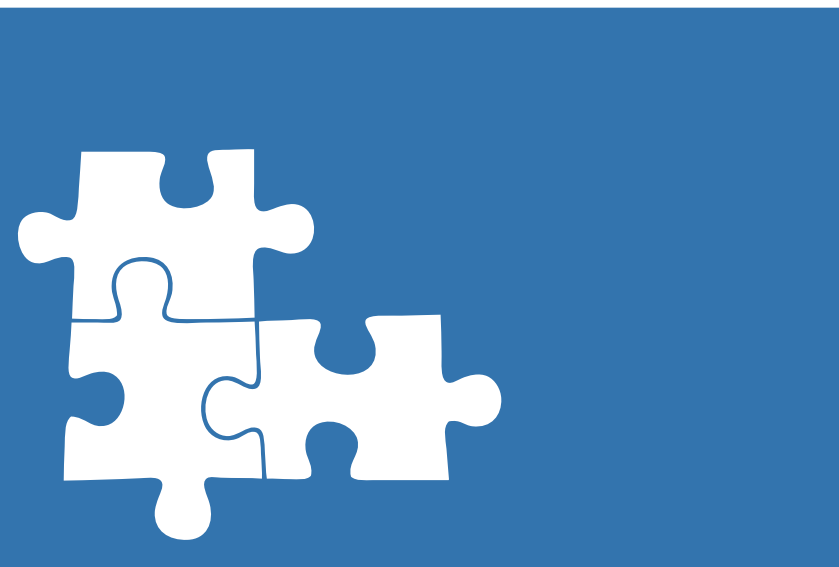
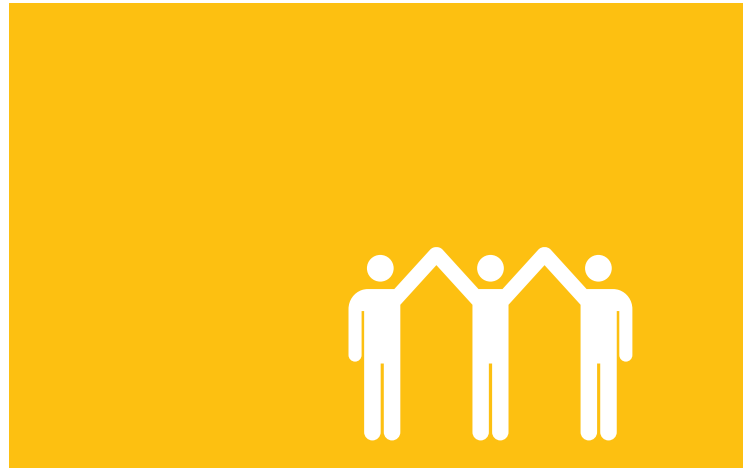


Certified Analytics Professional

CANDIDATE HANDBOOK

FOURTH EDITION





Certified Analytics Professional (CAP®) Program & Examination CANDIDATE HANDBOOK



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INTRODUCTION

About INFORMS

INFORMS is the world's largest professional society for those in the field of analytics, operations research (O.R.), and the management sciences. INFORMS is committed to meeting the professional needs of those who develop, apply, research, and teach advanced analytics, O.R. and the management sciences. INFORMS works to promote a broader understanding and recognition of the field by encouraging, facilitating, and rewarding excellence; communicating appropriate achievements and capabilities; providing lifelong education and career development opportunities; and attracting the best people.

About the INFORMS Certified Analytics Professional (CAP®) Program

INFORMS is pleased to continue the implementation of CAP® the professional certification program that meets the needs of analytics professionals. The Certified Analytics Professional (CAP®) program was developed in 2011–2012. The first examination was administered on April 7, 2013, at the INFORMS Analytics Conference, April 7–9, in San Antonio, Texas.

INFORMS analytics certification program advances the use of analytics by setting agreed upon standards for the profession and advances the profession by providing a means for organizations to identify and develop qualified analytics professionals, by contributing to the career success and continued competence for analytics professionals, and by improving the credibility and visibility of the analytics profession.

