Concept Maps for Construction, Browsing, and Sharing of Knowledge

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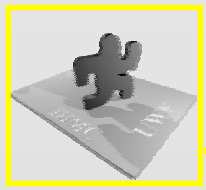


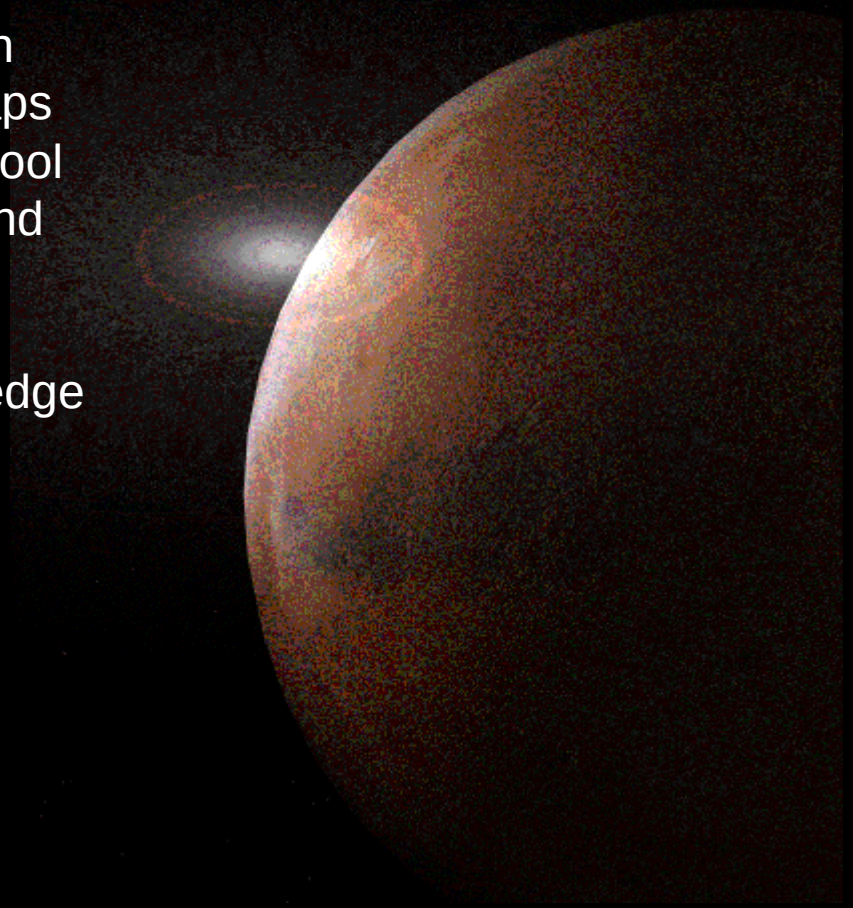
Content of presentation

- Current projects using Concept Maps-based technology between NASA Ames & IHMC
- Concept Maps
  - Description
  - Concept Map-based browser
  - Performance support systems
  - Distance learning
  - Collaboration: knowledge construction and sharing among scientists
  - Indexing

Mars & Astrobiology Project

NASA Ames Research Center

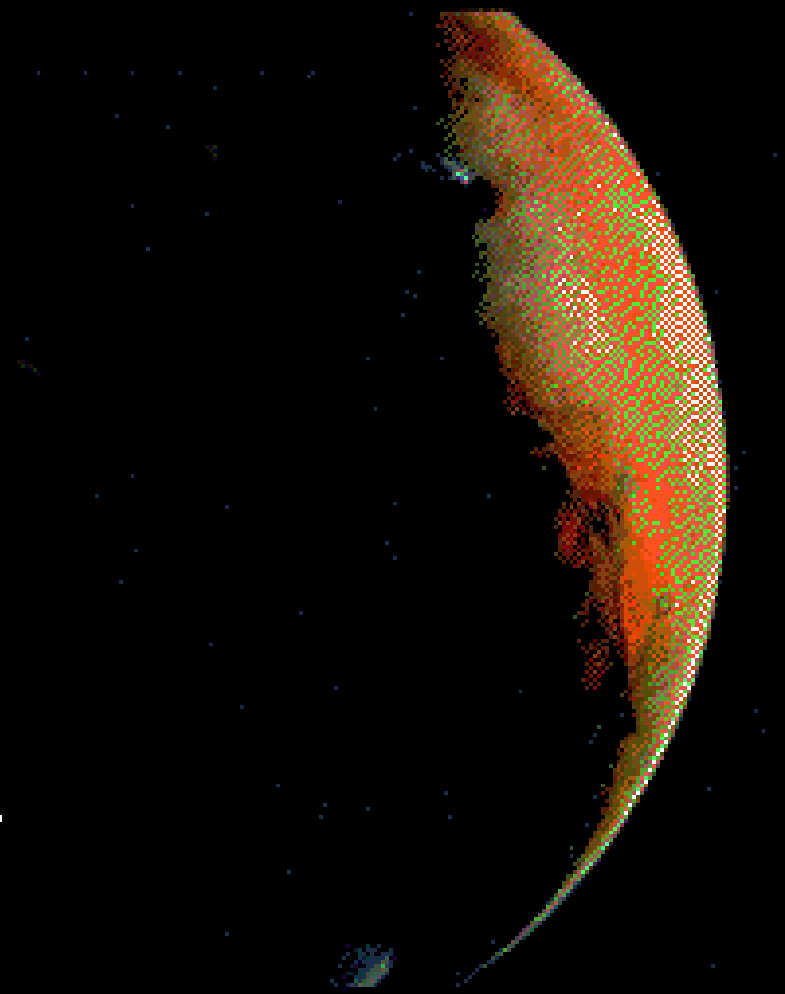
- Capture NASA's Mars expert's domain knowledge into browsable concept maps that will be made available to high-school students, and to the public, on a CD and on the Web
- Work on collaboration tools for knowledge construction and sharing with the Astrobiology Institute

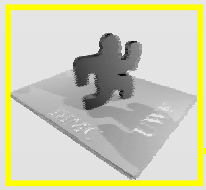


Case-Based Capture and Reuse of Aerospace Design Rationale

NASA Ames Research Center

- Use concept mapping tools to support the capture, representation and examination of how a designer conceptualizes a domain, to make this information available for indexing and retrieval in the Case Based Reasoning system.

