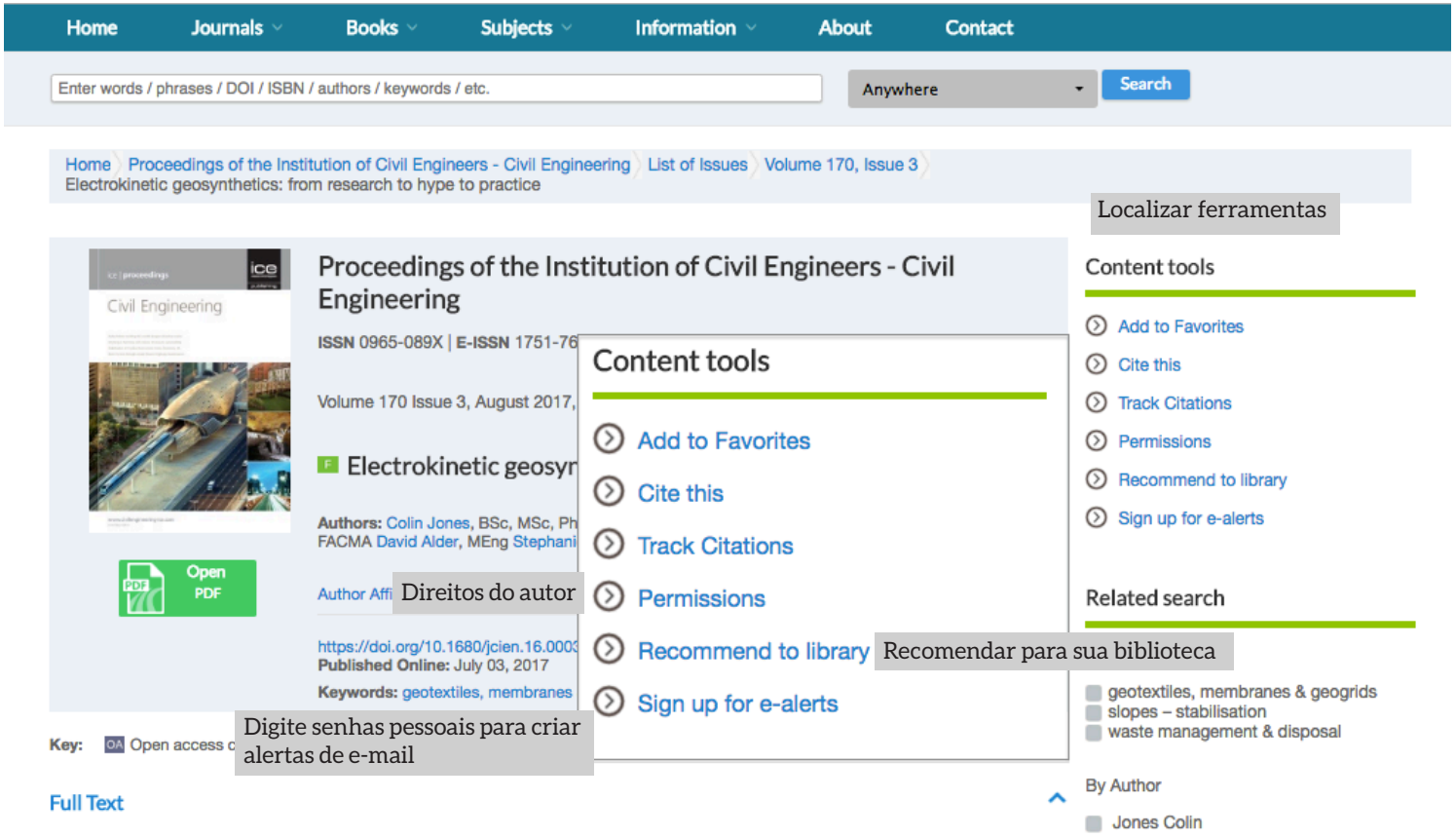

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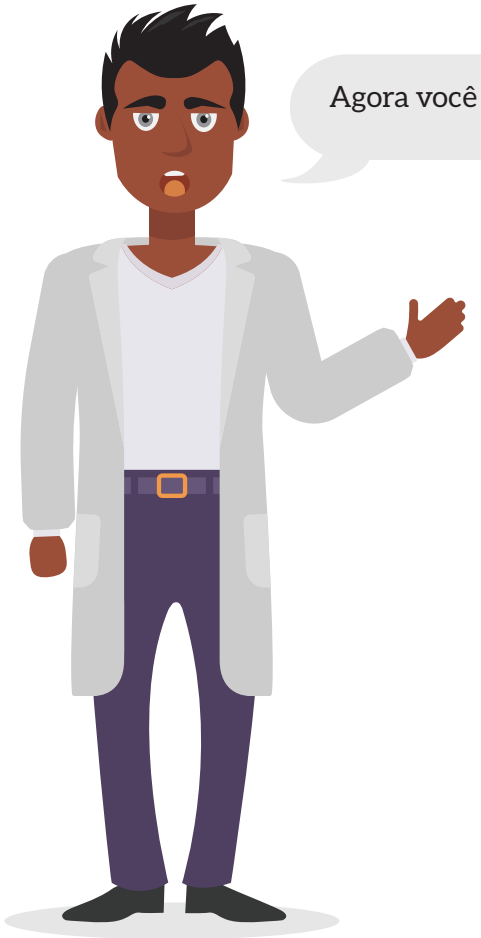

