Transitioning to NIfTI: an ITK-SNAP Case Study

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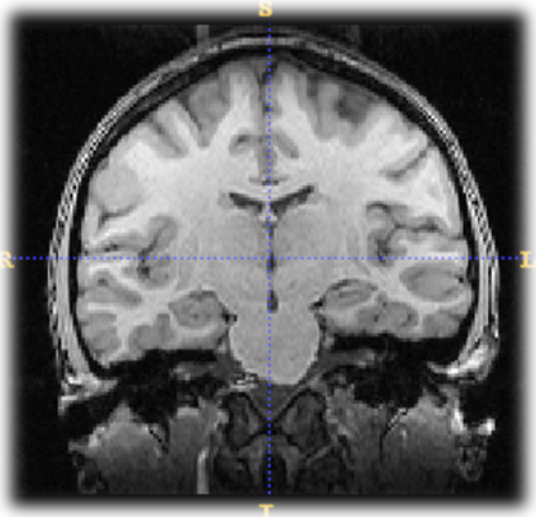
NIfTI: A Data Format for Neuroimaging

.nii

=

.hdr

.img




```
                        /**************************/  /************************/
struct nifti_1_header { /* NIFTI-1 usage         */  /* ANALYZE 7.5 field(s) */
                        /**************************/  /************************/

                                                /*--- was header_key substruct ---*/
 int   sizeof_hdr;    /*!< MUST be 348           */  /* int sizeof_hdr;      */
 char  data_type[10]; /*!< ++UNUSED++            */  /* char data_type[10];  */
 char  db_name[18];   /*!< ++UNUSED++            */  /* char db_name[18];    */
 int   extents;       /*!< ++UNUSED++            */  /* int extents;         */
 short session_error; /*!< ++UNUSED++            */  /* short session_error; */
 char  regular;       /*!< ++UNUSED++            */  /* char regular;        */
 char  dim_info;      /*!< MRI slice ordering.   */  /* char hkey_un0;       */

                                 /*--- was image_dimension substruct ---*/
 short dim[8];        /*!< Data array dimensions.*/  /* short dim[8];        */
 float intent_p1 ;    /*!< 1st intent parameter. */  /* short unused8;       */
                                                     /* short unused9;       */
 float intent_p2 ;    /*!< 2nd intent parameter. */  /* short unused10;      */
                                                     /* short unused11;      */
 float intent_p3 ;    /*!< 3rd intent parameter. */  /* short unused12;      */
                                                     /* short unused13;      */
 short intent_code ;  /*!< NIFTI_INTENT_* code.  */  /* short unused14;      */
 short datatype;      /*!< Defines data type!    */  /* short datatype;      */
 short bitpix;        /*!< Number bits/voxel.    */  /* short bitpix;        */
 short slice_start;   /*!< First slice index.    */  /* short dim_un0;       */
 float pixdim[8];     /*!< Grid spacings.        */  /* float pixdim[8];     */
 float vox_offset;    /*!< Offset into .nii file */  /* float vox_offset;    */
 float scl_slope ;    /*!< Data scaling: slope.  */  /* float funused1;      */
 float scl_inter ;    /*!< Data scaling: offset. */  /* float funused2;      */
 short slice_end;     /*!< Last slice index.     */  /* float funused3;      */
 char  slice_code ;   /*!< Slice timing order.   */
 char  xyzt_units ;   /*!< Units of pixdim[1..4] */
 float cal_max;       /*!< Max display intensity */  /* float cal_max;       */
 float cal_min;       /*!< Min display intensity */  /* float cal_min;       */
 float slice_duration;/*!< Time for 1 slice.     */  /* float compressed;    */
 float toffset;       /*!< Time axis shift.      */  /* float verified;      */
 int   glmax;         /*!< ++UNUSED++            */  /* int glmax;           */
 int   glmin;         /*!< ++UNUSED++            */  /* int glmin;           */

                                 /*--- was data_history substruct ---*/
 char  descrip[80];   /*!< any text you like.    */  /* char descrip[80];    */
 char  aux_file[24];  /*!< auxiliary filename.   */  /* char aux_file[24];   */

 short qform_code ;   /*!< NIFTI_XFORM_* code.   */  /*-- all ANALYZE 7.5 ---*/
 short sform_code ;   /*!< NIFTI_XFORM_* code.   */  /*   fields below here  */
                                                     /*   are replaced       */
 float quatern_b ;    /*!< Quaternion b param.    */
 float quatern_c ;    /*!< Quaternion c param.    */
 float quatern_d ;    /*!< Quaternion d param.    */
 float qoffset_x ;    /*!< Quaternion x shift.    */
 float qoffset_y ;    /*!< Quaternion y shift.    */
 float qoffset_z ;    /*!< Quaternion z shift.    */

 float srow_x[4] ;    /*!< 1st row affine transform.   */
 float srow_y[4] ;    /*!< 2nd row affine transform.   */
 float srow_z[4] ;    /*!< 3rd row affine transform.   */

 char intent_name[16];/*!< 'name' or meaning of data.  */

 char magic[4] ;      /*!< MUST be "ni1\0" or "n+1\0". */

} ;                   /**** 348 bytes total ****/
```