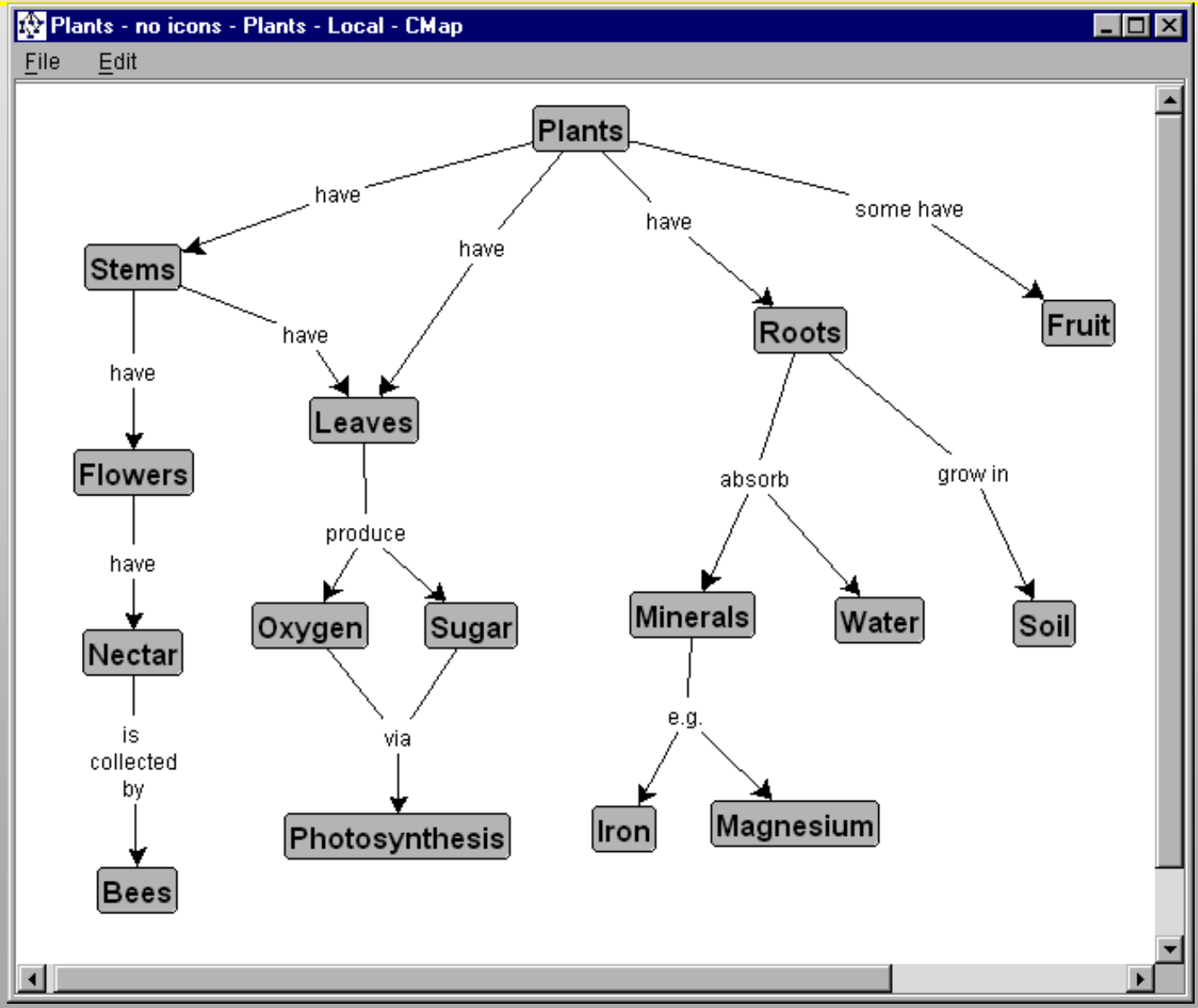




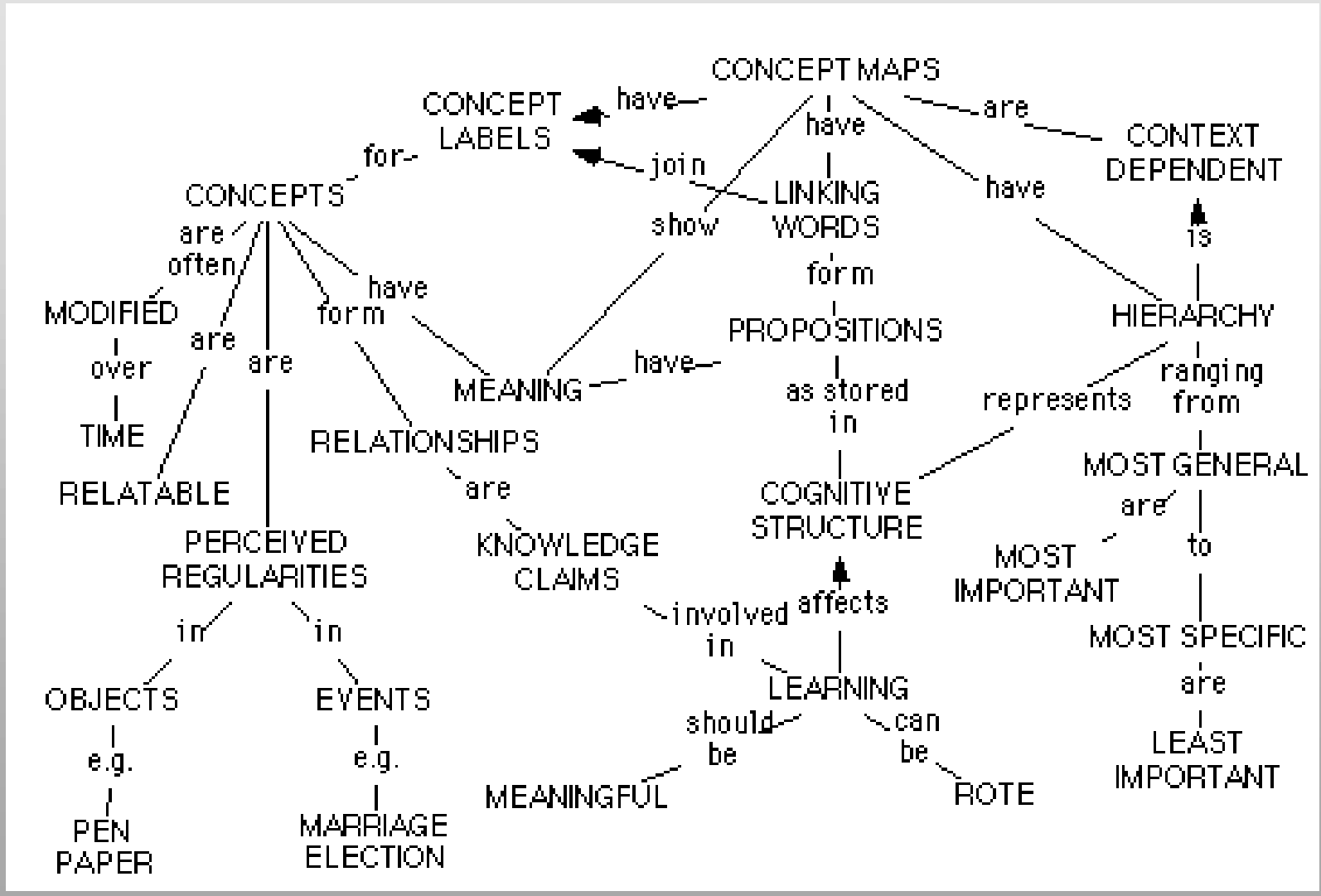
Projects Leverage on...

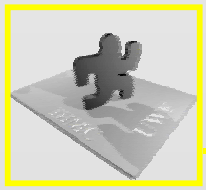
- Convergence of Technologies
  - Computer assisted instruction
  - Distance education
  - Expert systems
  - Performance support systems
  - WWW browsers
  - Just-in-time training
  - Collaboration tools
- Other IHMC projects with
  - IBM, NIMA, US Navy, State of Florida, ...

C-Maps in Knowledge Construction



Concept Map about Concept Maps

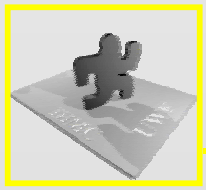




Concept Maps

- Developed in an educational setting by Novak (1977)
- Used as the primary language for description and communication of concepts within Assimilation theory (Ausubel)

- A Concept map:
  - is a graphical display of concept names connected by directed arcs encoding propositions in the form of simplified sentences
  - in educational settings, concept mapping techniques have aided people of every age to examine many fields of knowledge
  - represents meaningful propositions in a hierarchical framework
  - is the principal interface and medium for model construction/sharing

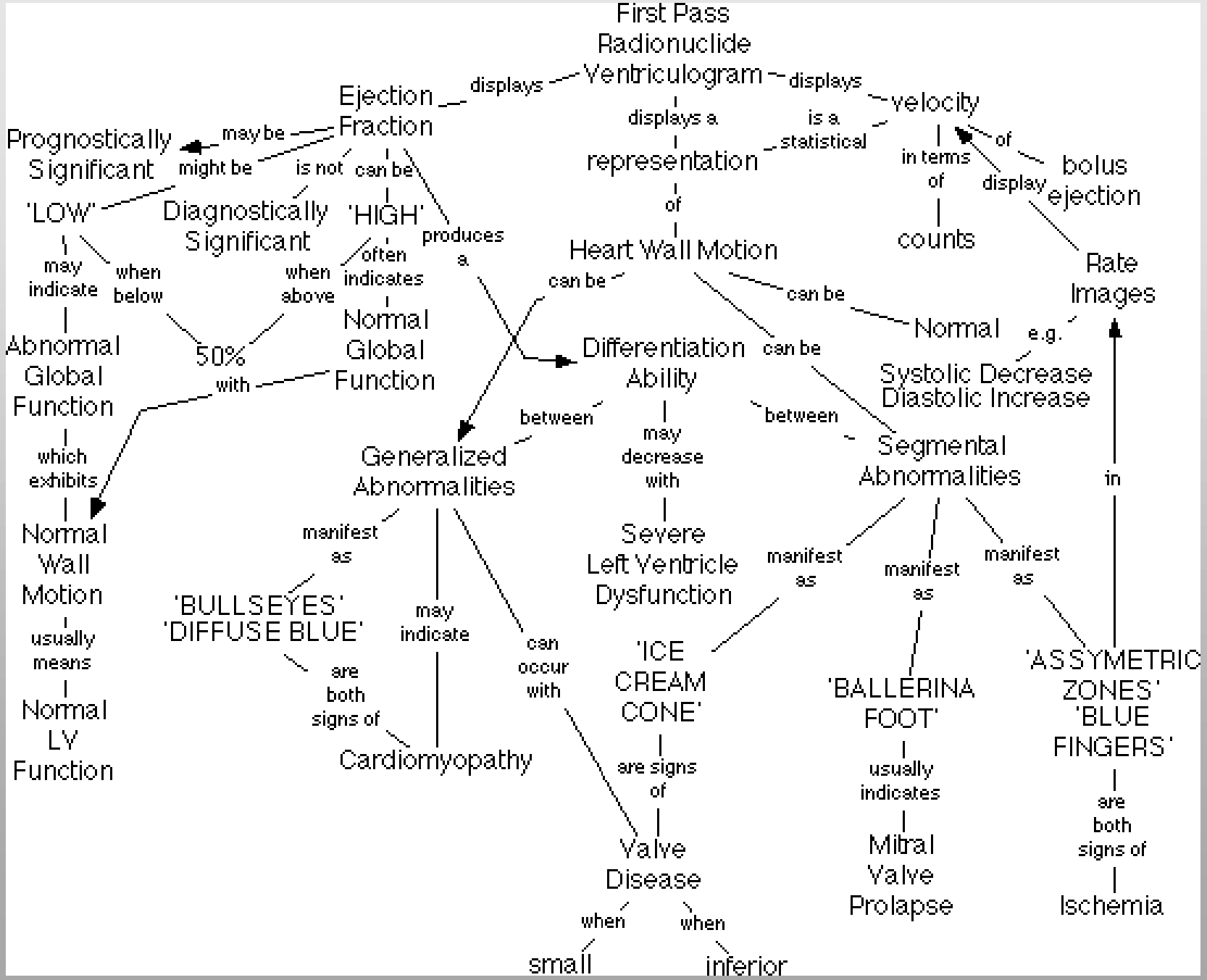


From an AI Perspective

- Concept maps seem similar to semantic networks and conceptual graphs
- …but concept maps:
  - are not “knowledge representations” in a computational or logical sense
  - are much more loosely defined, with no firm syntactic rules and no formal rules of interpretation or semantics
- Concept maps are a …

  pedagogic device for use by humans rather than

  … a formal device for use by reasoning engines


First Pass Radionuclide Ventriculogram
displays
Ejection Fraction
displays
velocity
displays a
representation
is a statistical
of
Heart Wall Motion
in terms of
counts
of
bolus ejection
display
Rate Images
may be
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can be
Prognostically Significant
'LOW'
Diagnostically Significant
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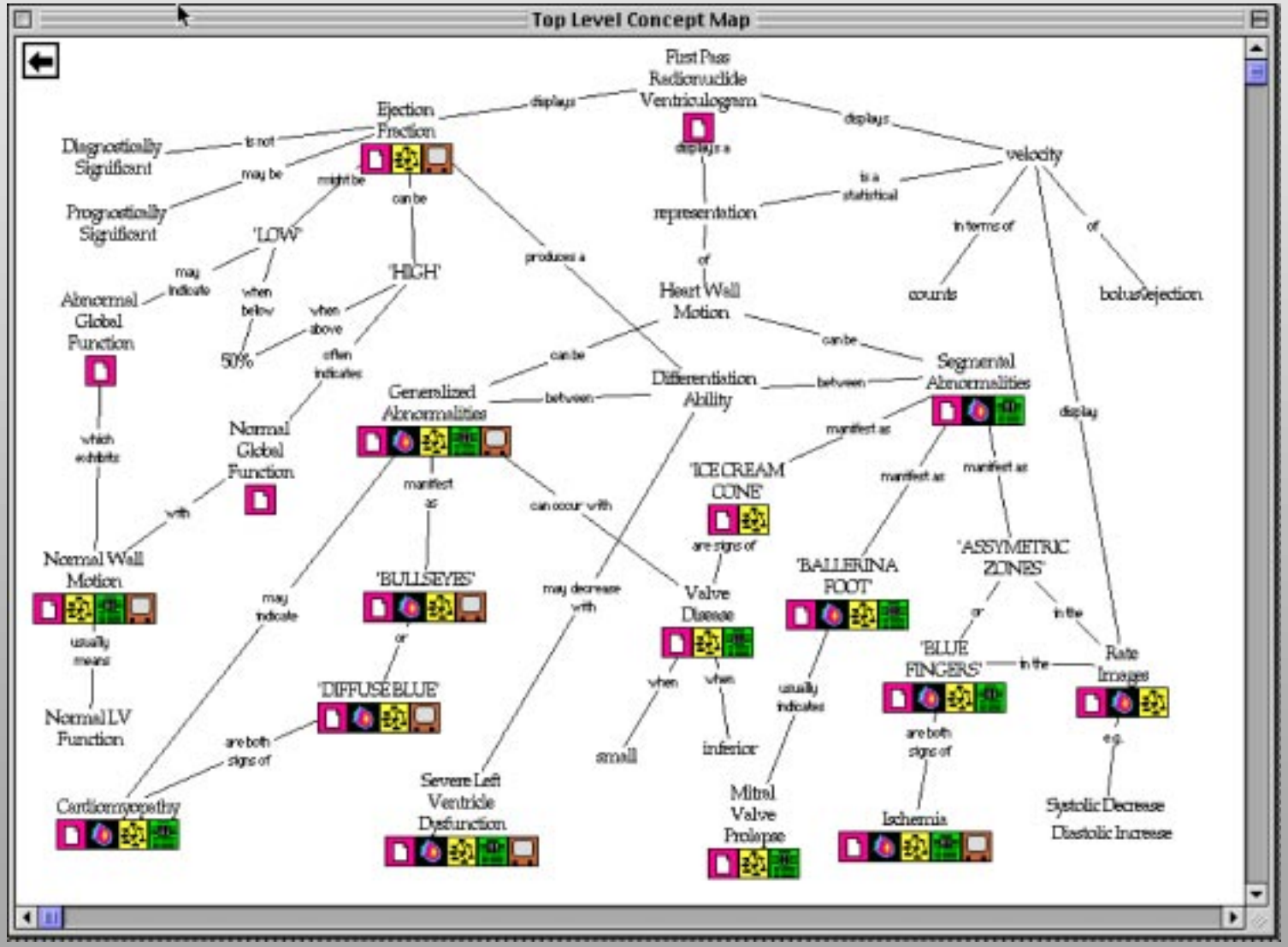
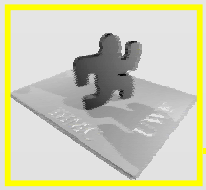
produces a
may indicate
when below
when above
often indicates
50%
with
Normal Global Function
Abnormal Global Function
which exhibits
Normal Wall Motion
usually means
Normal LY Function
can be
Differentiation Ability
can be
Normal
e.g.
Systolic Decrease Diastolic Increase
between
may decrease with
between
Severe Left Ventricle Dysfunction
Generalized Abnormalities
Segmental Abnormalities
in
manifest as
'BULLSEYES'
'DIFFUSE BLUE'
are both signs of
Cardiomyopathy
may indicate
can occur with
manifest as
'ICE CREAM CONE'
are signs of
Valve Disease
when small
when inferior
manifest as
'BALLERINA FOOT'
usually indicates
Mitral Valve Prolapse
manifest as
'ASSYMETRIC ZONES'
'BLUE FINGERS'
are both signs of
Ischemia