INFORMS defines analytics as the scientific process of transforming data into insight for making better decisions. Analytics is seen as an end-to-end process beginning with identifying the business problem to evaluating and drawing conclusions about the prescribed solution arrived at through the use of analytics tools and methodologies. Analytics professionals are skilled at this process.

INFORMS is the first professional society to develop a professional certification program for analytics professionals. Key components of the CAP® program include the following:

1. Formal credentialing requirements, including a standardized examination and required renewal process.
2. Program content based on the findings of a job task analysis working group, whose members represent a broad background of analytics practitioners (see the section titled "About the Professional Job Task Analysis Process").
3. Agreed-upon eligibility criteria that consist of academic preparation, work experience in analytics, and an attestation from an employer confirming adequate mastery of soft skills in analytics.
4. Certification program content that is both software and vendor neutral.
5. Successful completion of the certification process enabling analytics professionals (and their employers) to have confidence that they bring a core set of analytics skills to a project team.

The CAP® examination measures acceptable performance across seven major areas or domains of practice that adhere to the analytics end-to-end process: business problem framing, analytics problem framing, data, methodology selection, model building, deployment, and model life cycle management. See the "About the Professional Job Task Analysis Process" section for more information about the end-to-end process that is covered by the exam.

Because analytics is an end-to-end process, the CAP® examination assesses a breadth of knowledge across the seven domains, but not a depth of knowledge in any one methodology. Those interested in taking the CAP® examination should consider themselves to be analytics professionals or semi-professionals, and not analytics amateurs. They should be interested in adhering to the highest standards of good analytics practice and following a path of continual professional development in analytics. Candidates must have at least three



years of experience in analytics depending on their academic degree. See the “Eligibility Requirements” section for more information on qualifying for the CAP® examination.

CAP® program development formally began in August 2011, when INFORMS established the INFORMS Certification Task Force to plan and develop this new analytics certification.

Members of the original INFORMS Certification Task Force are as follows:

- Terry Harrison, CAP (Penn State University)
- Lisa Kart, CAP (Gartner)
- Bill Klimack (Chevron)
- David Leonhardi (Boeing)
- Jack Levis (UPS)
- Vijay Mehrotra (University of San Francisco)
- Paul Messinger, CAP (University of Alberta)
- Polly Mitchell-Guthrie (SAS)
- Scott Nestler, CAP (University of Notre Dame)
- Michael Rappa (North Carolina State/Institute for Advanced Analytics)
- Barry Thomas (University of Iowa)

Following the first CAP® examination in April 2013, an independent Analytics Certification Board (ACB) began administering the INFORMS analytics certification program. The ACB replaced the INFORMS Certification Task Force and became the official governing body. The ACB has independent authority to make all final decisions regarding program procedures, program content, approval of applicants and granting of certification independent of input from INFORMS governance including INFORMS Board of Directors.

Members of the Analytics Certification Board are as follows:

- Chair: Polly Mitchell-Guthrie, SAS
- Vice-Chair: Scott Nestler, PhD, CAP, U.S. Army
- Tom Davenport, PhD, Babson College
- Bill Franks, Teradata
- Esma Gel, Arizona State University
- Jeanne Harris, Columbia University
- Terry Harrison, PhD, CAP, Penn State University
- Lisa Kart, CAP, Gartner
- Kathy Kilmer, Disney
- Jack Levis, UPS
- Jonathan Owen, PhD, CAP, General Motors
- Glenn Wegryn, CAP, Analytic Impact, LLC
- Melissa Moore, INFORMS Exec. Director, Ex officio



Vision and Mission Statements of the CAP® Program

Vision

To advance the use of analytics to transform the world by setting agreed-upon standards for the profession.

Mission

To advance the analytics profession by providing a high-quality program of certification and by promoting continuing competence for practitioners.

Nondiscrimination Policy

INFORMS does not discriminate among candidates on the basis of race, color, creed, gender, age, religion, national origin, ancestry, disability, military discharge status, sexual orientation, or marital status. INFORMS strives to adhere to all applicable laws and regulations pertaining to nondiscrimination practices. INFORMS will arrange for reasonable accommodation for any individual requesting it.