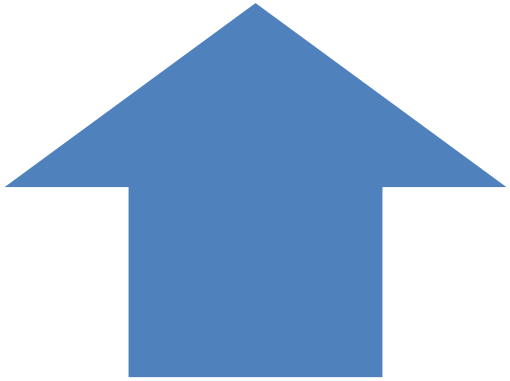
Why Should My Tool Support NIfTI?

Advantages

- Interoperability with major tools
- Support for many types of data
- Known *intent* associated with images
- Representation of *spatial transformations*

Challenges

- May require a paradigm shift in the design of your tool
- Limited support for storing metadata

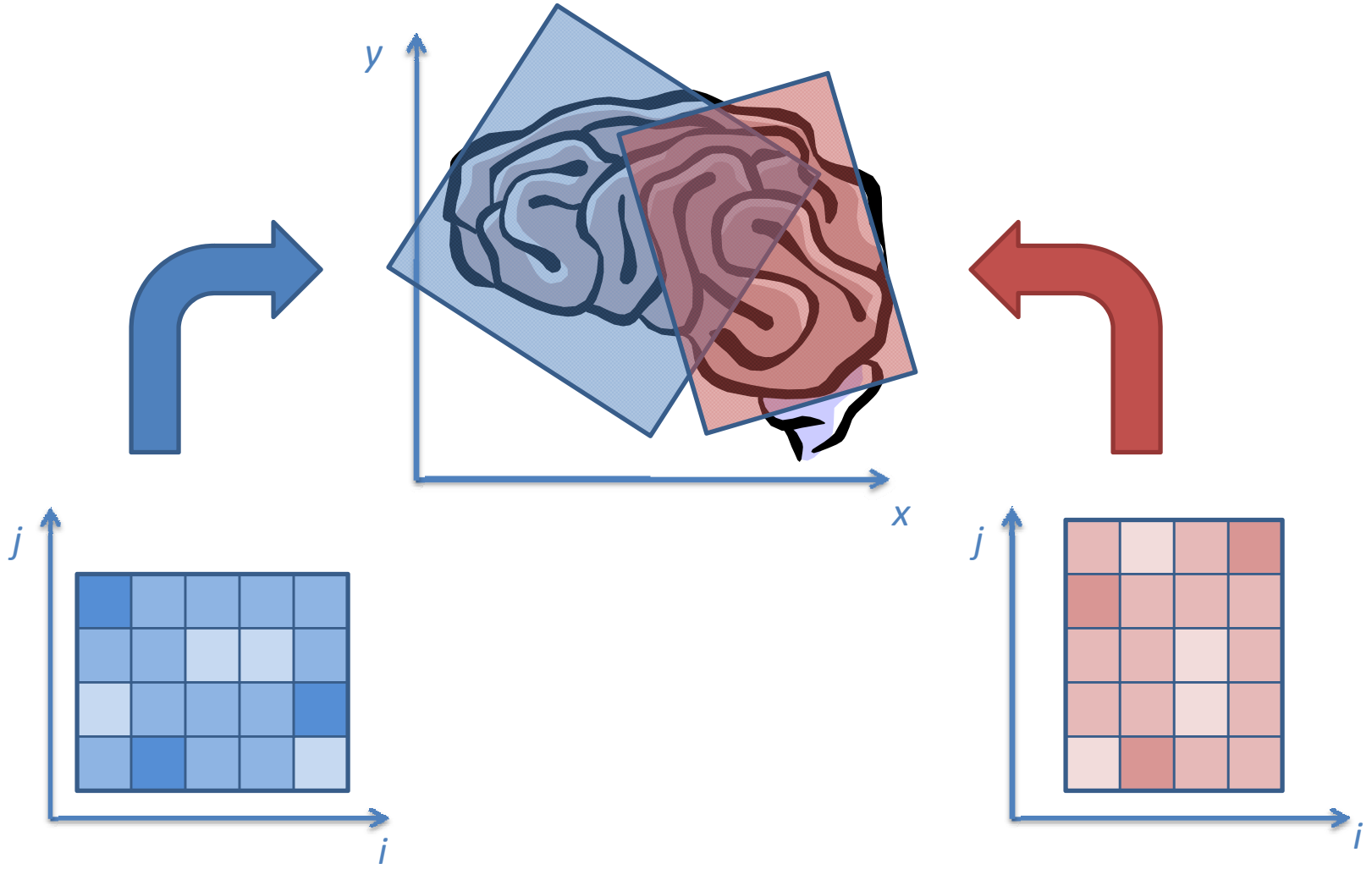


Adding Basic NIfTI IO is Simple:

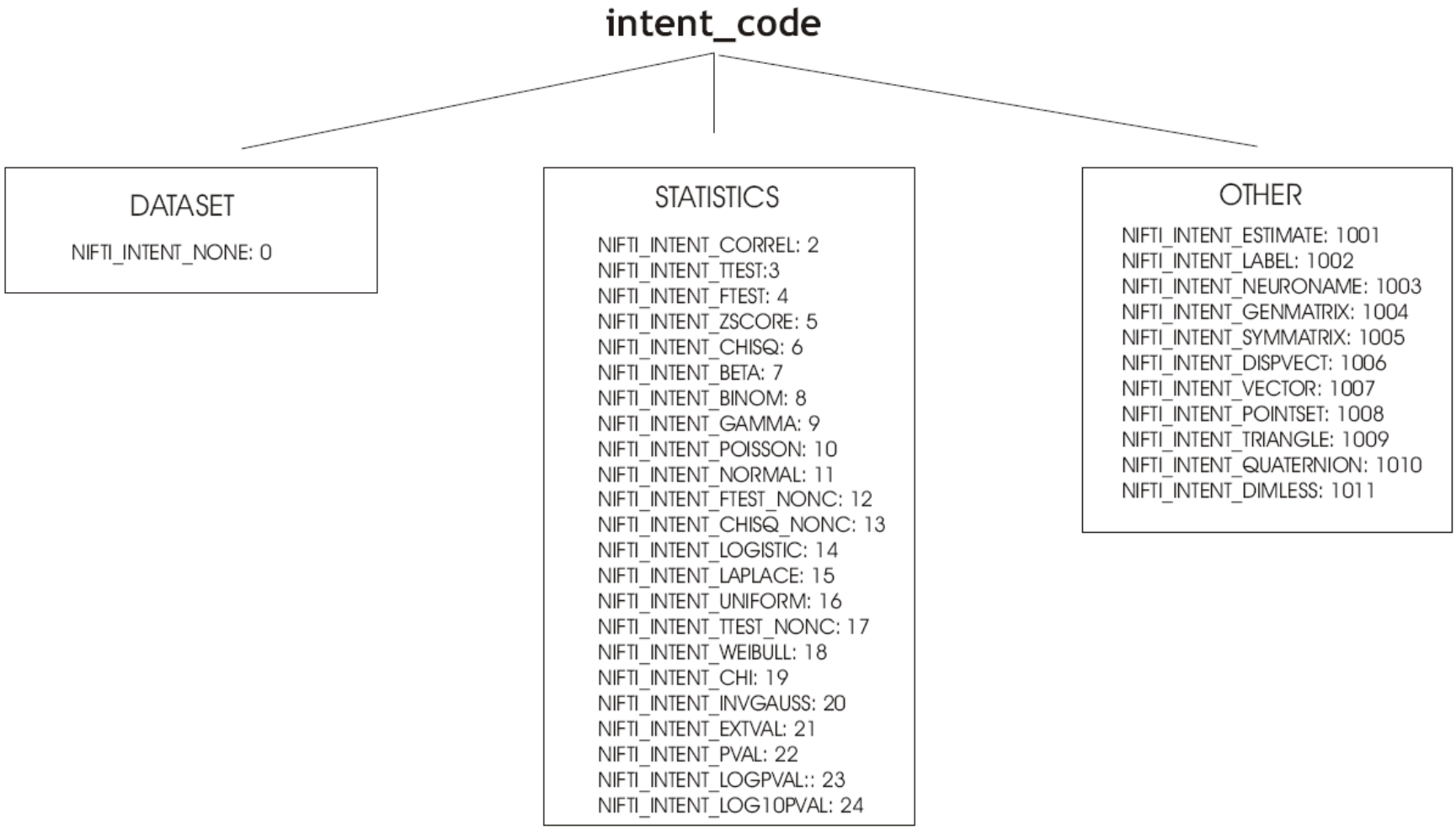
```
#include <nifti1_io.h>

int main()
  {
  nifti_image *nim;
  nim = nifti_image_read("test.nii");
  ...
  }
```