C-Maps as Navigational Tool





C-Maps as Navigational Tool

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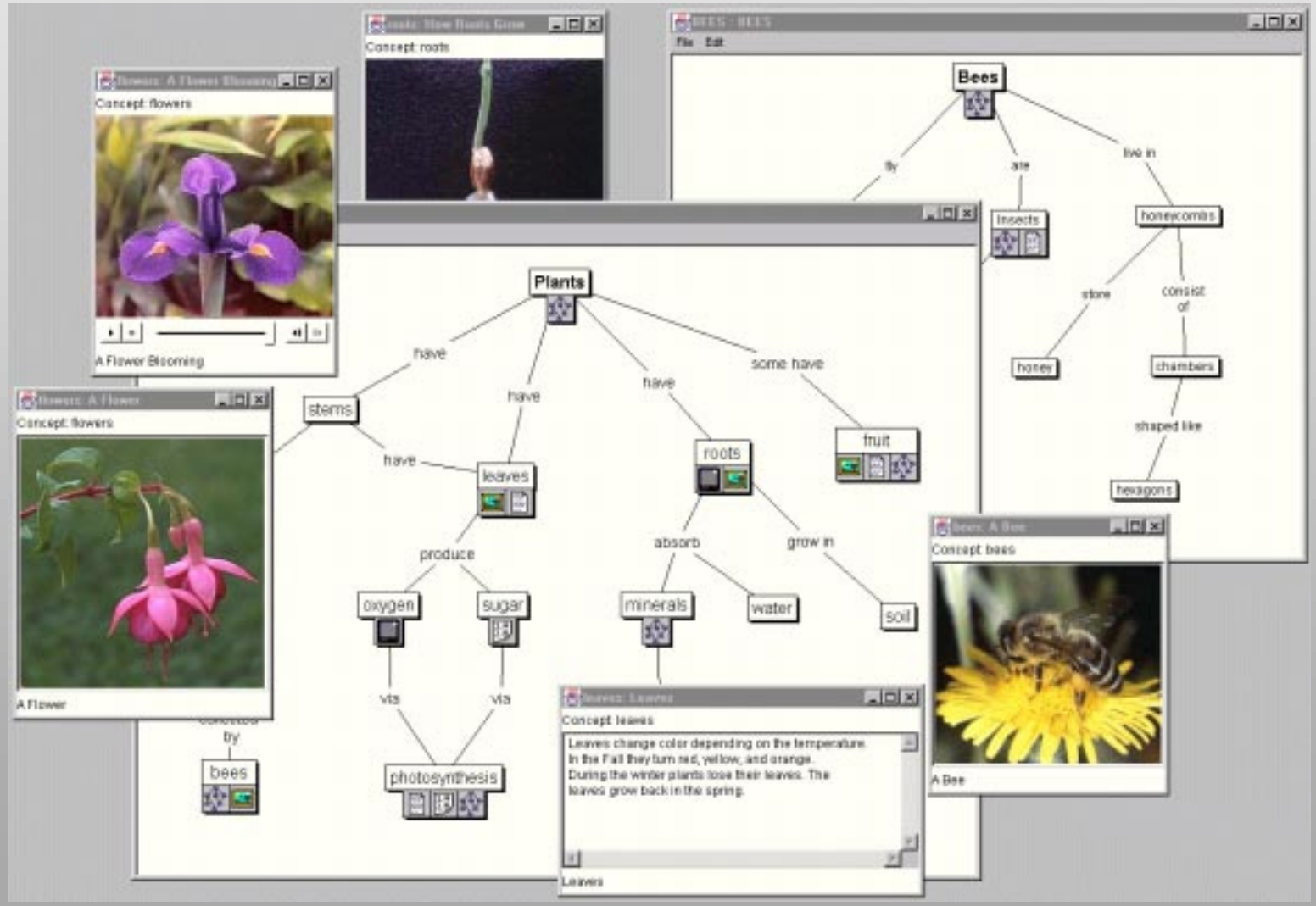
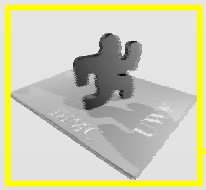
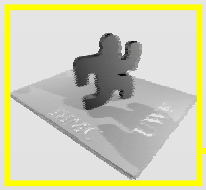




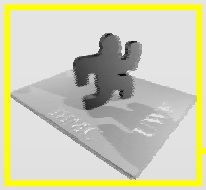
Browsable Model

- A concept map-based multimedia model elicited from a domain expert
- Allows hierarchical organization of knowledge from a general, top level, subsuming concept map, to highly detailed concept maps
- Concept maps are populated with icons that indicate other information sources - text, video, graphics, links to other maps, etc.



C-Maps as Navigational Tool

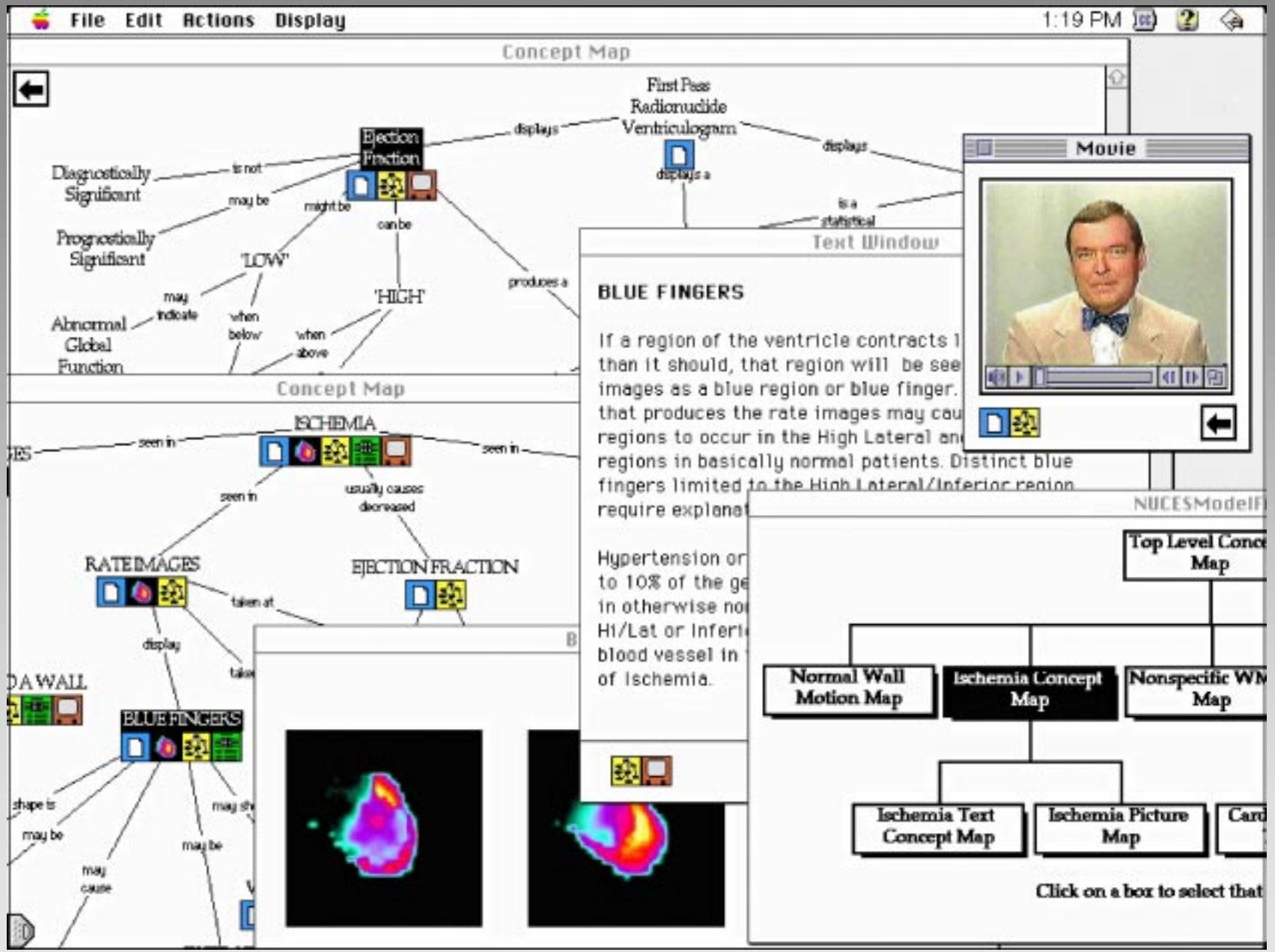
- Problems with browsers
  - where am I?
  - where do I want to go?
  - how do I get there?
- Advantages of C-Maps for navigation
  - navigation based on an expert's knowledge
  - links have semantics
  - concise representation



Complementing Projects: NUCES

NUCES: Nuclear Cardiology Expert System

- Grant from State of Florida
- Aid cardiologist and radiologist in diagnosis of heart disease -- interpretation of functional images of the heart
- Includes training component