Eligibility Requirements

Eligibility requirements for the CAP® credential include the following.

Education

- A BA/BS degree or an MA/MS degree in an analytics-related area is recommended for consideration for the CAP® program. These analytics-related areas include, but are not limited to, the following: analytics, operations research, management science, statistics, engineering, business (and directly related areas such as marketing, finance, etc.), theoretical or applied mathematics, information technology, computer science, decision science, and others deemed appropriate by INFORMS Analytics Certification Board. The degree must be obtained from a regionally accredited college or university recognized by the U.S. Department of Education or similar entities in other countries.
- INFORMS requires submission of a photocopy or electronic version of an official university or college transcript to demonstrate compliance with all education requirements.
- Waivers of the educational criteria will be considered on a case by case basis.

Experience

- Applicants must have
 - at least three (3) years of professional analytics related experience for individuals holding an MA/MS degree or higher in a related educational area (educational areas considered to be related to analytics are enumerated under "Education");
 - at least five (5) years of professional analytics related experience for individuals holding a BA/BS degree in a related educational area (educational areas considered to be related to analytics are enumerated under "Education");
 - at least seven (7) years of professional analytics related experience for individuals holding a BA/BS degree or higher in an educational area unrelated to analytics.



- Applicants are expected to provide information on professional experience including the name of the company/employer, name and title of the immediate supervisor, contact information for the immediate supervisor, and dates of employment in a professional analytics position.

Effectiveness

An important trait of a Certified Analytics Professional is the demonstrated achievement of an acceptable level of “soft skills,” in addition to the knowledge, skills, and abilities covered by the CAP® examination process. These soft skills include, but are not limited to, the following:

- Ability to communicate with a client/employer regarding the framing of an analytics problem.
- Understanding of the background of the client/employer regarding its organization and specific industry focus.
- Ability to explain the findings of the analytics process in sufficient detail to ensure clear understanding by the client/employer.

The CAP® program relies on a confirmation by a person in a supervisory capacity that the applicant possesses the skills enumerated above. The confirmation process requires that all applicants obtain documentation of their acceptable soft skills proficiency in the official confirmation form (see Appendix A for the Employer Confirmation Statement). It requires the signature of a current or previous supervisor of analytics work who is not a relative of the candidate and is designed for current or previous employers of individuals hired to provide professional analytics services.

Individuals who can show that they are unable to contact a past employer, client, or acceptable substitute, may submit a written summary of a recent analytics project describing in detail the application of soft skills in the successful completion of the project and in the implementation of its findings. Candidates choosing this option should contact INFORMS staff for additional information. Representatives of the INFORMS Analytics Certification Board may also, in some cases, require a telephone interview with a candidate in addition to the written summary to assess an applicant’s soft skills.

Ethics

Applicants must pledge to adhere to the first of its kind code of ethics for analytics practitioners. The Code of Ethics is presented on page 26.

Examination

Applicants for the CAP® must take and pass an examination based on analytics practice. The practice parameters are detailed in the Job Task Analysis (JTA). The JTA influences the content of the examination; all test items are directly linked to the JTA.



About the Professional Job Task Analysis Process

The Job Task Analysis (JTA) study defines the current knowledge, skills, and abilities (KSAs) that must be demonstrated by analytics professionals to effectively and successfully provide these services. KSAs are validated according to their frequency of use and importance. The JTA also serves as a “blueprint” for the content (performance domains) of the INFORMS CAP® examination.

INFORMS upholds stringent guidelines for the construction and implementation of the examination development and administration process. An 11-member panel of subject matter experts (SMEs) was selected to develop the first JTA for the CAP® credential. This group was called the Analytics Certification Job Task Analysis Working Group.

