A Strategy for Global Observation of Forest Cover

Executive Summary

Draft for comments, Version 1.2

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1.1 GOFC as a CEOS response to global concerns

As the twentieth century draws to a close, there is an emerging global consensus that the cumulative effects of past and present human activities are having a global impact on the Earth's ecosystems, atmosphere, and climate, and that steps must be taken to improve our knowledge and change policies and management practices throughout a broad range of human activities.

The international support for the Kyoto Protocol of the Framework Convention on Climate Change, together with earlier support for the International Convention on Biological Diversity, represent the first steps down a long, difficult path toward a sustainable future on the Earth.

Forests play a central role in the issues of greenhouse gasses, climate change, and biodiversity. In a general sense, the role forests play in the carbon and water cycles, and in providing rich habitat for diverse plants and animals, is well known. However, much additional research is required to understand the detailed role of forests. Scientists working on many aspects in the field of global change require global, regional, and local observations of forests to develop a better understanding of the complex, inter-related processes involved. At the same time, policy makers realize that we cannot afford to wait until all of the scientific questions are solved; global observations of forests are needed to monitor changes in the Earth's forests and provide objective, quantitative information to assess progress toward long-term objectives. As a result of the Kyoto protocol, particular emphasis is placed on reforestation, afforestation, and deforestation,

Earth observation satellites have been providing data for natural resource management since 1972. The data from these satellites has been widely used to map and monitor forest resources. However, these efforts have generally been made as individual projects within individual jurisdictions, such as states, provinces, or forest management units.

More recently, the global change science community, the United Nations Food and Agriculture Organization, and a number of national and regional efforts have worked to use earth observation data to create a consistent regional and global pictures of the earth's forests, and to monitor changes in the forests worldwide. These efforts have shown the difficulties involved and the progress needed in assembling continental and global data sets to address the science and policy questions surrounding forests.

Recognizing the accomplishments to date, but also the shortcomings, the Committee on Earth Observation Satellites has initiated a program of Global Observation of Forest Cover as part of its Integrated Global Observing Strategy. The objectives are to increase international cooperation in the integration and use of data from multiple earth observation satellites, in conjunction with in-situ data, for mapping and monitoring the earth's forests, and to provide feedback to the space agencies to enable them to better coordinate future space missions. GOFC will develop the means to undertake operational inventories of forest cover, fire and forest biophysical characteristics using satellite data.

1.2 What GOFC has accomplished, and what can be expected from GOFC

Since July 1997, teams of scientists, remote sensing specialists, and knowledgeable representatives from user organizations have been meeting and planning a strategy to lead to ongoing global observation of forest cover. In this process, we have endeavored to reach out and obtain input from a broad spectrum of user groups, in addition to drawing heavily from persons with the greatest current experience in assembling and processing large regional and global datasets. We have held six international workshops, first to outline a GOFC concept, and then to produce this detailed strategy document. More than fifty specialists from fifteen countries and seven international organizations have participated in this design process. During this same period, the GOFC project leader held briefing meeting with twenty-six international organizations, scientific bodies, forest management agencies, non-governmental organizations, and earth-observation agencies to inform them about the GOFC concept and obtain their feedback.

As a consequence of these interactions, GOFC has already resulted in increased dialog with international organizations, science bodies, forest management agencies, and non-governmental organizations which require forest information.

This document presents our strategy. The essence of our strategy is to develop and demonstrate operational forest monitoring at regional and global scales by developing prototype projects along three primary themes:

- Forest Cover Characteristics and Changes
- Forest Fire Monitoring and Mapping
- Forest Biophysical Processes

As part of this process, we propose to assemble teams to execute prototype projects, develop consensus algorithms and standard methodologies for product generation and product validation in conjunction with in-situ measurements, and develop and demonstrate procedures for improved data access for the user community.