File Edit Actions Display
1:19 PM
Concept Map
First Pass Radionuclide Ventriculogram
displays
displays a
displays
Ejection Fraction
Diagnostically Significant
is not
may be
might be
can be
Prognostically Significant
'LOW'
'HIGH'
may indicate
when below
when above
Abnormal Global Function
produces a
is a statistical
Movie
Text Window
BLUE FINGERS
If a region of the ventricle contracts l
than it should, that region will be see
images as a blue region or blue finger.
that produces the rate images may cau
regions to occur in the High Lateral an
regions in basically normal patients. Distinct blue
fingers limited to the High Lateral/Inferior region
require explanat
Hypertension or
to 10% of the ge
in otherwise no
Hi/Lat or Inferi
blood vessel in
of Ischemia.
Concept Map
ISCHEMIA
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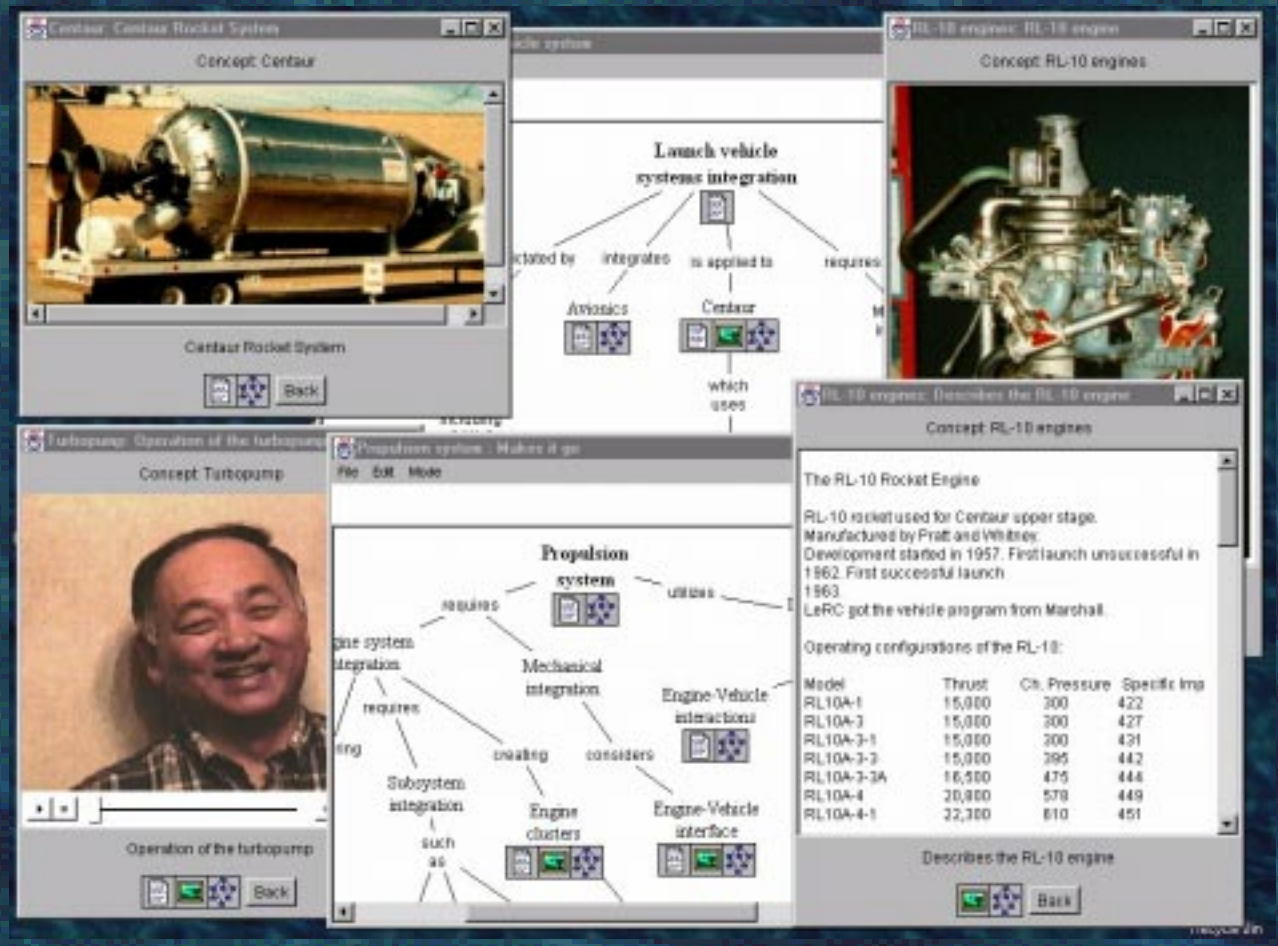
seen in
usually causes decreased
RATE IMAGES
EJECTION FRACTION
taken at
display
BLUE FINGERS
may be
may be
may cause
NUCESModelF
Top Level Conce Map
Normal Wall Motion Map
Ischemia Concept Map
Nonspecific WM Map
Ischemia Text Concept Map
Ischemia Picture Map
Click on a box to select that

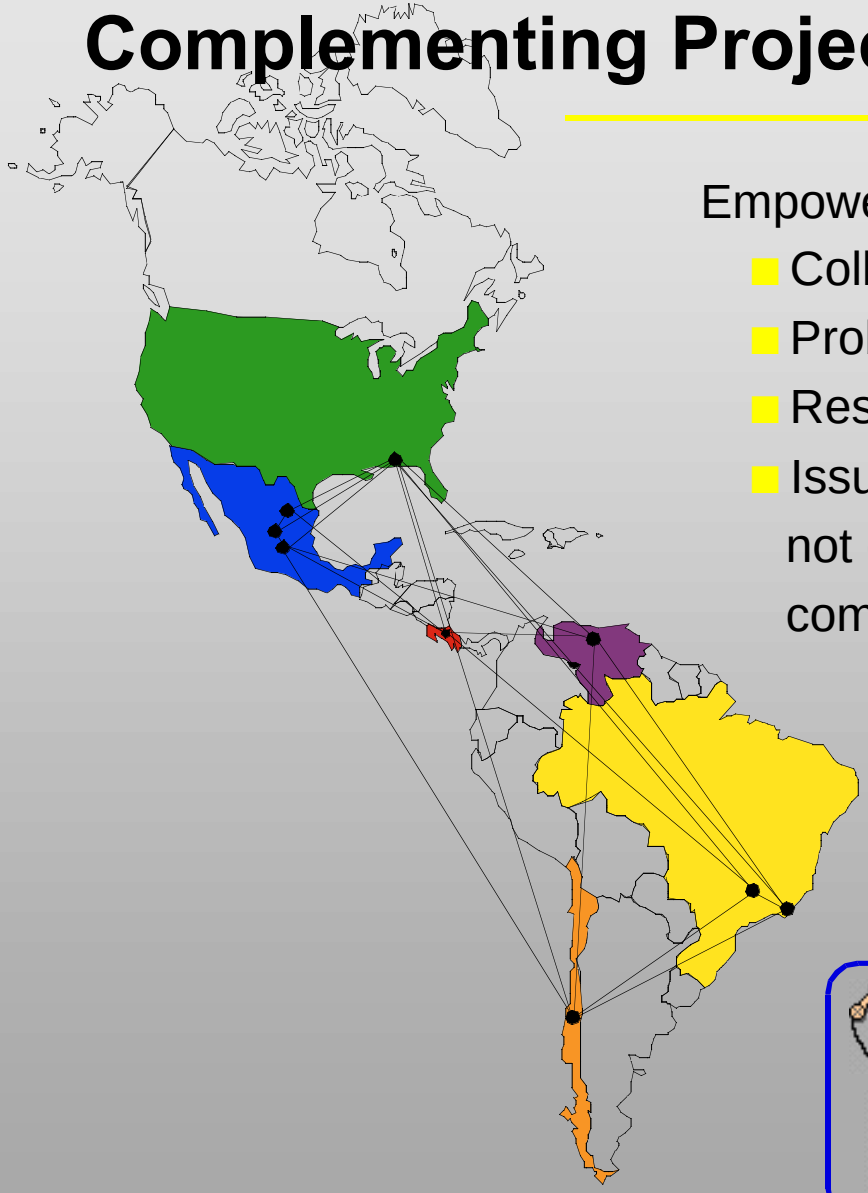
Complementing Projects: NASA LeRC

NASA Lewis Research Center

- Corporate Memory
- Preserve Senior Engineers' knowledge of launch vehicle systems integration with regard to the Centaur/RL-10 rocket system
- Prototype is a browsable, multimedia model of the experts' domain knowledge of the system

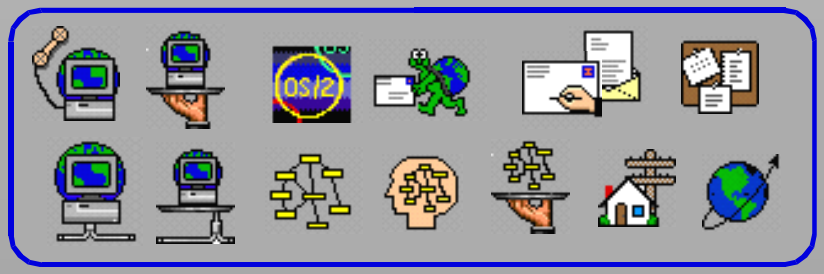


Complementing Projects: Quorum



Empower K-12 students of the region to:

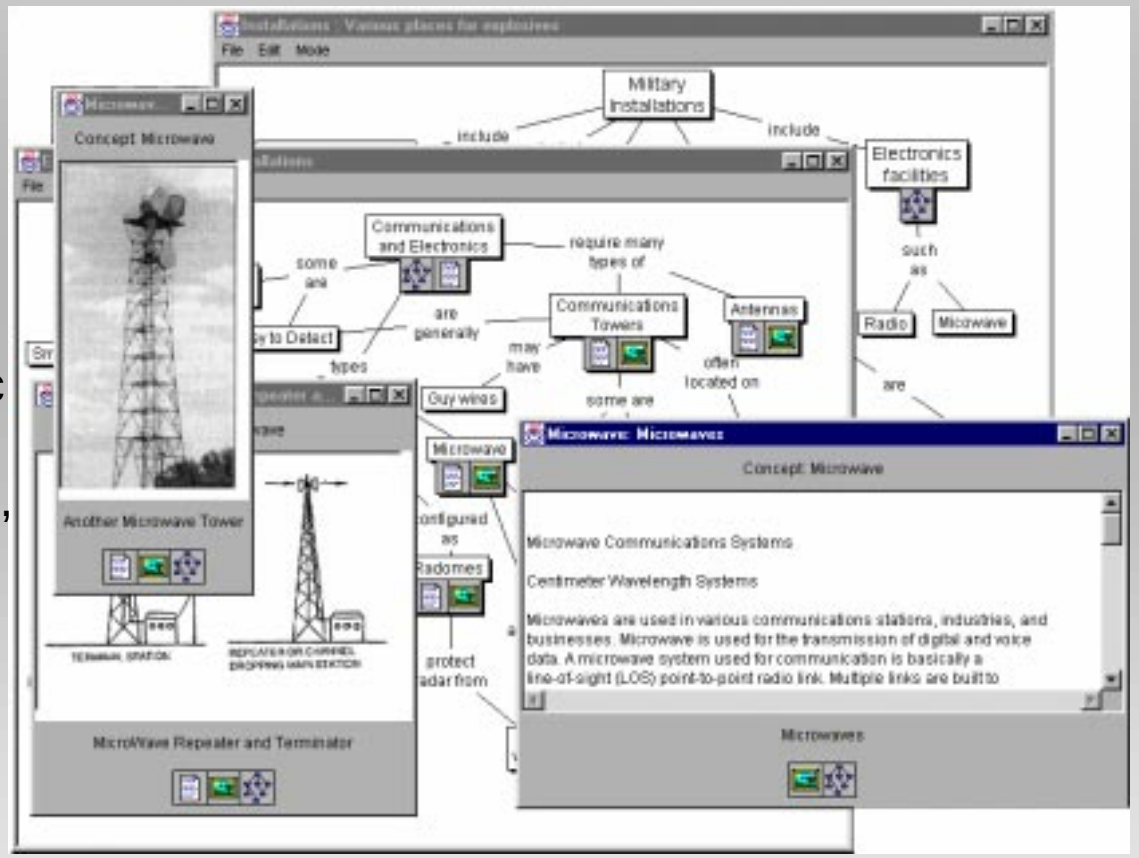
- Collaborate in their projects
- Problem solving
- Research
- Issues that are global in nature, involving not only problems of their own communities, but also other communities