The following leaders in the analytics profession comprised the first panel selected to participate in this important project:

- Arnold Greenland (University of Maryland)
- Bill Klimack (Chevron)*#
- Jack Levis (UPS)*#
- Daymond Ling (Canadian Imperial Bank of Commerce)^N
- Freeman Marvin, CAP (Innovative Decisions, Inc.)
- Scott Nestler, CAP (University of Notre Dame)[#]
- Jerry Oglesby (SAS)
- Michael Rappa (North Carolina State/Institute for Advanced Analytics)[#]
- Tim Rey (Dow Chemical)
- Rita Sallam (Gartner)^N
- Sam Savage, CAP (Stanford/Vector Economics)

*INFORMS Board Member

[#]Credentialing Task Force Member

^NNonmember of INFORMS

The findings of this working group were then validated by a random sample of practicing analytics professionals. Feedback from this survey resulted in slight modifications of the performance domains, tasks, and knowledge that comprise the test blueprint that determines the content of the CAP® examination.

The table below includes the final domains and their representation on the certification exam that were derived from the JTA and a review of validation survey recommendations.

Domain	Approximate Weight
I. Business Problem (Question) Framing	12%–18%
II. Analytics Problem Framing	14%–20%
III. Data	18%–26%
IV. Methodology (Approach) Selection	12%–18%
V. Model Building	13%–19%
VI. Deployment	7%–11%
VII. Model Life Cycle Management	4%–8%



The INFORMS CAP® examination is based on the following test blueprint derived from the JTA process. The final agreed-upon weights reflect the percentage of questions from each domain that will be included in each test form.

The JTA and the test blueprint resulting from this process will be reviewed periodically and updated as needed to reflect current practices in analytics. The following list of domains also includes the key tasks associated with each domain.

(12%–18%) Domain I Business Problem (Question) Framing

(The ability to understand a business problem and determine whether the problem is amenable to an analytics solution.)

- T-1 Obtain or receive problem statement and usability requirements
- T-2 Identify stakeholders
- T-3 Determine whether the problem is amenable to an analytics solution
- T-4 Refine the problem statement and delineate constraints
- T-5 Define an initial set of business benefits
- T-6 Obtain stakeholder agreement on the problem statement

(14%–20%) Domain II Analytics Problem Framing

(The ability to reformulate a business problem into an analytics problem with a potential analytics solution.)

- T-1 Reformulate problem statement as an analytics problem
- T-2 Develop a proposed set of drivers and relationships to outputs
- T-3 State the set of assumptions related to the problem
- T-4 Define key metrics of success
- T-5 Obtain stakeholder agreement

(18%–26%) Domain III Data

(The ability to work effectively with data to help identify potential relationships that will lead to refinement of the business and analytics problem.)

- T-1 Identify and prioritize data needs and sources
- T-2 Acquire data
- T-3 Harmonize, rescale, clean, and share data
- T-4 Identify relationships in the data
- T-5 Document and report findings (e.g., insights, results, business performance)
- T-6 Refine the business and analytics problem statements

(12%–18%) Domain IV Methodology (Approach) Selection

(The ability to identify and select potential approaches for solving the business problem.)

- T-1 Identify available problem solving approaches (methods)
- T-2 Select software tools
- T-3 Test approaches (methods)¹
- T-4 Select approaches (methods)¹



(13%–19%) Domain V Model Building

(The ability to identify and build effective model structures to help solve the business problem.)

- T-1 Identify model structures¹
- T-2 Run and evaluate the models
- T-3 Calibrate models and data¹
- T-4 Integrate the models¹
- T-5 Document and communicate findings (including assumptions, limitations, and constraints)

(7%–11%) Domain VI Deployment

(The ability to deploy the selected model to help solve the business problem.)

- T-1 Perform business validation of the model
- T-2 Deliver report with findings
- T-3 Create model, usability, and system requirements for production
- T-4 Deliver production model/system¹
- T-5 Support deployment

(4%–8%) Domain VII Model Life Cycle Management

(The ability to manage the model life cycle to evaluate business benefit of the model over time.)

- T-1 Document initial structure
- T-2 Track model quality
- T-3 Recalibrate and maintain the model¹
- T-4 Support training activities
- T-5 Evaluate the business benefit of the model over time
- T-6 Tasks that are beyond the scope of the CAP® certification exam and that will not be tested.

