1D Finite Element Analysis

Shortcoming of the classical (variational) Ritz method

- Difficult to construct approximation functions
  - Especially in > 1 dimension
  - No systematic way of choosing them

$$u \approx u_h = \sum_{j=1}^{m} c_j \phi_j \qquad ???$$

Finite Element Method overcomes this shortcoming

- By...

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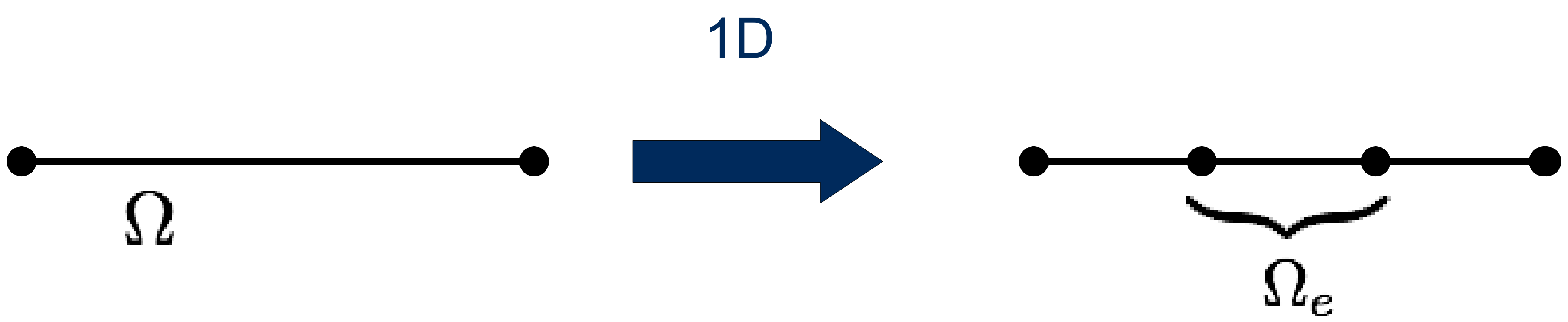
Return to day 1

The Finite Element Method (FEM) in a nutshell

- The domain of the problem is represented by a collection of simple subdomains, called *finite elements.*
  - The collection of finite elements is called the *finite element mesh.*



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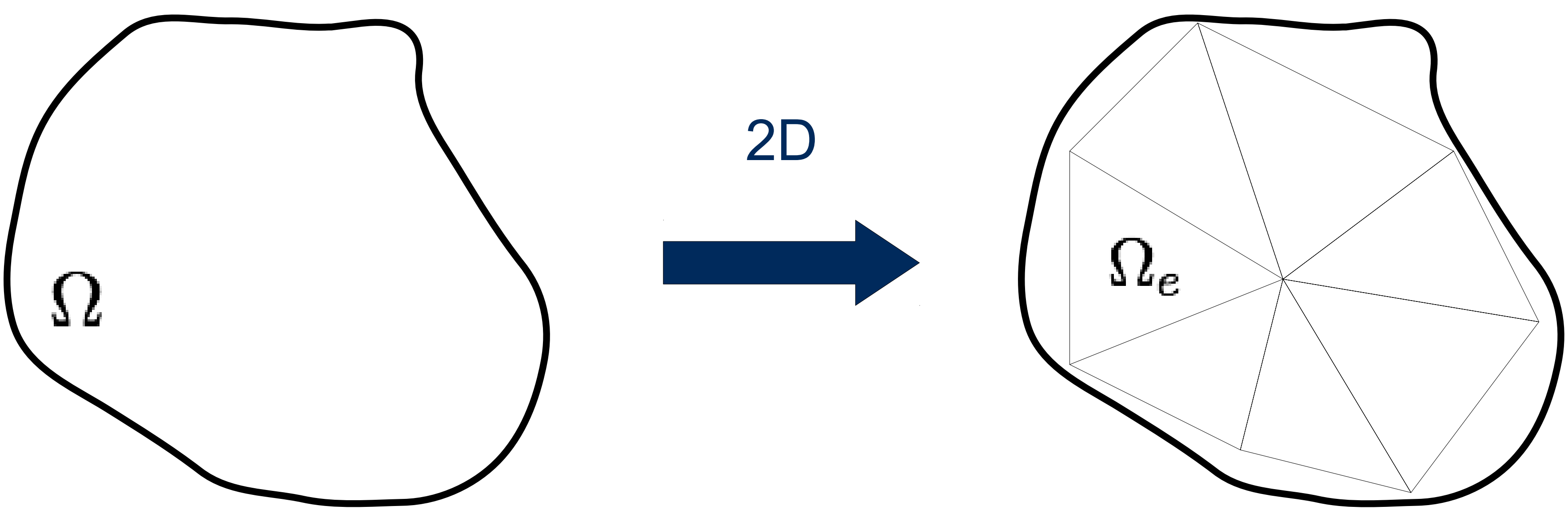

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- Over each finite element, the physical process is approximated by functions (polynomials or otherwise) and algebraic equations relating physical quantities at selective points, called *nodes,* are developed.

$$u \approx u_h = \sum_{j=1}^{n} u_j \psi_j$$

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- Over each finite element, the physical process is approximated by functions (polynomials or otherwise) and algebraic equations relating physical quantities at selective points, called *nodes,* are developed.
- The element equations are *assembled* using continuity and/or “balance” of physical quantities and solved.

Determining the interpolation (shape) functions

- The approximate solution should be:
  - Continuous over the element and differentiable (required by weak form).
  - Complete.
  - Should be an interpolant of the nodal variables of interest.

Determining the interpolation (shape) functions (cont.)

- The interpolation (shape) functions are denoted by:

$$\psi_j \qquad \text{or} \qquad N_j$$

- For weak form derivation of element equations the interpolation functions must satisfy the essential boundary conditions (for admissibility).