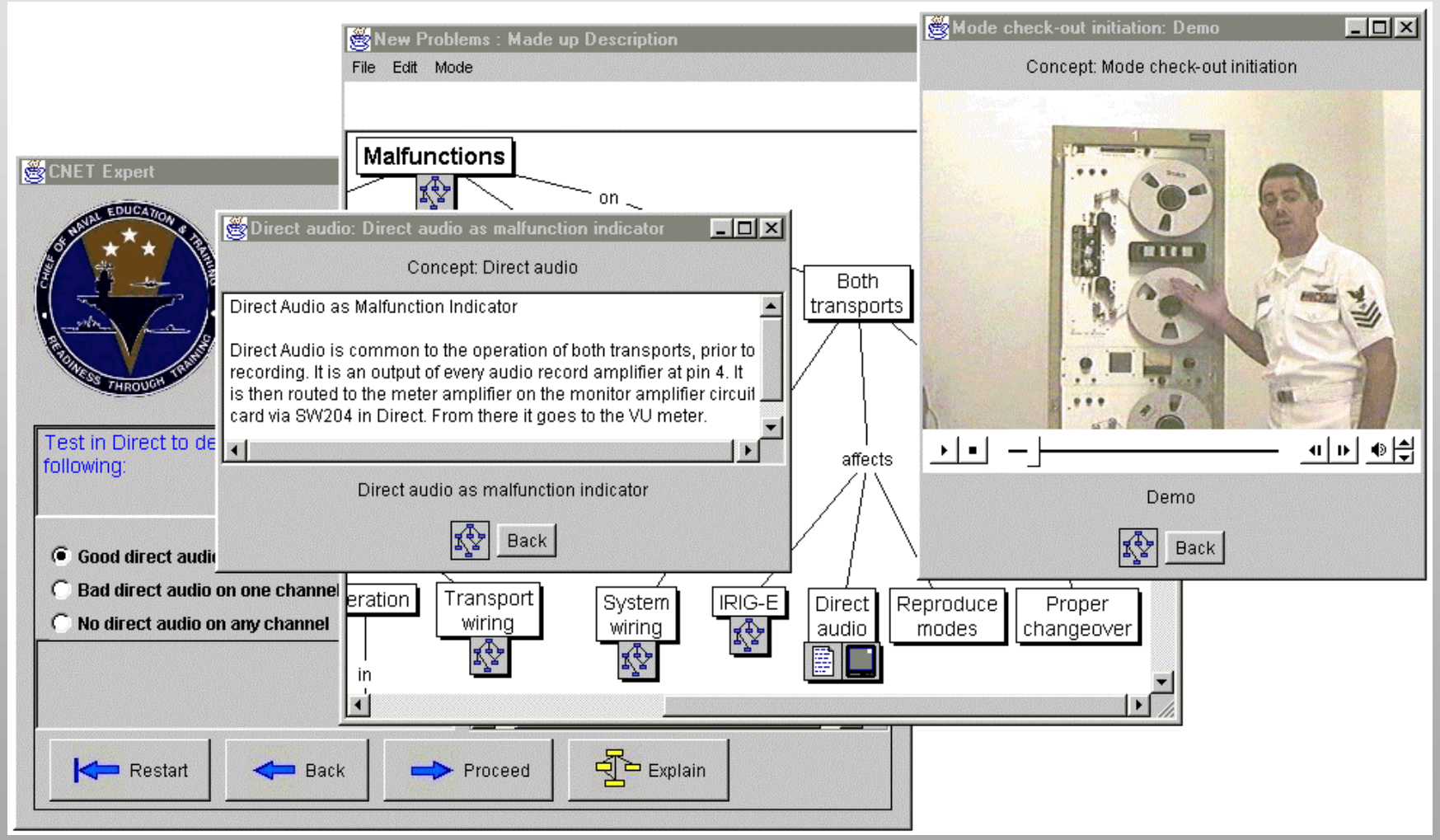
Complementing Projects: NIMA

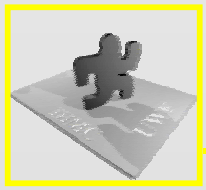
Distributed Performance Support System with Embedded Training

- Information sources for imagery analysts:
  - more diverse
  - more technically complex
  - multimedia oriented
- Provides domain-specific expertise to support the imagery analyst, anytime, anywhere



Complementing projects: Navy CNET

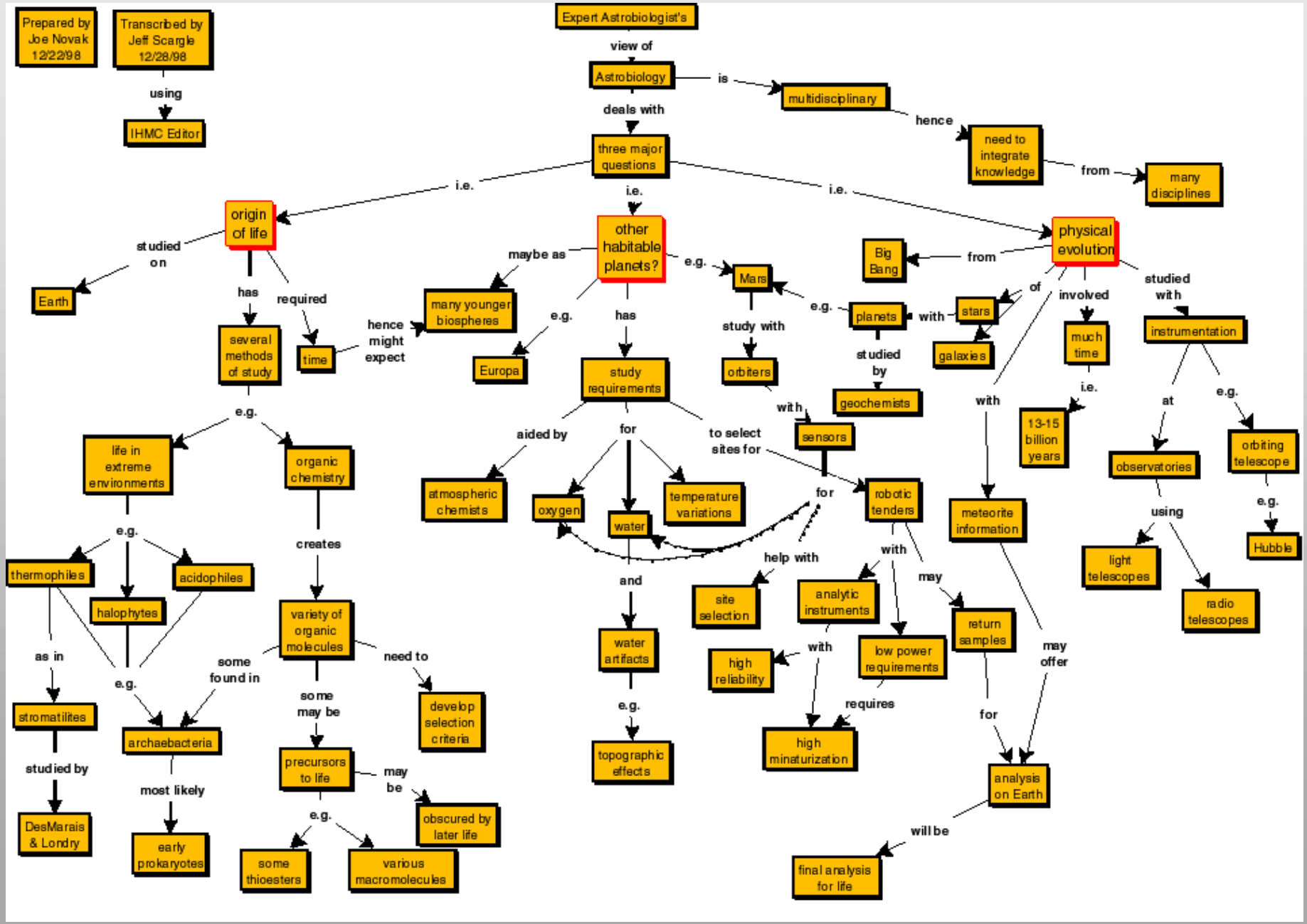


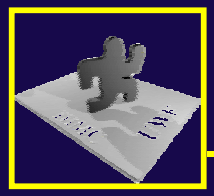


Development of software tools

- Provide a methodological and technological foundation for collaboration
- Empower users to:
  - construct,
  - experiment with,
  - navigate,
  - criticize,
  - and share

...knowledge models about specific topics though concept maps


Prepared by Joe Novak 12/22/98
Transcribed by Jeff Scargle 12/28/98
using
IHMC Editor
Expert Astrobiologist's
view of
Astrobiology
is
multidisciplinary
hence
need to integrate knowledge
from
many disciplines
deals with
three major questions
i.e.
origin of life
studied on
Earth
has
several methods of study
e.g.
life in extreme environments
e.g.
thermophiles
halophytes
acidophiles
as in
stromatilites
studied by
DesMarais & Londry
e.g.
archaebacteria
most likely
early prokaryotes
organic chemistry
creates
variety of organic molecules
some found in
some may be
precursors to life
e.g.
some thioesters
various macromolecules
may be
obscured by later life
need to
develop selection criteria
required
time
hence might expect
other habitable planets?
maybe as
many younger biospheres
e.g.
Europa
has
study requirements
aided by
atmospheric chemists
for
oxygen
water
temperature variations
and
water artifacts
e.g.
topographic effects
e.g.
Mars
study with
orbiters
with
sensors
to select sites for
robotic tenders
for
help with
site selection
with
high reliability
with
analytic instruments
with
low power requirements
requires
high minaturization
may
return samples
for
analysis on Earth
will be
final analysis for life
e.g.
planets
studied by
geochemists
from
Big Bang
with
stars
galaxies
of
involved
much time
i.e.
13-15 billion years
studied with
instrumentation
at
observatories
using
light telescopes
radio telescopes
e.g.
orbiting telescope
e.g.
Hubble
with
meteorite information
may offer