How Does My Tool Handle Image-Space Transformations?



Which “Intents” Can My Tool Support?



ITK-SNAP: A Case Study

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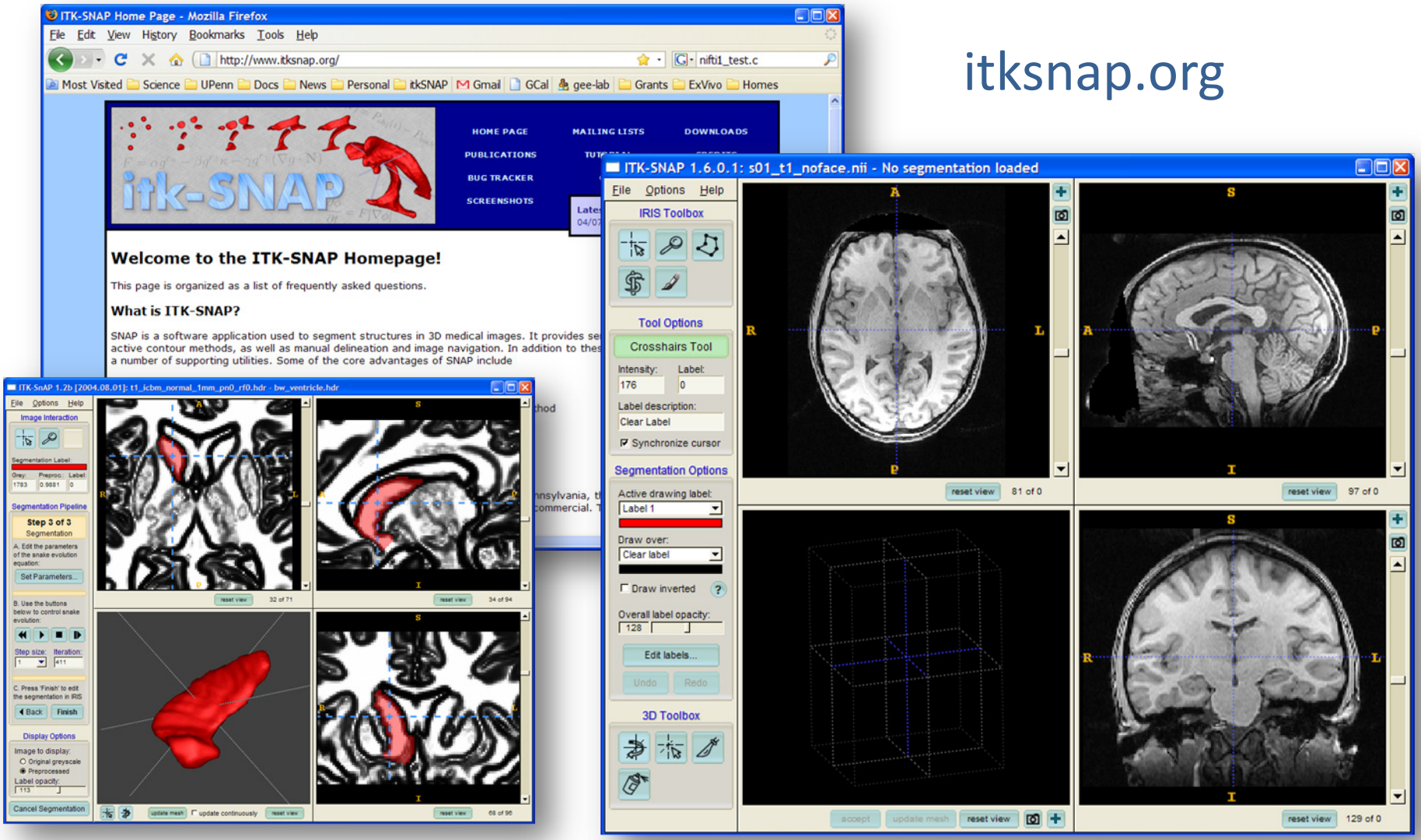
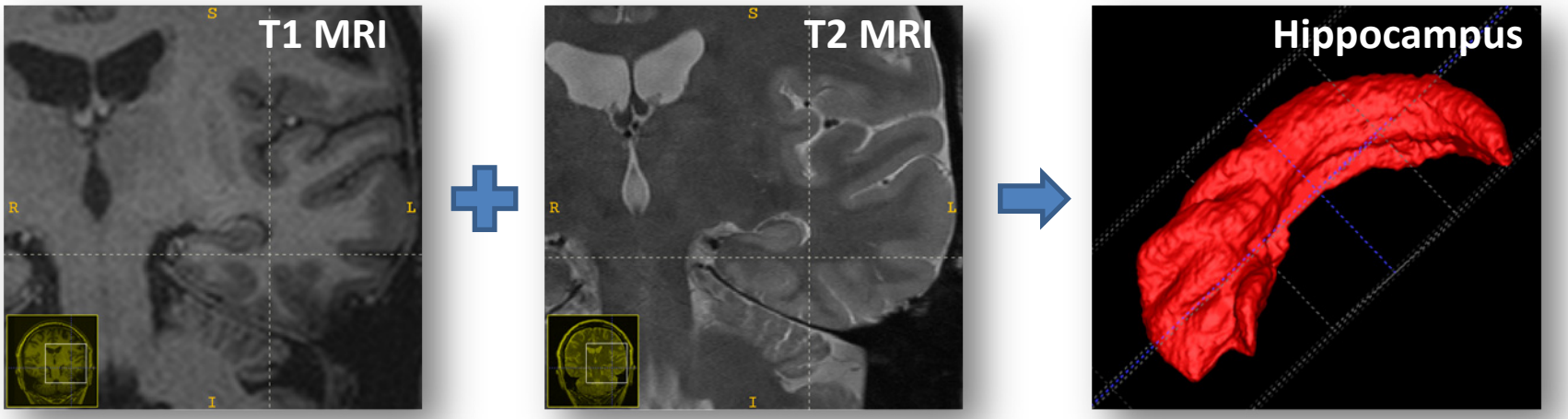


