pCT Collaboration Documentation

Data Acquisition/Processing and Image Reconstruction Software: Theory and Implementation Details

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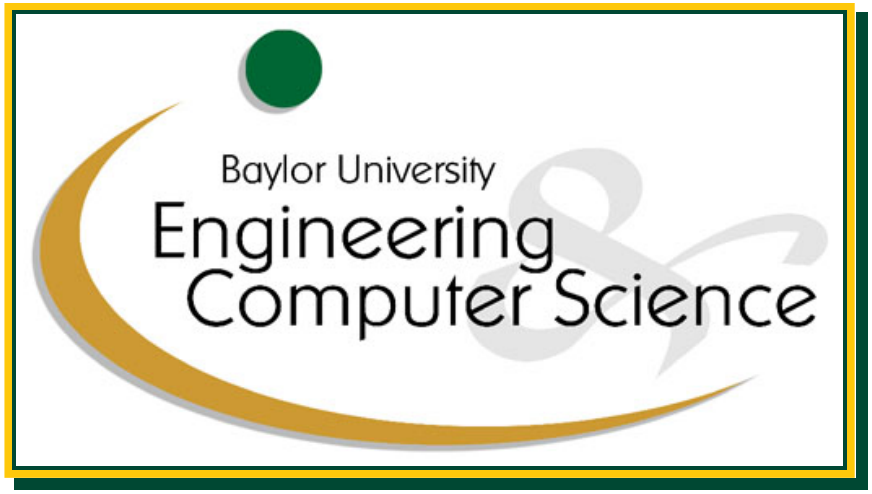

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Block-Iterative Algorithms: Notation

- m : total # of proton histories
- n : total # of image vector voxels
- B : total # of BIP blocks
- $\{a{:}b\} = \{\, i \mid i \in [a,b]\}$: interval of indices
- $A_{*,j}$: Column vector composed of all $* = 1{:}m$ rows of the j-th column of the matrix A
- $A_{i,*}$: Row vector composed of all $* = 1{:}n$ columns of the i-th row of the matrix A
- $A_{\{a:b\},j}$: Column vector composed of the interval $a{:}b$ of rows of the j-th column of the matrix A
- $A_{i,\{a:b\}}$: Row vector composed of the interval $a{:}b$ of columns of the i-th row of the matrix A
- $x_{(k)}$: Image vector x at iteration k
- $\mathcal{I} = \{1, 2, 3, \cdots, m\}$: the sequentially ordered set of all proton history indices
- $\mathcal{B}_{(k)} = \{1, 2, 3, \cdots, B_{(k)}\}$: the sequentially ordered set of all BIP block indices, where the # of BIP blocks $B_{(k)}$ may vary as a function of iteration k.
- $f_{(k)} : \mathcal{I} \to \mathcal{B}_{(k)} = \left\{ \{f_{(k)}(i) = b\}_{i \in \mathcal{I}, b \in \mathcal{B}_{(k)}} \right\}$
  $= \{\, f_{(k)}(1), f_{(k)}(2), f_{(k)}(3), \cdots, f_{(k)}(m) \mid f_{(k)}(i) = b \in \mathcal{B}_{(k)}, i \in \mathcal{I}\}$: function $f_{(k)}$ assigning one of the $B_{(k)}$ BIP block indices to each of the m proton historie indices, thereby setting the # of histories and the order they are processed within each block as well as the order that these blocks of histories are processed in the k-th iteration. This function may be varied as a function of iteration k, permitting the user to assign different BIP block configurations and/or history ordering schemes.
- $\mathcal{M}_{b(k)} = \left\{ i \in \mathcal{I} \;\middle|\; f_{(k)}(i) = b, \bigcup_{b \in \mathcal{B}_{(k)}} \mathcal{M}_{b(k)} = \mathcal{M} \right\}$: the ordered set of proton history indices within the b-th BIP block during iteration k, assigned according to the function $f_{(k)}$
- $\mathcal{M}_{(k)} = \left\{ \{\mathcal{M}_{b(k)}\}_{b \in \mathcal{B}_{(k)}} \right\} = \{\, \mathcal{M}_{1(k)}, \mathcal{M}_{2(k)}, \cdots, \mathcal{M}_{B(k)}\}$: the ordered family of sets of BIP blocks of proton history indices for iteration k, assigned according to the function $f_{(k)}$
- $H_i = \left\{ x \in \mathbb{R}^n \;\middle|\; \langle A_{i,*}, x \rangle = b_i, i \in \mathcal{I} \right\}$: the hyperplanes corresponding to the ith row of the $m \times n$ linear

system $Ax = b$ upon which the image vector $x_{(k)}$ is projected