Mars - MarsCD2 - Jocote - CMap

File Edit

MARS

is

The Red Planet, Outer neighbor to Earth, 4th Planet from Sun

is source of

Myth and Science Fiction

has been subject to

Telescopic Study since Galileo's time

is one of nine

Planets

orbit

Sun

lies at center of

Solar System

lies within

Milky Way Galaxy

contains

Billions of Stars and, probably, Planets

formed

4.5 Billion Years Ago

has been subject to

Study by spacecraft since 1964

provides basis for

Mars Exploration Strategy

includes

Continued Search for Evidence of Life

includes

Understanding Mars as a way of better understanding Earth

provides evidence concerning

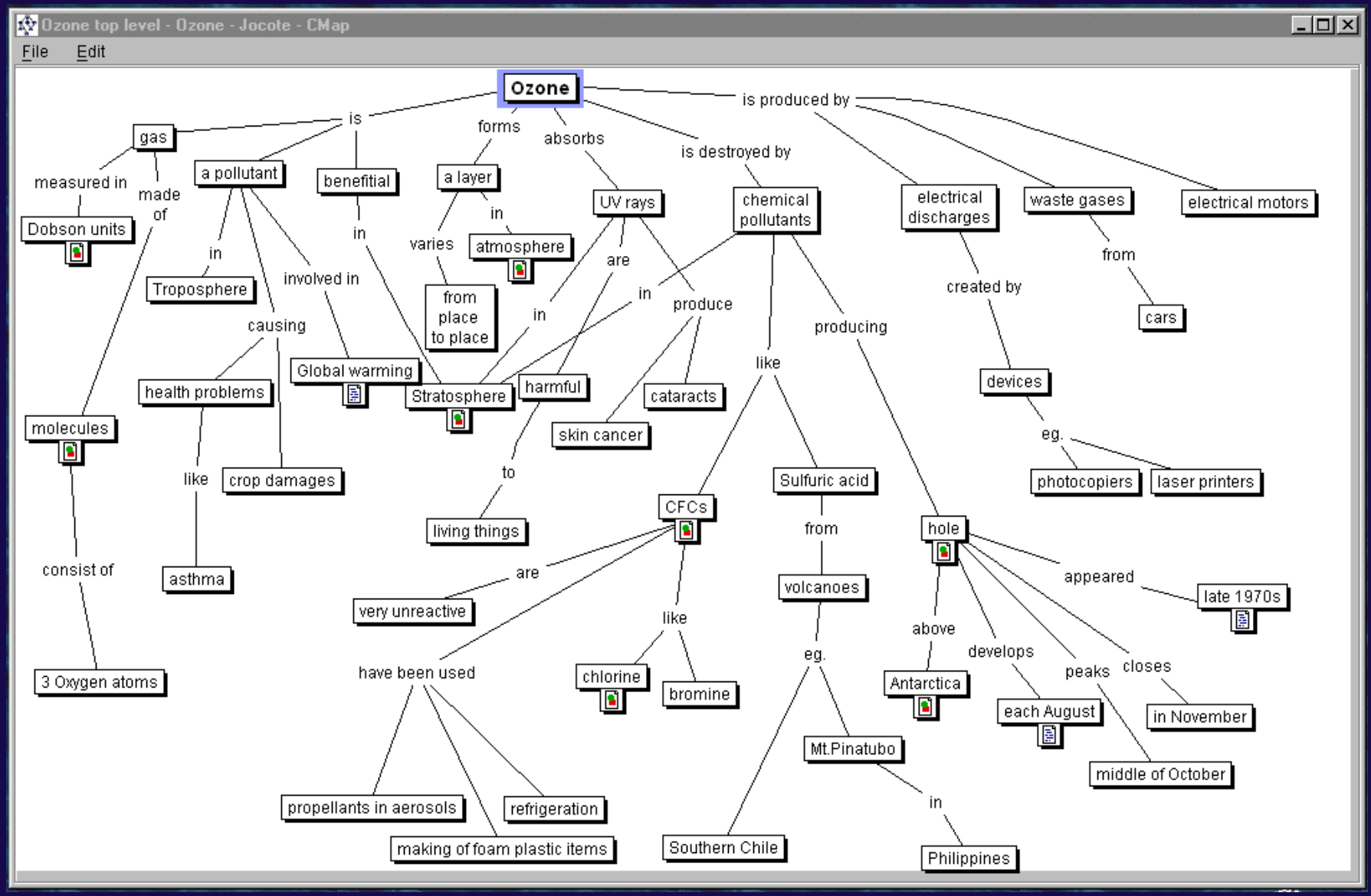
Mars as Potential Abode for Life

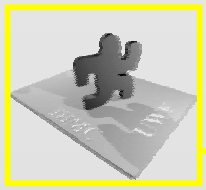
inspires

would help us answer question

raises question

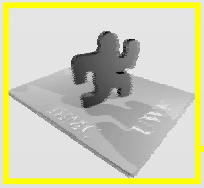
Is Life a common cosmic phenomenon?


Ozone top level - Ozone - Jocote - CMap
File
Edit
Ozone
is
gas
measured in
Dobson units
made of
molecules
consist of
3 Oxygen atoms
a pollutant
in
Troposphere
causing
health problems
like
asthma
crop damages
involved in
Global warming
benefitial
in
forms
a layer
varies
in
atmosphere
from place to place
absorbs
UV rays
are
in
Stratosphere
harmful
to
living things
produce
cataracts
skin cancer
is destroyed by
chemical pollutants
like
CFCs
are
very unreactive
have been used
propellants in aerosols
refrigeration
making of foam plastic items
like
chlorine
bromine
producing
Sulfuric acid
from
volcanoes
eg.
Mt.Pinatubo
in
Philippines
Southern Chile
is produced by
electrical discharges
created by
devices
eg.
photocopiers
laser printers
waste gases
from
cars
electrical motors
hole
above
Antarctica
appeared
late 1970s
develops
each August
peaks
middle of October
closes
in November



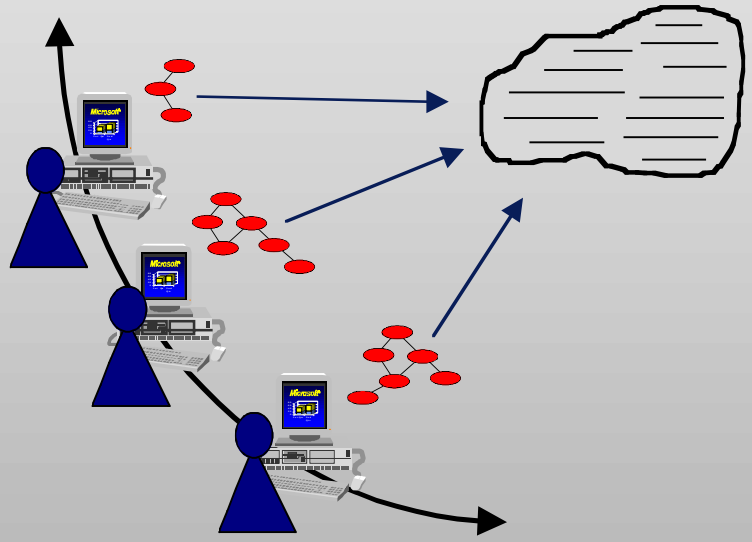
Collaboration Efforts / Intentions

- Criticism of concept maps, leading to discussion lists
- Collaboration in the construction of shared maps
- “Layers” of maps from various users
- Comparison and differences between concept maps
- Collaboration in the construction of individual concept maps (knowledge soups)



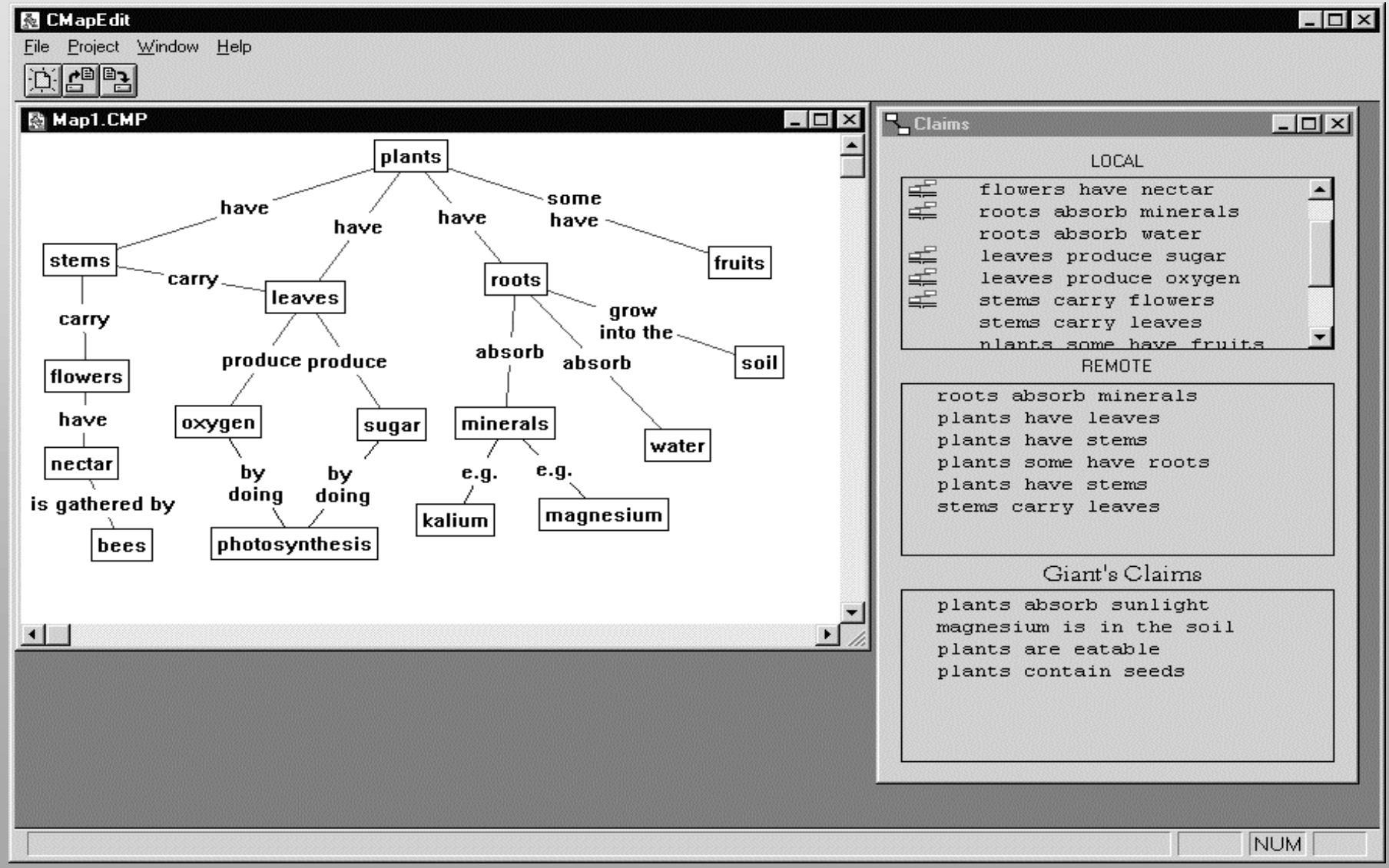
Knowledge Soups

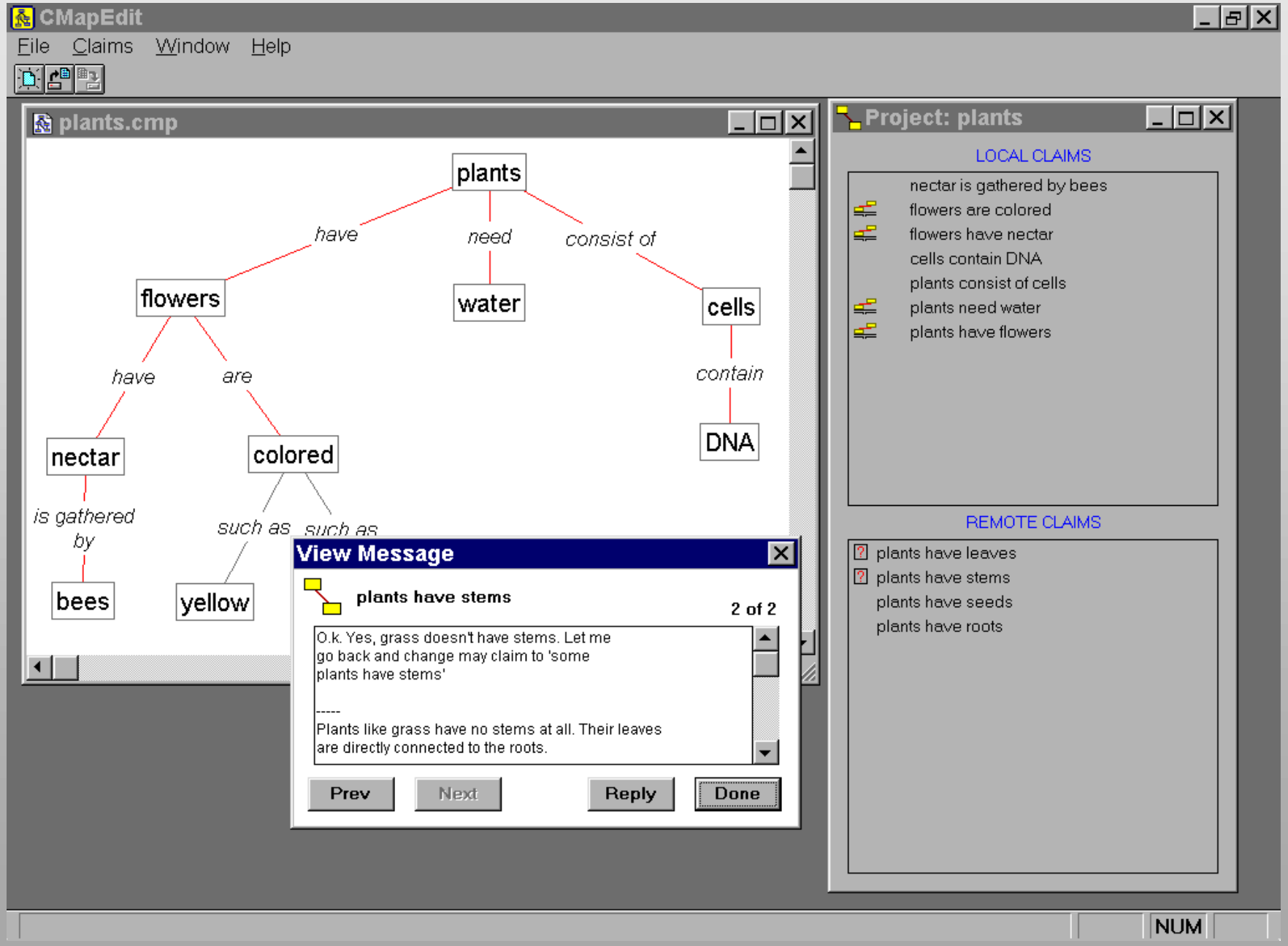
- Automatic or manual extraction of propositions to the user's local workspace
- User can select propositions and "publish" all or some of them (hence make claims to the public)
- Published propositions / claims become part of the knowledge soup



