

RNAStudio, a full-featured object-oriented program for visualizing RNA secondary structures[☆]

Hao Zhang, Ci-Quan Liu*

Modern Biological Center, Yunnan University, Kunming, Yunnan 650091, PR China

Accepted 26 November 2001

Abstract

The function of a RNA molecule relies on the underlying physical mechanisms and geometric properties in terms of secondary or tertiary structure, in which one of the most important properties is topological connectivity. RNAStudio, available at <http://rnastudio.51.net>, brings the convenience of Windows to the representation of RNA folding topology including the sections mentioned below. © 2002 Published by Elsevier Science Inc.

Keywords: RNA secondary structure; RNA folding topology; RNAStudio

1. Completely designed in compliance with object-oriented principles

Many discrete objects are built-in, supporting almost all of the most-wanted operations and attributes for RNA folding, such as SKELETON, FOLDING BACKBONE, NUCLEOTIDE, BOND, TICK MARK, TEXT TAG, etc. Its abstraction permits the final product to be flexible and extendible; encapsulation ensures its implementation is reliable; inheritance makes a large-scaled development project possible. RNAStudio takes advantage of object-oriented design to greatly simplify matters for a sophisticated system, e.g. ease of use is achieved via polymorphism of action verbs, thus dramatically reducing the number of action verbs, which are usually corresponding to respective menu items, and the complexity of the interface. As a natural user interface, RNAStudio defines its operation according to events, thus enhancing its intuitive nature. For a casual or novice user who has not memorized large portions of the manual, this is especially helpful and empowering.

2. Full-featured visual editing functionality

As a visual workbench, RNAStudio provides ‘what you see is what you get’ (WYSIWYG) response to the end user. Structures can be arranged and annotated according to user’s wishes, nucleotides can be numbered and colored, basepairs or bonds can be specially highlighted, and several fonts, line types, brush patterns and colors can be applied to make particularly interesting conformations, bases or regions appear differently. RNAStudio will be useful for rendering publication-ready RNA secondary structure representations. RNAStudio can also serve as a visual RNA structure exploration tool to provide an intuitive and familiar graphical representation of information about RNA structures. Its features include an integrated environment where users can draw, display, print and send e-mail without leaving the application. Also, multiple structures may be superimposed in one coordinate system to allow a side-by-side comparison. Intermediaries and products can be edited and stored to and restored from persistent physical storage media, allowing multiple sessions for editing a complicated structure and multiple users share a single structure data set; built-in internet information exchange support allows working documents be sent as attachments to electronic mail.

3. OLE/COM container

RNAStudio is an ActiveX container that stores its files in the compound file format, allows external objects to be

[☆] Work supported by the National Natural Science Foundation of China, Grant Nos. 39770418 and 30024004, and partly by the Knowledge Innovation Program of the Chinese Academy of Sciences, project “Frontier Research in Theoretical Biophysics and Bioinformatics”, Grant No. KJCX1-08.

* Corresponding author. Tel.: +86-871-5195-400; fax: +86-5191-823.
E-mail address: tbrg@public.km.yn.cn (C.-Q. Liu).