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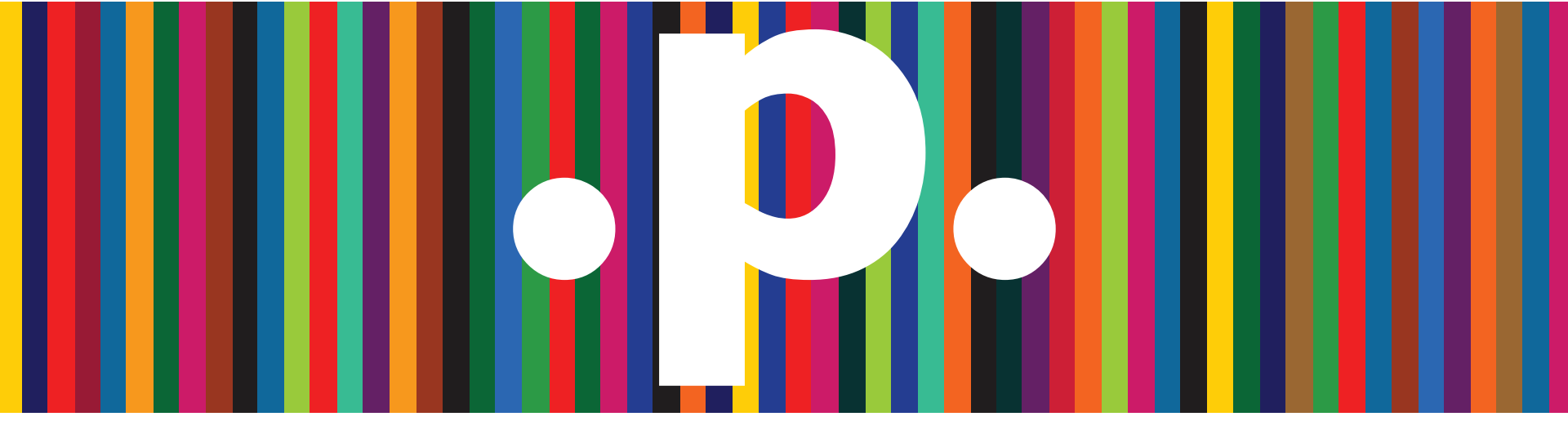

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