As a consequence, we will identify gaps and overlaps in earth observation data, ground systems, methods, and scientific knowledge from the experience gained in developing and executing GOFC prototype projects. The ultimate objective is to lead to sustained, on-going operation without the need for major funding by CEOS members. Additionally, GOFC will

- Create and strengthen partnerships between CEOS members and user agencies;
- Identify gaps and overlaps in CEOS member programs and make recommendations how these might be resolved;
- Lead to increased operational use of earth-observation data for policy decision making at national, regional, and global levels;
- Provide validated products which can be used to derive credible information concerning the forest component of the carbon budget for research and policy use;
- Promote common data processing standards and interpretation methods, which are necessary for inter-comparison of regional studies;
- Stimulate advances in the state of the art in the management and dissemination of large volume datasets and information from multiple sensors;

- Use data from multiple sensors, in combination with in-situ data, to produce validated prototype information products which satisfy clearly identified requirements of user agencies;
- Enhance the use of earth-observation information products for forest management and scientific research concerning forest biophysical processes.

1.3 CEOS Support Required

To succeed, GOFC will require support from CEOS as a whole, and from individual CEOS members who choose to become involved in GOFC projects. The IGOS partnership mechanism must help form meaningful partnerships with forest management, policy and science communities, and funding agencies. CEOS agencies will be requested to provide essential data for the pilot projects. This requirement will extend beyond the production of primary data products to the provision of support for the production of derived products. Just as important, it will be necessary for many organizations which produce earth observation data products from raw data to update their production systems to provide for increased automation and large volume processing, in order to reduce the costs of earth observation data so that global observation of forest cover becomes economically feasible. CEOS member agencies will also be asked to conduct and promote targeted R&D on science and technical issues identified by GOFC and its partners.

WGISS and WGCV have already played an important role in the development of GOFC. The support of individual WGISS and WGCV working groups will be essential for addressing and resolving further technical issues which arise in the development and execution of GOFC pilot projects.

1.4 Primary Themes

We believe that the best way to make demonstrable progress toward widespread operational use of earth observation technology to address forest issues is through a suite of well-considered pilot projects. Each must provide information of value to user communities with clearly stated requirements. Each must be achievable using proven technology, although an integrated system may not yet exist. Through the course of execution of the pilot projects, CEOS member agencies and participants will benefit from increased communication, and technological capabilities will be expanded. Strategies will be developed and funding sources will be identified to make the transition to on-going routine operation. GOFC has adopted the approach of involving the operational users in the design of these pilot activities so as to ensure adoption by the operational agencies at the completion of the pilot phase.

We identify three primary themes:

- Forest Cover Characteristics and Changes
- Forest Fire Monitoring and Mapping
- Forest Biophysical Processes

GOFC can make a key contribution to all of these by providing integrated datasets from multiple sensors.

Forest cover characteristics and changes: This is the most important but the most challenging of the proposed themes. The products have the greatest appeal to the widest spectrum of users including forest resource managers, policy makers, and scientists studying the global carbon cycle and

biodiversity loss. We propose a systematic program for periodic mapping of land cover at coarse resolution (250 – 1000 m) on a five year cycle, combined with periodic mapping and monitoring of forested areas at fine (~25 m) resolution. Very large datasets must be acquired, assembled, processed, and analyzed from coarse resolution optical sensors, fixed and pointable fine resolution optical sensors, and SAR sensors. Most of the needed technology has been demonstrated, but assembling coordinated systems to generate the required products will be very challenging. The proposed approach is shown schematically in Figures 1 and 2.

Forest Fire Monitoring and Mapping: The global increase in wildfire following the 1997-98 el Niño event has served to emphasize the urgent need for improved information from CEOS members' space systems. Data from existing and near-term coarse resolution sensors can satisfy most of the information requirements, and automated algorithms for much of the information extraction have been demonstrated. A distributed network of low cost receiving and processing facilities could satisfy many of the requirements for operational fire monitoring and mapping. The proposed approach is shown schematically in Figure 3. At the same time there are clearly defined areas where additional research can improve and validate information extraction. Cross-linkages with the forest cover characteristics and changes theme and the forest biophysical processes theme will provide additional information on fuel consumption and gas and aerosol emission. At the same time, information from this theme will be a valuable input into the other two themes as an indicator of forest disturbance and gas and aerosol emissions. We continue to collaborate with the with the IGOS Disaster Management Support Project to harmonize our efforts.

Forest biophysical processes: This theme reflects a key component of the sizeable effort to use earth observation data to understand, and eventually balance, the earth's carbon budget. With the signing of the Kyoto protocol in 1997, information on the carbon cycle now has policy as well as scientific implications. The major goal for this objective is to quantify net primary productivity of forests, combining satellite data with ecosystem process models. The approach is shown schematically in Figure 4.