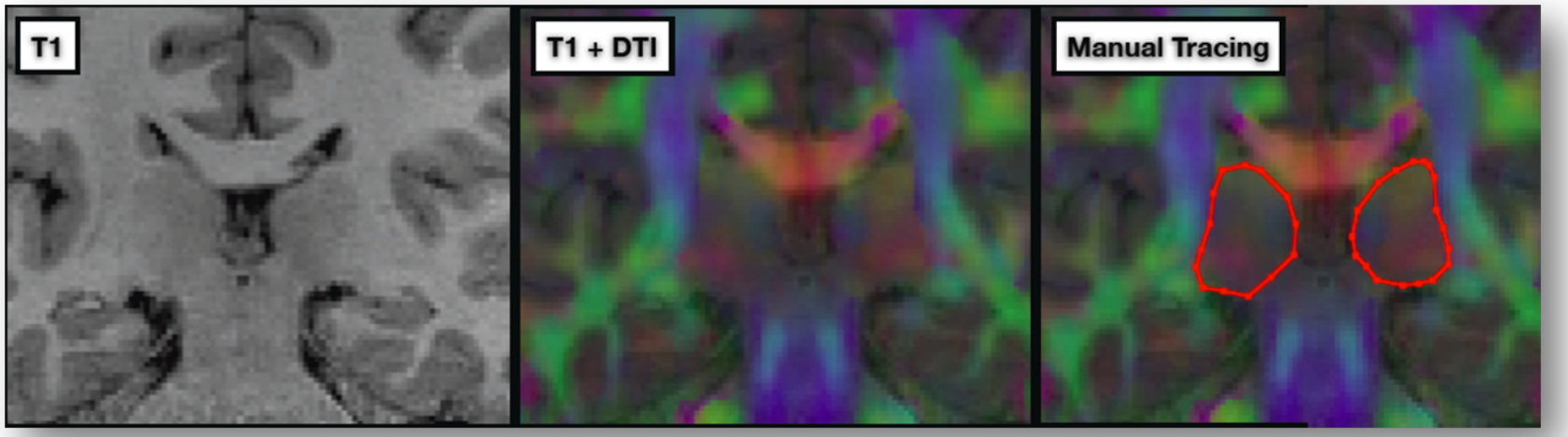
Multi-Layer Support

- Rationale:
  - MRI studies often include different modalities (T1/T2/DTI)
  - Data from multiple modalities can improve segmentation
  - Spatial relationship between modalities captured by NIfTI
- Use Case: Hippocampus Segmentation in T1/T2