APPLYING FOR & SCHEDULING AN EXAMINATION

Steps in the Certification Process

1. Potential applicant decides to apply for certification and determines whether he or she meets the eligibility requirements by reading the Candidate Handbook.
2. Applicant secures a photocopy or electronic version of an official transcript, not a copy of the diploma from his or her regionally accredited college or university documenting the required academic preparation for the CAP® credential.
3. Applicant provides contact information for a recent supervisor of analytics in the workplace who will confirm soft skills.
4. Applicant completes and submits the online application form to INFORMS.
5. INFORMS staff reviews application to determine whether the candidate is eligible to be scheduled for the examination.



6. INFORMS staff provides the eligible candidate with information on the available exam administration sites.
7. Candidate reviews available exam sites, chooses one, and remits exam fee to INFORMS.
8. Candidate takes examination at the designated test site. All examinations are scored by a consulting psychometrician or INFORMS certification staff.
9. INFORMS certification staff sends the candidate a written pass/fail notice by postal mail marked CONFIDENTIAL or email within 20 business days of the completion of the examination. Failing candidates will also receive information about their examination performance in major content areas.
10. Eligible candidates who pass the examination and have a complete application on file (see NOTE below) will be sent a certificate and information regarding the use and display of the certification logo within six to eight weeks of the completion of their examination.

Failing candidates should begin a process of targeted professional development to address the weak performance areas cited in their examination results letter.

NOTE: If application is incomplete, i.e., either transcripts or Confirmation Statement on Analytics Soft Skills is not provided, candidates may be eligible to test. If candidate passes the exam, he or she will not be awarded the CAP® credential until the application is complete. Candidates will have 90 days from date of exam to complete the application. If candidate is unsuccessful, he or she will have 90 days to complete the application. Applications must be completed in order to re-test. If application is not completed in 90 days, candidates will have to reapply as new applicants.

11. All certificants must renew their certification every three (3) years. See the "Certification Renewal Process" section for more information.

NOTE: Certification is only granted to individuals who meet all eligibility requirements and achieve a passing score on the examination. Grandfathering of certification status is not permitted for any candidates failing to meet these requirements.

Application and Payment Submission Process

www.certifiedanalytics.org

To apply for the CAP® certification examination, please follow these steps:

1. Complete and submit to INFORMS the "CAP® Certification Application and Agreement" form online at www.informs.org/applyforcertification
2. Submit a photocopy or electronic version of your official university or college transcript to INFORMS. Transcript must show name and logo of university or college. A copy of diploma is not sufficient.
3. Provide contact information for a previous or current employer who will complete the "Confirmation Statement on Analytics Soft Skills" form
4. Agree to the Code of Ethics
5. Remit application payment fee to INFORMS (waived for INFORMS members)

Once accepted, choose test site location and remit exam payment fee to INFORMS



NOTE: If application is incomplete, i.e., either transcripts or Confirmation Statement on Analytics Soft Skills is not provided, candidates may be eligible to test. If candidate passes the exam, he or she will not be awarded the CAP credential until the application is complete. Candidates will have 90 days from date of exam to complete the application. If candidate is unsuccessful, he or she will have 90 days to complete the application. Applications must be completed in order to re-test. If application is not completed in 90 days, candidates will have to reapply as new applicants.

INFORMS strives to process applications in a timely manner. Process time is seven (7) business days from receipt of application, payment, and accompanying documents sent online or via postal mail. This timeline does not apply to the Confirmation Statement on Analytics Soft Skills form sent from employers. INFORMS will process payment and other materials while awaiting receipt of this form.

Applicants can submit payment of the certification fees in any of the following ways: credit card (MasterCard, Visa, American Express, Discover), check made payable to INFORMS in U.S. dollars drawn on a U.S. bank, or wire transfer (contact INFORMS for details).

Fees and Refunds

All INFORMS certification fees must be drawn on U.S. banks and payable in U.S. dollars. Specific fees may change from time to time based on the decisions of INFORMS. INFORMS offers discounts on certification fees to current INFORMS members. INFORMS may offer discounts to other certification partners. If your organization is interested in becoming a certification partner, please contact INFORMS.

Refunds may be provided in some circumstances, but not after a candidate has begun an examination. INFORMS reserves the right to impose a processing fee on certification exam refunds. Application fees are nonrefundable.