Figure 1: Forest Cover Characteristics
(Centrally coordinated/regionally executed)

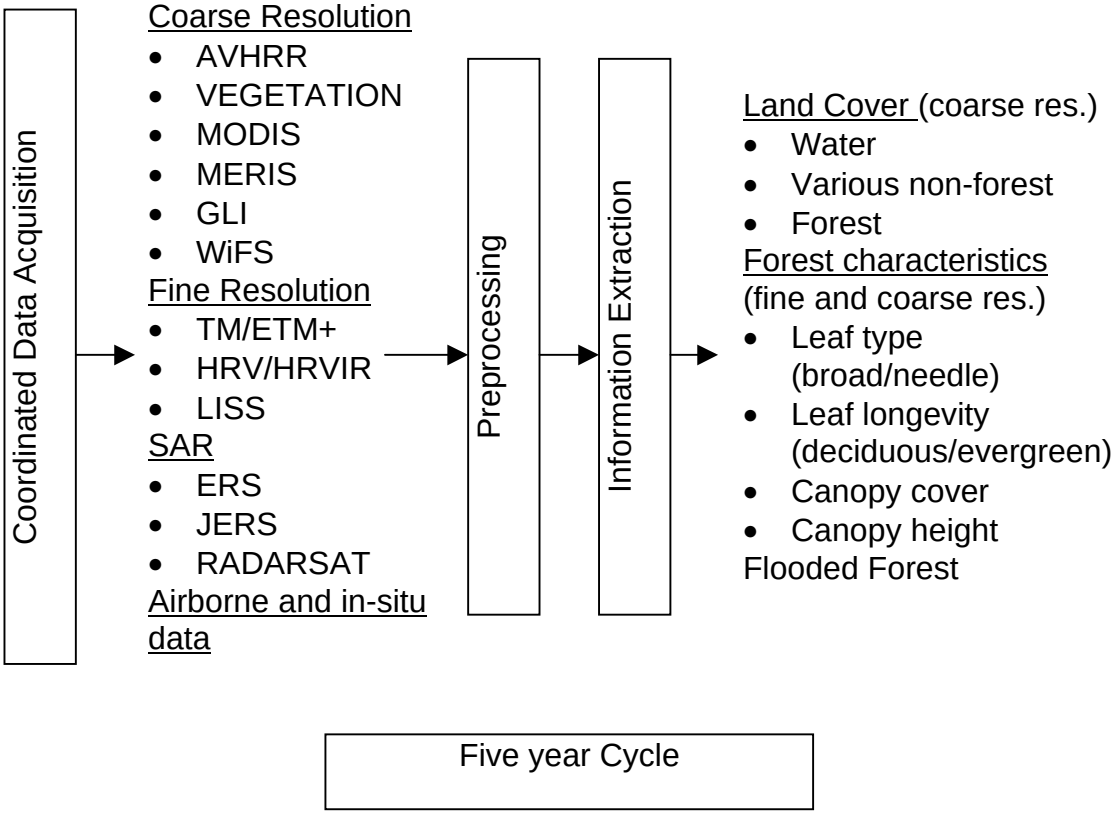


Figure 2: Forest Cover Changes
(Centrally coordinated/regionally executed)