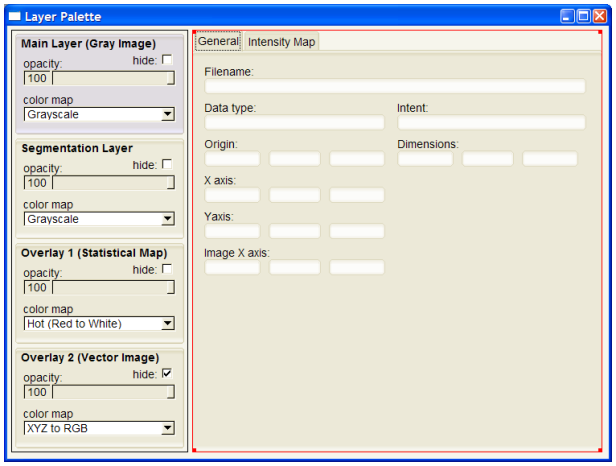
Multi-Component Image Support

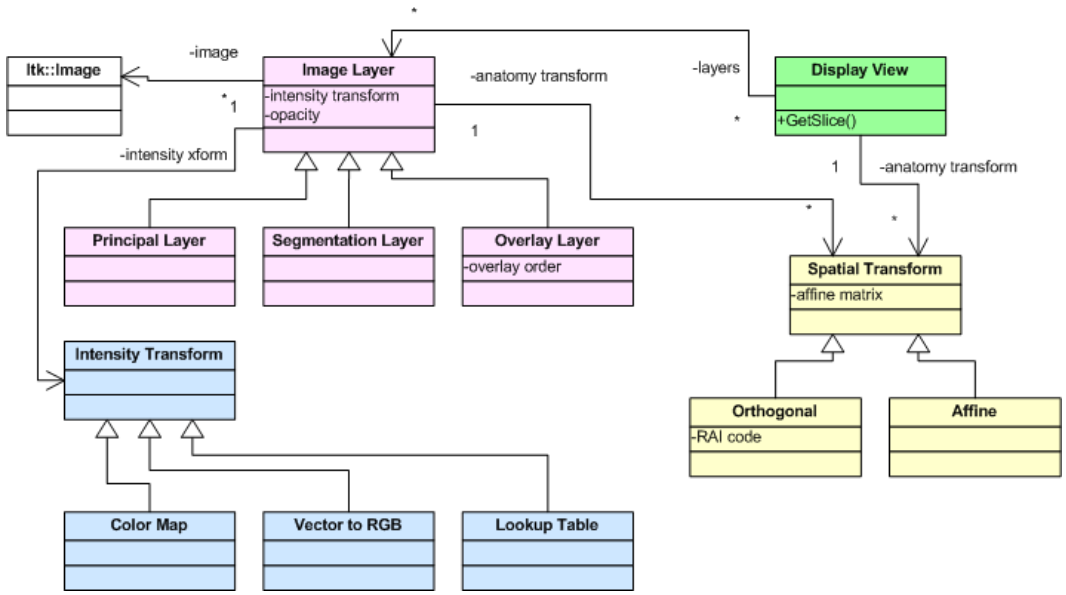
- Rationale:
  - Enable segmentation of complex, DTI and RGB data
  - Take advantage of NIfTI *intent* information
- Use Case: Thalamus Segmentation in T1/DTI



Implementation: Layered Design

- A new layer palette
  - Each layer has its own display properties, transform
  - Principal layer defines “working” space
  - Segmentation layer tied to principal layer
  - Overlay layers can be oblique to principal layer





Conclusions

- NIfTI offers new capabilities for image analysis tools
  - Encode spatial transformations
  - Describe data intent
  - Interoperability across all major tools
- Taking advantage of new features is nontrivial
  - A redesign of the whole tool may be required
- ITK-SNAP 2.0 will be a fully NIfTI capable tool

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