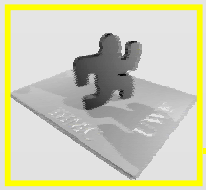
- System searches claims in the knowledge soup and presents them on the user's workspace (remote claims)
- Only claims related to the user's own claims will be presented

Knowledge Soups



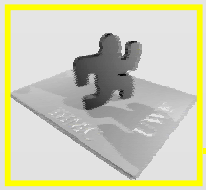

CMapEdit
File Claims Window Help
plants.cmp
plants
have
need
consist of
flowers
water
cells
have
are
contain
nectar
colored
DNA
is gathered by
such as
such as
bees
yellow
View Message
plants have stems
2 of 2
O.k. Yes, grass doesn't have stems. Let me go back and change may claim to 'some plants have stems'

Plants like grass have no stems at all. Their leaves are directly connected to the roots.
Prev
Next
Reply
Done
Project: plants
LOCAL CLAIMS
nectar is gathered by bees
flowers are colored
flowers have nectar
cells contain DNA
plants consist of cells
plants need water
plants have flowers
REMOTE CLAIMS
plants have leaves
plants have stems
plants have seeds
plants have roots
NUM



Publishing & Peer Review

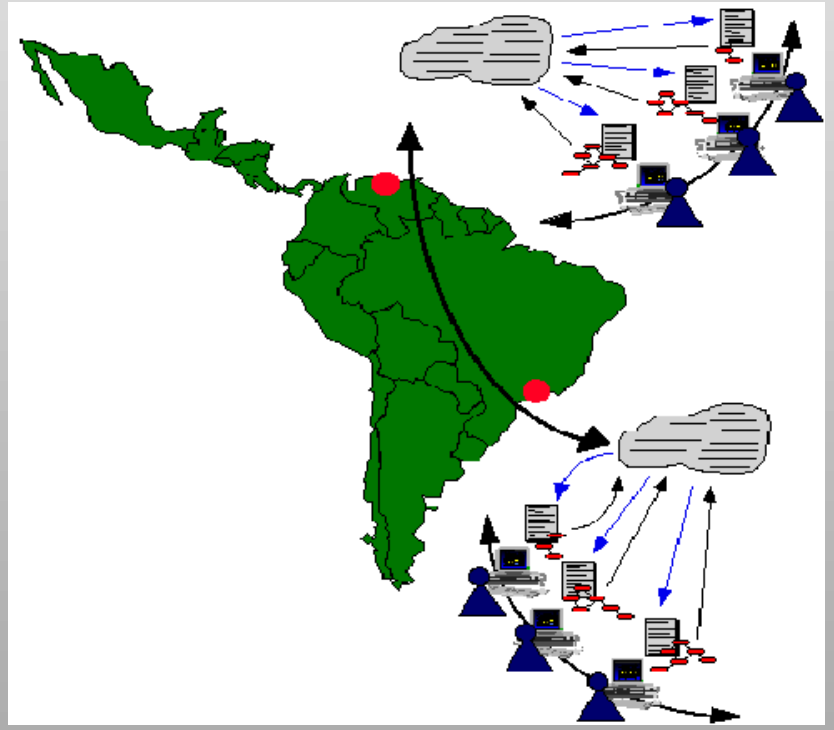
- Public claims can be seen by others and can be utilized in their own map-building process
- User only sees claims that are directly related to the ones she contributed to the soup
- A user can query a claim submitted by another user, if she disagrees with it or finds it puzzling, and the originator of the claim can respond
- Discussion threads are attached to specific knowledge claims — users only see dialogs that are related to claims they themselves have published — and hence that they can contribute to

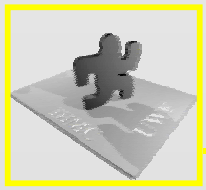


Soups from Distant Lands

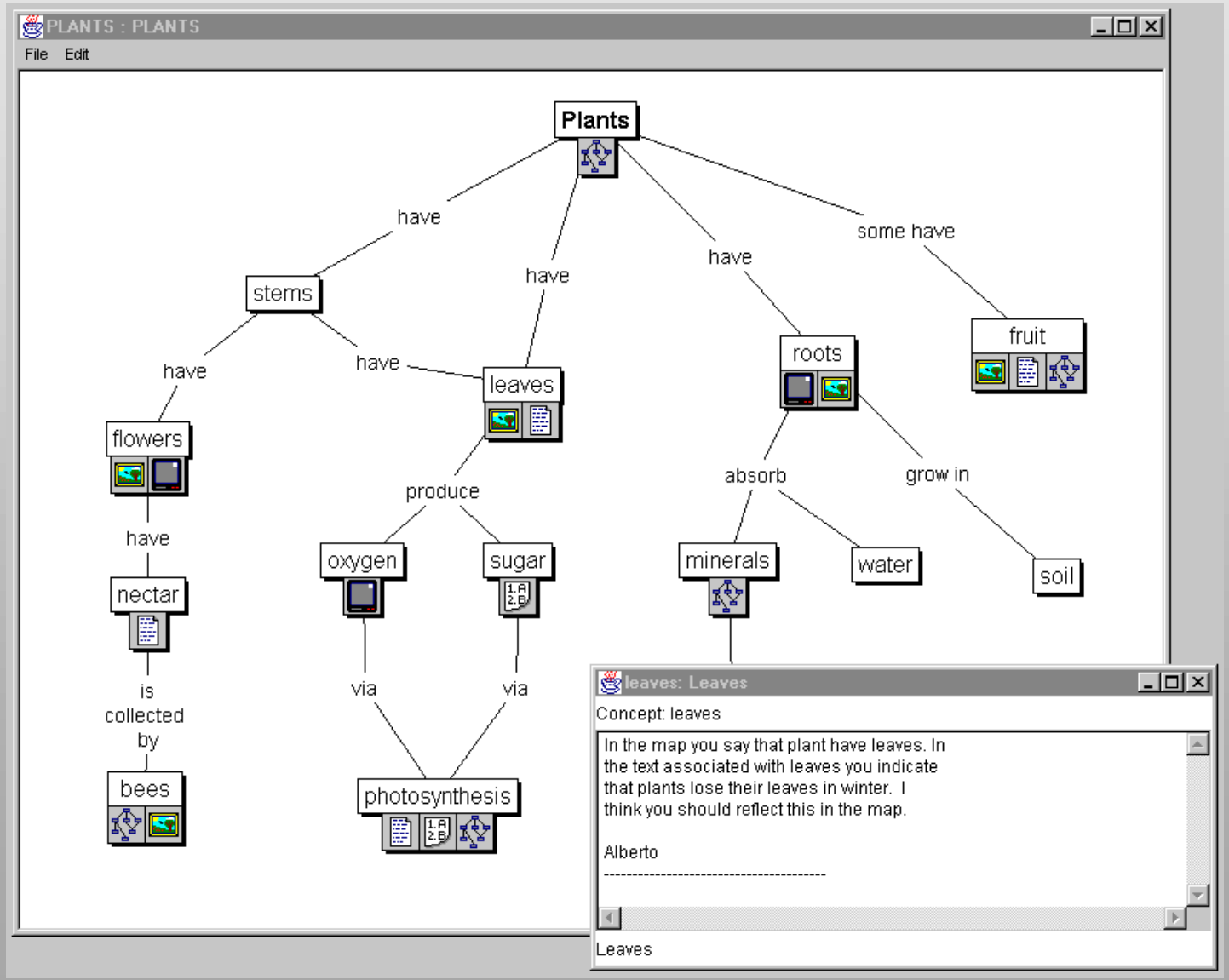
- Soups can be made public for access by students in other classrooms, regions, or countries
- A teacher can import a knowledge soup from another classroom (or school)
- Result:

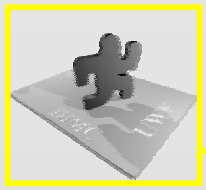
  A "kettle" of knowledge soups, collaboratively developed by students and available to other students for their use in their knowledge construction