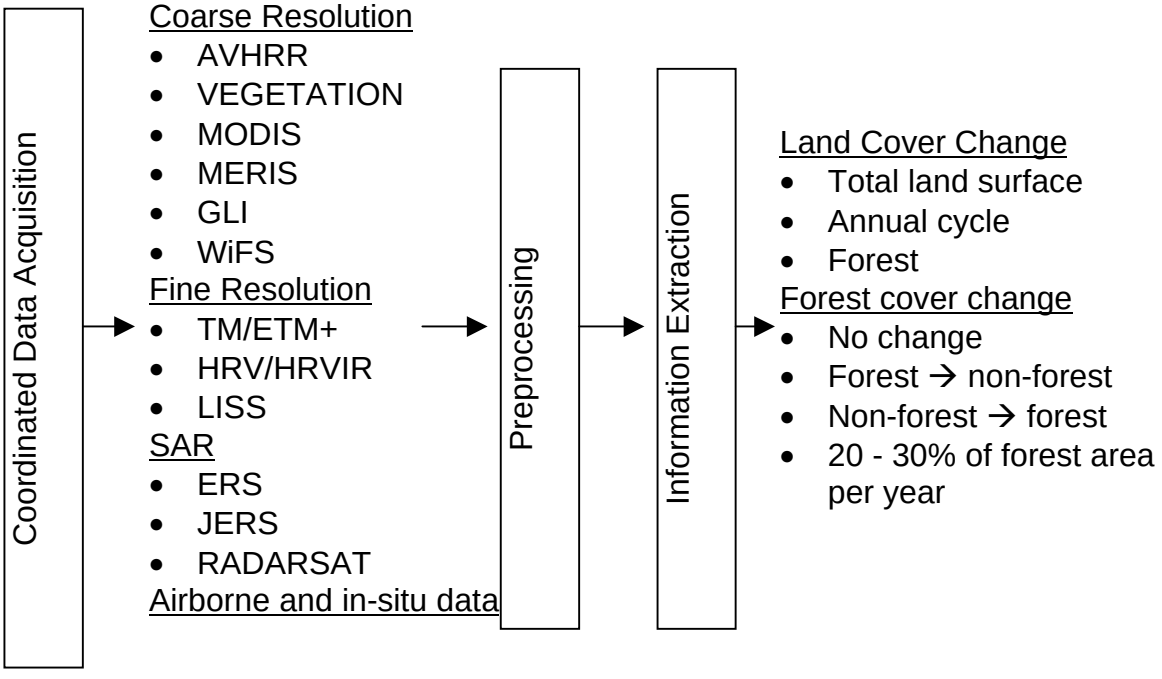


Figure 3:Forest Fire Monitoring and Mapping
(Centrally coordinated/regionally or nationally executed)

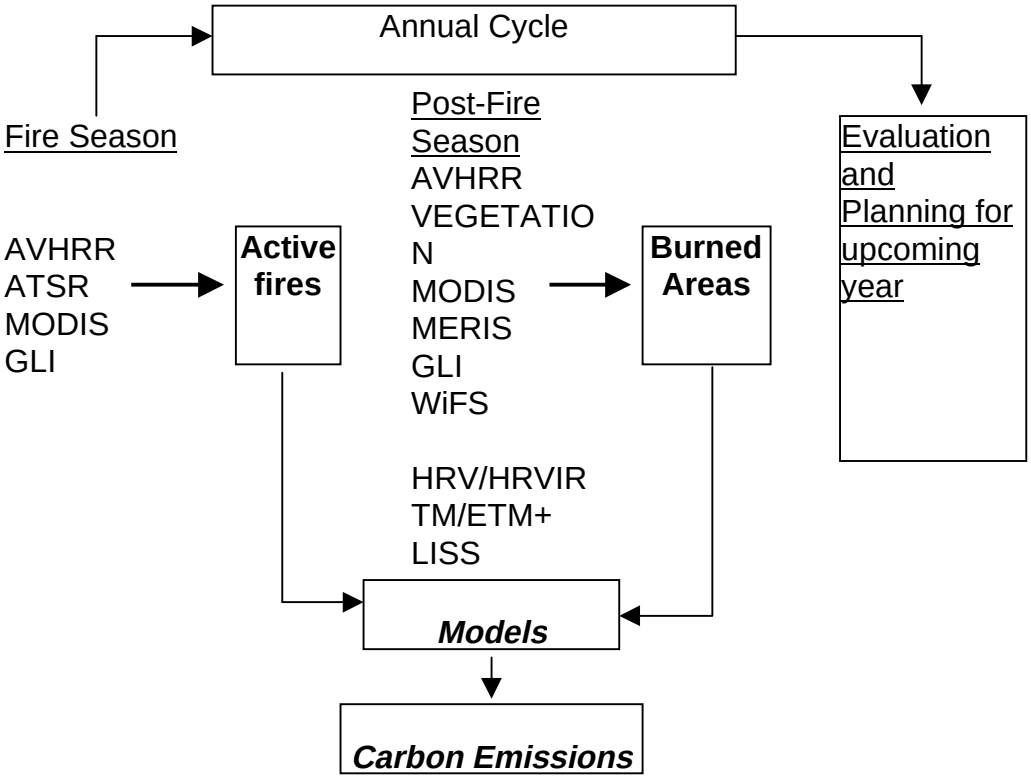
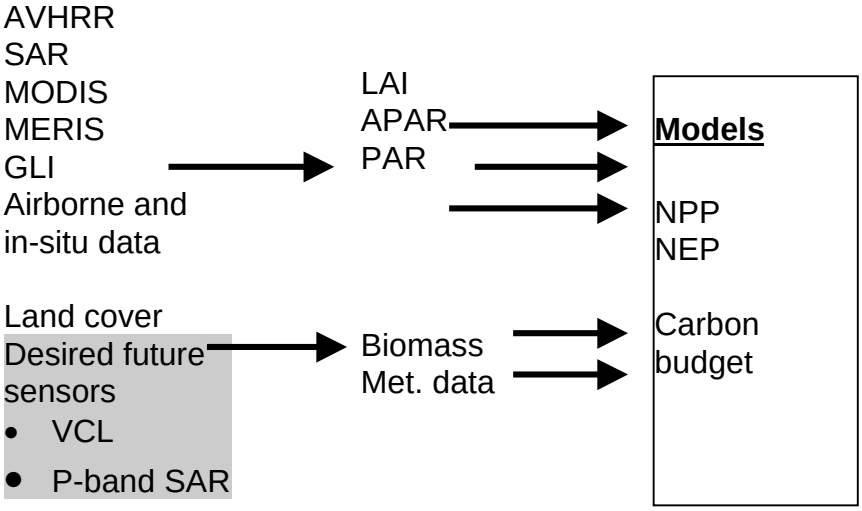