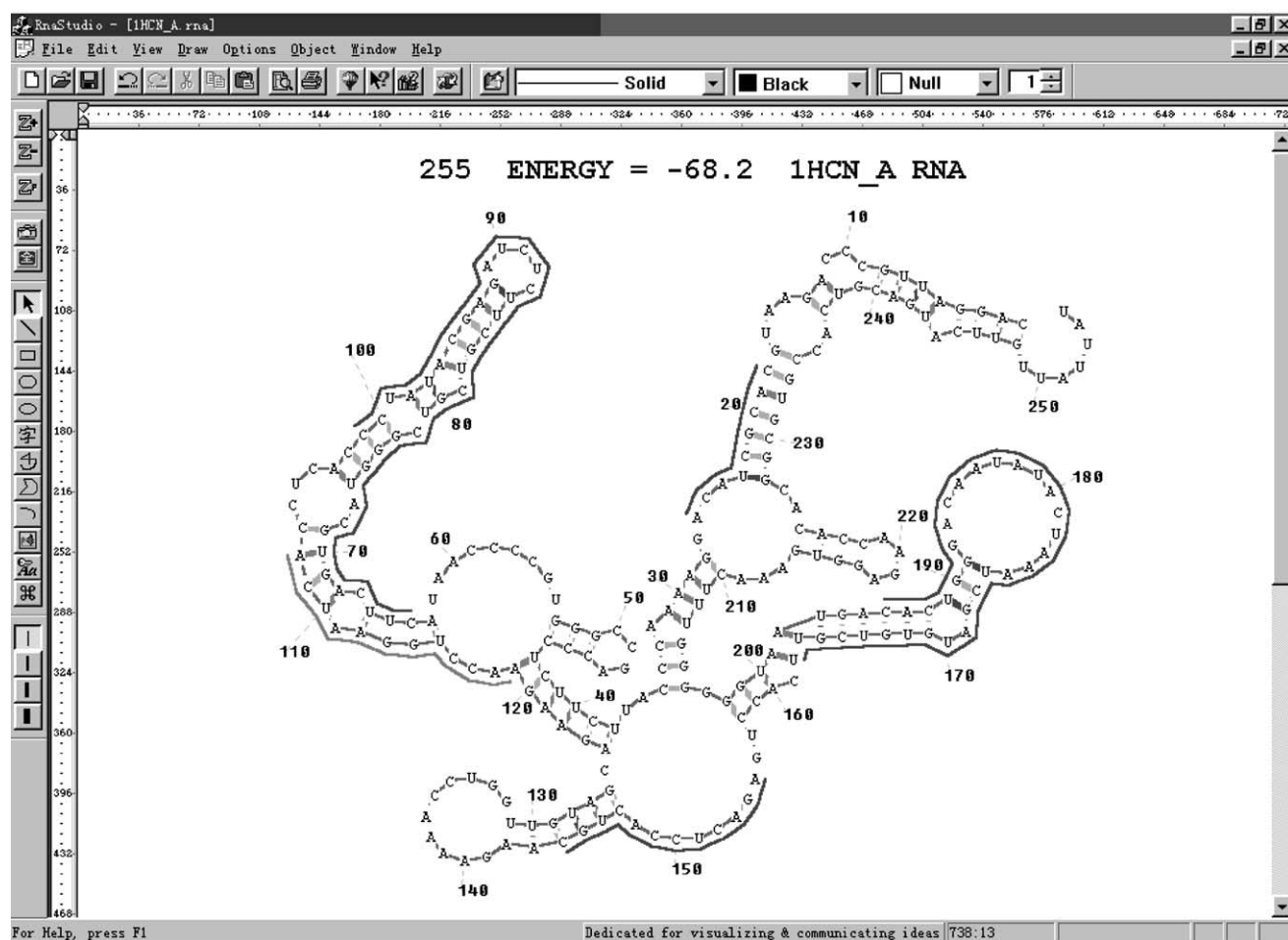


Fig. 1. Look and feel of RnaStudio running on Windows98. This demonstrates its following facets: (1) object-oriented features and visual workbench compliance. (2) As seen, structure annotated by a rich combination of means; structural elements can be colored, isobar aligned and text tagged. (3) An instance where segments of isobar are used to illustrate secondary structure units of a protein (PDB ID: 1HCN) mapped onto the template mRNA secondary structure (NCBI entry:31868).

incorporated into the working document, supports in-place activation and editing of OLE/ActiveX objects, and acts as a drop target for drag-and-drop operations.

4. Windows95 and Internet support

RnaStudio supports Windows95 logo compliance: a Win32 executable, support for long filenames, support for

UNC pathnames (Uniform Naming Convention) use of system colors and metrics, compatibility with Windows NT, tight integration with the Windows95 shell, support for dragging and dropping to or from Microsoft Internet Explorer, registration of large and small icons, use of the system registry instead of an .ini file, support for MAPI, display of a shortcut menu or dialogs box in response to a right-button mouse click, storage of *Summary Information* with its documents, and a set-up and uninstall program (Fig. 1).