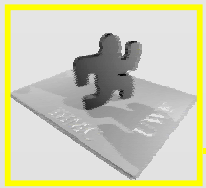
Constructive Criticism while Browsing



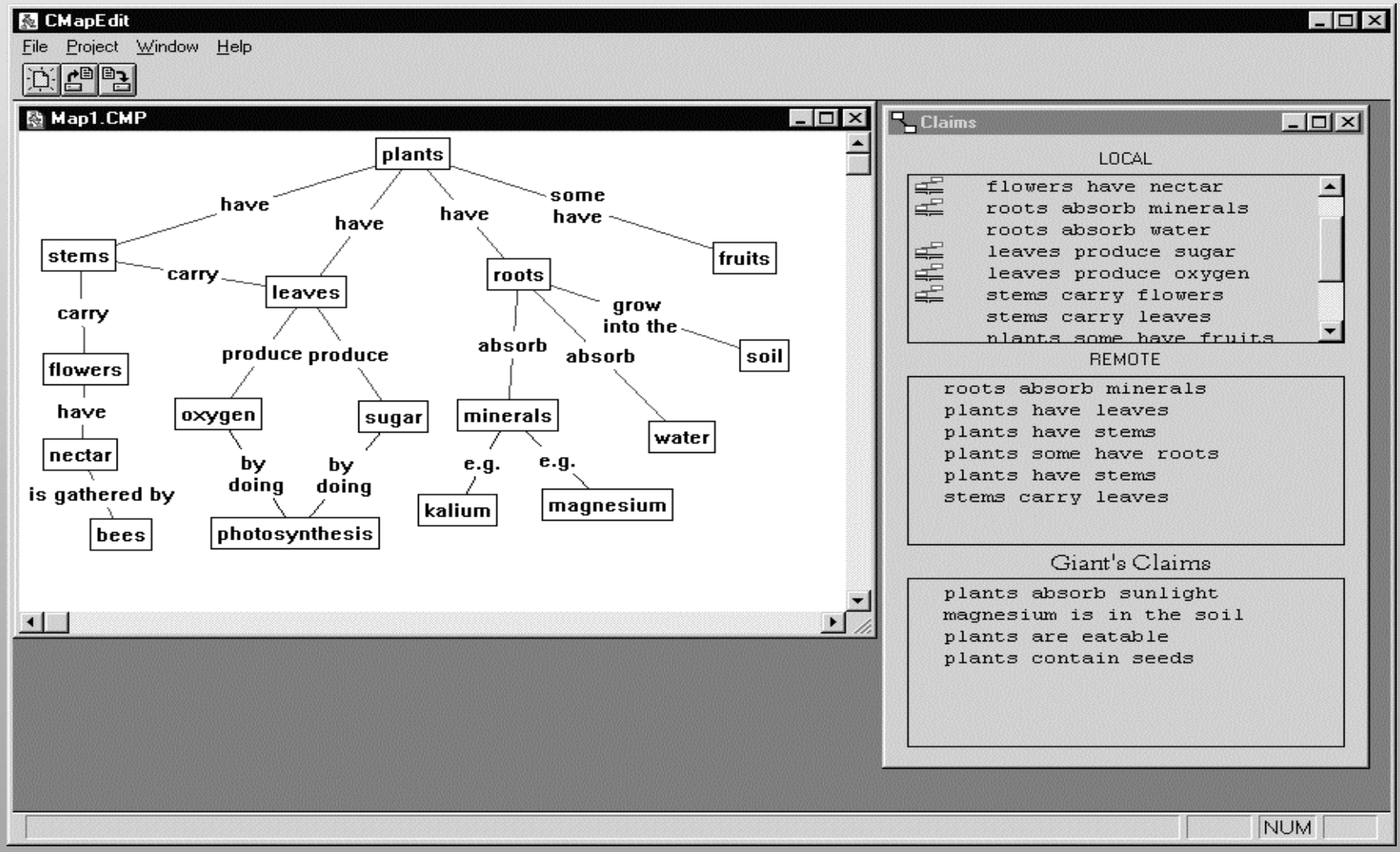


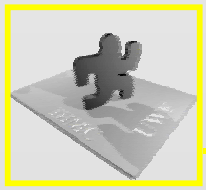
Giant: Artificial Idiot (AI)

- Goal: creating a tool that interacts with students
- Giant knows
  - claims of the student
  - concepts and links in the concept map
  - claims in the knowledge soup
- Giant's tasks include
  - comparing one student's claims with claims from the knowledge soup
  - drawing plausible conclusions using simple heuristics
  - using conclusions to create claims and questions



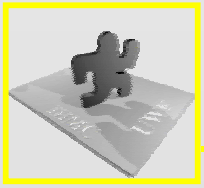
Giant's Environment





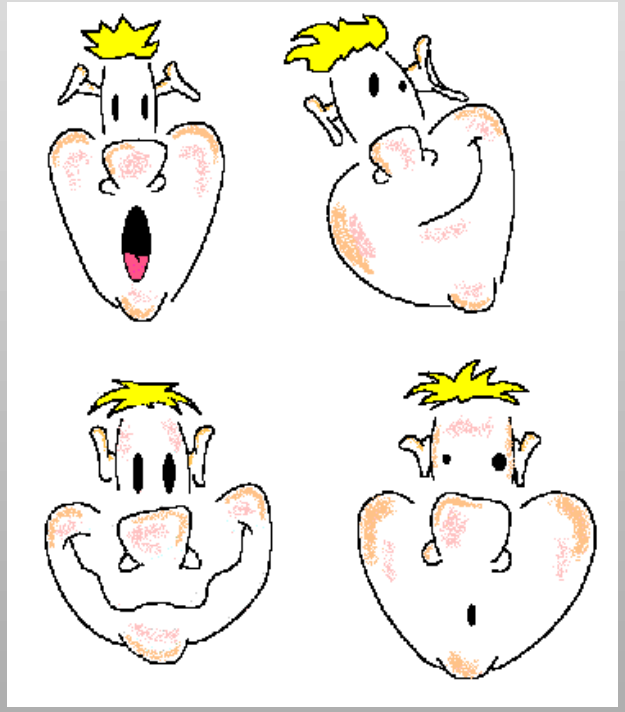
Giant's Behavior

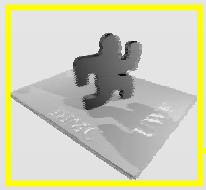
- Stimulates the student's work by
  - making new claims using the information in the soup
  - forcing student to reconsider claims
  - asking questions
- Is not judging the student's work
  - giant does not know if a claim is correct or not
- Knows a lot but still may act ignorant
  - giant can not distinguish between interesting and boring claims
  - giant selects claims from the soup randomly



Behavior and Appearance

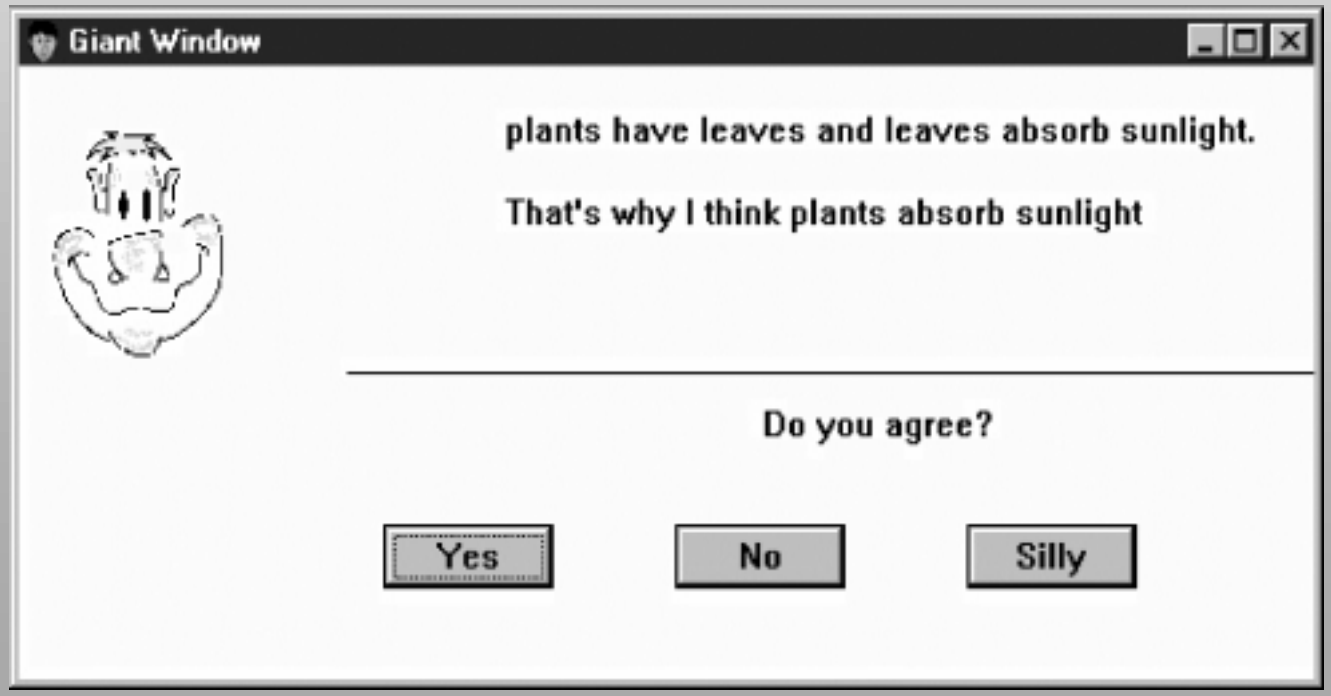
- Giant's artificial 'personality'
  - friendly, eager learner
  - does not intrude upon student
  - works in the background and generates own claims
  - displays own 'understanding' of the world
  - generates mostly interesting, but sometimes less intelligent, conceptually incorrect conclusions
  - 'knows' a lot but lacks common-sense

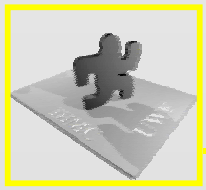




Giant's Reasoning

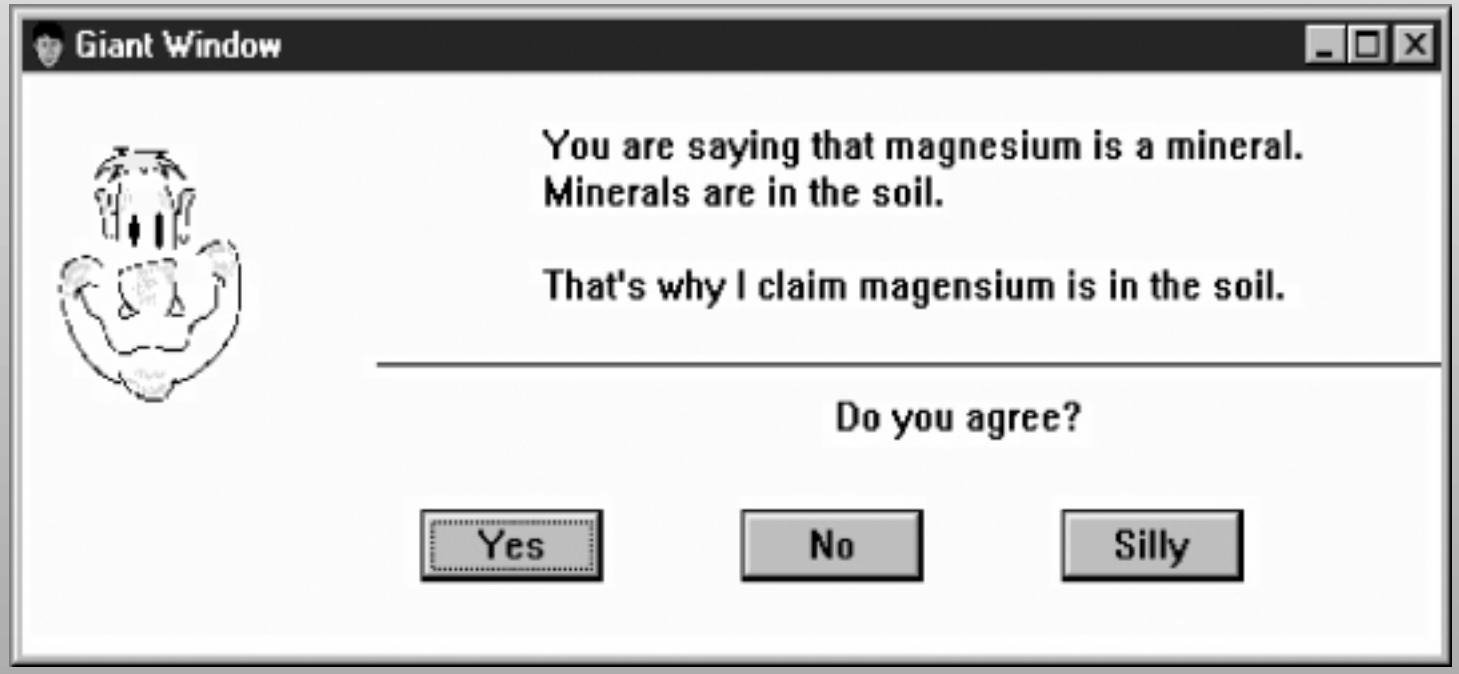
- Students can ask for an explanation of the giant's claim
- Giant explains reasoning and asks student for verification

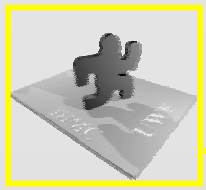




Giant's Reasoning

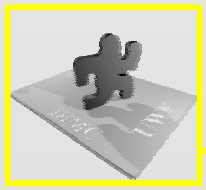
- Student becomes a teacher to the giant





Further research

- Context information collected during navigation as support for:
  - Support in Case-Based Reasoning
  - Knowledge Discovery
- Support tool for research
- Agent based searching



Summary

- Concept Maps as a flexible tool for
  - construction,
  - organization,
  - navigation,
  - criticism,
  - sharing of knowledge