Figure 4: Forest Biophysical Processes
Confederation of Investigation Teams

- National/regional
- Global

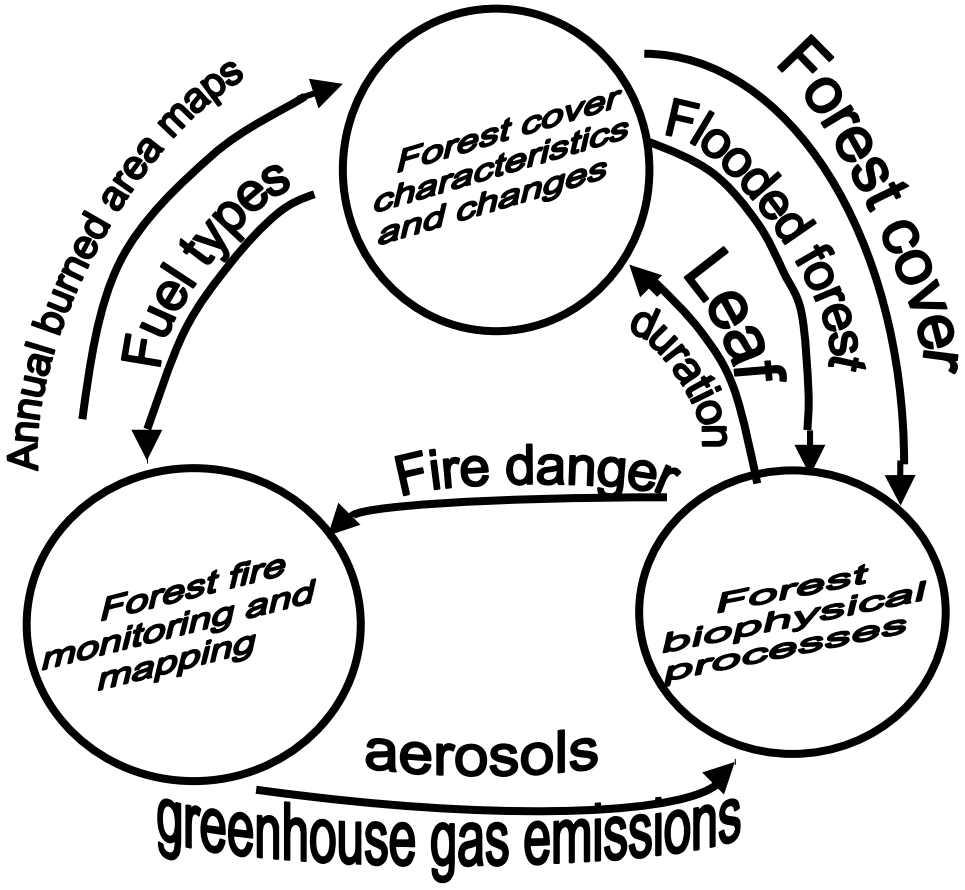


AVHRR research
EOS research
MERIS research
GLI research

In conjunction with IGBP, GOFC could provide a mechanism to coordinate

Each of these themes of GOFC could be implemented as called for in this document and result in significant progress. But the natural interconnections (shown in Figure 5) make an implementation of all three components significantly stronger than simply the sum of the three parts.