Consult www.informs.org/certification for most up to date list of fees. At time of publication, the following fees are currently approved for the CAP® program:

Exam fee: INFORMS members ^a	\$495
Exam fee: Nonmembers	\$695
Annual maintenance fee	\$100, payable beginning 4th year of certification
Member reexamination fee ^b	\$300
Nonmember reexamination fee ^b	\$400
Hand-scoring fee	\$75
Processing fee on approved refunds	\$100
Appeals processing fee	\$150
Group rate for 10 or more (Contact INFORMS for specifics)	

^aApplicants must be a member of INFORMS in good standing at the time of application to receive the member discount. No refunds will be granted for applicants joining INFORMS after submission of certification application materials.

^bReexamination fees apply to second and third attempts to pass the CAP® examination within the first year of submitting an approved application. See the section titled "Reexamination" for more details.



Scheduling an Examination

Once an application is accepted and exam fee paid, applicants may choose an examination site. INFORMS certification staff will send written confirmation of the scheduled examination date, time, and site. The certification website lists updated information on additional examination sites as they become available.

Cancellation of an Examination

Should the need arise to cancel a scheduled CAP® examination, candidates must notify INFORMS certification staff at least three (3) business days or 72 hours prior to the scheduled examination date.

Candidates who contact INFORMS more than three (3) business days or 72 hours prior to the examination date will have their examination rescheduled at no additional cost. Refunds may be provided in some circumstances less a \$100 processing fee. Candidates who cancel their examination less than three (3) business days or 72 hours before their examination will not receive a refund and will be required to pay the full examination fee to reschedule their examination.

INFORMS understands that there may be situations where cancellations are required by circumstances beyond the control of candidates, such as the following:

- Natural disasters
- Medical emergencies
- Death or illness in the immediate family
- Travel cancellations or power failure due to inclement weather

INFORMS certification staff will handle these situations on an individual basis. Candidates will be expected to submit written documentation along with possible supporting documentation to avoid a potential cancellation penalty.

INFORMS reserves the right to cancel any examination due to inclement weather, power failure, or other unforeseen circumstances that make holding the exam untenable. Affected candidates will have their examinations rescheduled at no additional cost.

Special Examination Arrangements

Candidates with Disabilities

INFORMS complies with the Americans with Disabilities Act (ADA). INFORMS strives to ensure that no individual with a documented disability is deprived of the opportunity to take the certification examination solely by reason of that disability provided that reasonable special accommodations can be made.

To request special accommodations, candidates must complete the INFORMS Certification Examination Special Accommodations form (Appendix B). The form includes a statement of the disability and a history of previous accommodations in education, training, assessment, or the workplace. Candidates must provide all documentation with their application and fees at least 45 days prior to a desired examination date. INFORMS also requires that applicants notify INFORMS of any requests for special accommodations when calling to schedule examinations.



PREPARING FOR THE EXAMINATION

The CAP® examination is a 100-item written test composed of multiple-choice questions with four options. There is only one correct or best answer for each question. Candidates will be given three (3) hours to complete the examination.

Sample Test Questions

The following sample test questions were developed by subject matter experts in the analytics field. The correct answer key at the end of this list of questions provides the correct answers to each question. **These sample questions will never appear in an actual CAP® examination and are provided as an example of the type of question found on the examination.**

The 24 questions published here are intended to familiarize certification candidates and potential certification candidates with the format of the questions that appear on the CAP® examination. They are also intended to provide a sample of the content (knowledge and skill) assessed by the CAP® examination. These questions are not intended as a self-assessment instrument nor should they be used to predict success or failure on the CAP® exam. Candidates and potential candidates should bear in mind that the CAP® examination is a “pass/fail” assessment and that passing does not require correct answers to all questions. It should also be kept in mind that examination preparation efforts will likely increase knowledge and sharpen skills.

Rationale for the correct answer is provided at the end of this section. The Candidate Handbook at www.informs.org/certification has rationale for both correct and incorrect responses provided.

Candidates are encouraged to first select their correct answer option prior to checking to see why it is correct.

