

**Introduction**

Variational formulation in modeling. Functions with values in the extended reals. Examples in imaging.

**Convex Functions**

Definition of convex functions, Jensen's inequality, characterization by gradient and Hessian. Epigraph, relation between convex functions and convex sets. Lower semicontinuity, equivalent definitions, properties. Continuity properties of convex functions. Minima of convex functions, local and global minima, coercivity and strict convexity imply existence and uniqueness.

**Regularization and Subdifferentials**

Inf-convolution and Moreau-Yosida regularization, proximation (its variational characterization, firmly-nonexpansiveness). Subdifferentials, directional derivative, characterization of subdifferential. Fermat's rule. Subdifferential calculus.

**Operators and Iterative Convergence**

Orthogonal projection to convex sets, projection is firmly nonexpansive. Non-expansive, averaged operators, asymptotically regular operators, Opial's theorem. Convergence of Picard sequence for averaged operators. Forward-backward splitting algorithm.

**TEXTBOOKS/ REFERENCES:**

1. D. P. Bertsekas: Convex Optimization Theory
2. I. Ekeland, R. Temam: Convex Analysis and Variational Problems
3. R. T. Rockafellar: Convex Analysis