Figure 5: Linkages between GOFC themes



While much progress in this area will take place independently of GOFC, GOFC can contribute to a more integrated global approach by:

- Providing opportunities to inter-compare results from different sensors and different algorithms;
- Providing linkages to organizations such as GTOS which can facilitate the sharing of in-situ observations.
- Promote ground observation networks and campaigns to validate forest biophysical process products.

1.5 Expanding the circle of consultation

This document provides a strategy, not a blueprint, to attain CEOS goals as defined by IGOS. A large number of representatives of producer and user agencies has participated in the development of this

strategy, and many more have been consulted by the members of the GOFC design teams. Nonetheless, to achieve a broad consensus, wider consultation is needed. All organizations which have participated in the development of GOFC to date will be given an opportunity to comment. Subsequently, a revised draft will be circulated to organizations which may have an interest but which have not participated in this development. It will be particularly important to obtain feedback from foresters, forest managers, and forest policy makers from countries which have large areas of forests. We propose to hold one or more workshops in the first half of 1999 for this purpose.

Because of the comprehensive view we are taking of both earth observation technology and user requirements, the final document will serve as a reliable pointer to the way ahead. This strategy document will provide a basis for the CEOS agencies and partners to support and develop projects to meet the GOFC objectives. After the first year the complement of GOFC projects will be listed and evaluated to determine critical gaps in the strategy.

1.6 Initiating action

Even though this Strategy may be modified somewhat through wider circulation and comment, we are confident that the collective experience of the design team members, coupled with the additional consultations they have made during the course of the GOFC design phase, have produced a basis to initiate action. We propose to approach CEOS member agencies and user organizations to assemble teams of lead and participating agencies for each of the three primary themes, recognizing that the magnitude of the Forest Cover Characteristics and Changes theme may necessitate further discussion before initiating action in that particular area. The GOFC Executive must be formed, including representation from the lead agencies and participating users. The best way to move ahead is to begin working on specific pilot projects.

1.7 Schedule

Since GOFC is not a funded R&D effort but rather a partnership of voluntary participants, it is not possible to define a firm schedule as one might for an engineering project. Nevertheless, it is helpful to propose a possible schedule to examine how much progress could be made in the remaining four years of GOFC with rapid, enthusiastic participation. A schedule to achieve IGOS and GOFC objectives is proposed here to provide a starting point for further development.

Forest Cover Characteristics and Changes: We propose a two-phase approach. Each phase would be an end-to-end exercise of data acquisition, data analysis, and evaluation/validation of the resulting products. It is important to carry out an end-to-end exercise to ensure all the necessary components function properly, and to identify weak areas where remedial work is necessary. The first phase could be accomplished in as little as two years (1999-2000), although that is a very ambitious schedule. The first phase should cover one or two regions. The second phase (2001-2002) could cover several regions, expanding to all of the forested regions of the Earth if sufficient resources are available.

Forest Fire Monitoring and Mapping: There is a natural cycle time for this project: the annual seasonal cycle which normally includes one “fire season” in each region. The proposed GOFC initiative would also follow an annual cycle, with near-real-time fire monitoring during the fire season, followed by post-season fire mapping. The first two years (1999-2000) are proposed to be a testing phase, first for several countries, and then for many countries. By the third year (2001) the system could be in full

operation for most countries. This would be a distributed effort, with an annual meeting at the end of each year to discuss accomplishments and difficulties, and to make plans for the following year.

Forest Biophysical Processes: The EOS-AM1 mission is expected to be launched in mid-1999, with validation campaigns taking place during the next few years. Research teams for the ADEOS-2 and ENVISAT missions are being selected. GOFC should facilitate communication and coordination among these groups, and should strive to promote regional and global pilot projects incorporating multiple teams and approaches working toward community consensus algorithms.