1. Which of the following BEST describes the data and information flow within an organization?
 - a) Information assurance
 - b) Information strategy
 - c) Information mapping
 - d) Information architecture
2. A multiple linear regression was built to try to predict customer expenditures based on 200 independent variables (behavioral and demographic). 10,000 rows of data were fed into a stepwise regression, each row representing one customer. 1,000 customers were male, and 9,000 customers were female. The final model had an adjusted R-squared of 0.27 and seven independent variables. Increasing the number of rows of data to 100,000 and rerunning the stepwise regression will MOST likely:
 - a) have negligible impact upon the adjusted R-squared.
 - b) increase the impact of the male customers.
 - c) change the heteroskedasticity of the residuals in a favorable manner.
 - d) decrease the number of independent variables in the final model.



3. A clothing company wants to use analytics to decide which customers to send a promotional catalogue in order to attain a targeted response rate. Which of the following techniques would be the most appropriate to use for making this decision?
- a) Integer programming
 - b) Logistic regression
 - c) Analysis of variance
 - d) Linear regression
4. Which of the following is an effective optimization method?
- a) Analysis of variance (ANOVA)
 - b) Generalized linear regression model (GLM)
 - c) Box-Jenkins Method (ARIMA)
 - d) Mixed integer programming (MIP)
5. A box and whisker plot for a dataset will MOST clearly show:
- a) the difference between the second quartile and the median.
 - b) the 90% confidence interval around the mean.
 - c) where the [actual-predicted] error value is not zero.
 - d) if the data is skewed and, if so, in which direction.
6. In the initial project meeting with a client, which of the following is the MOST important information to discuss?
- a) Timeline and implementation plan
 - b) Analytical model to use
 - c) Business issue and project goal
 - d) Available budget
7. Which of the following statements is true of modeling a multi-server checkout line?
- a) A queuing model can be used to estimate service rates.
 - b) A queuing model can be used to estimate average arrivals.
 - c) Variability in arrival and service times will tend to play a critical role in congestion.
 - d) Poisson distributions are not relevant.



8. A company is considering designing a new automobile. Their options are a design based on current gasoline engine technology or a government proposed "Green" technology. You are a government official whose job is to encourage automakers to adopt the "Green" technology. You cannot provide funding for development or production costs, but you can provide a subsidy for every car sold. The development costs and the wholesale price, in USD (\$), of the cars are shown in the table following:

	Gasoline Technology	"Green" Technology
Production Wholesale Price/vehicle	25,000	40,000
Variable Cost/vehicle	15,000	35,000
Fixed Development Cost	100,000,000	200,000,000

How large a subsidy per vehicle sold will be required, assuming there will be enough demand to motivate the switch?

- Greater than \$5000
 - Less than \$5000
 - Cannot be determined
 - Equal to \$5000
9. A furniture maker would like to determine the most profitable mix of items to produce. There are well-known budgetary constraints. Each piece of furniture is made of a predetermined amount of material with known costs, and demand is known. Which of the following analytical techniques is the MOST appropriate one to solve this problem?
- Optimization
 - Multiple regression
 - Data mining
 - Forecasting
10. You have simulated the net present value (NPV) of a decision. It ranges between -\$10 million and +\$10 million. To BEST present the likelihood of possible outcomes, you should:
- present a single NPV estimate to avoid confusion.
 - present a histogram to show the distribution of various NPV estimates.
 - trim all outliers to present the most balanced diagram.
 - relax constraints associated with extreme points in the simulation.
11. A company ships products from a single dock at their warehouse. The time to load shipments depends on the experience of the crew, products being shipped and weather. The company thinks there is significant unmet demand for their products and would like to build another dock in order to meet this demand. They ask you to build a model and determine if the revenue from the additional products sold will cover the cost of the second dock within two years of it becoming operational. Which of the following is the MOST appropriate modeling approach?"
- Optimization because it is a transportation problem.
 - Optimization because the company's objective to maximize profit and capacity at the dock is a limited resource.
 - Forecasting because you can determine the throughput at the dock, calculate the net revenue and compare this with the cost of the new dock.
 - Discrete event simulation because there are a sequence of discrete random events

through time.

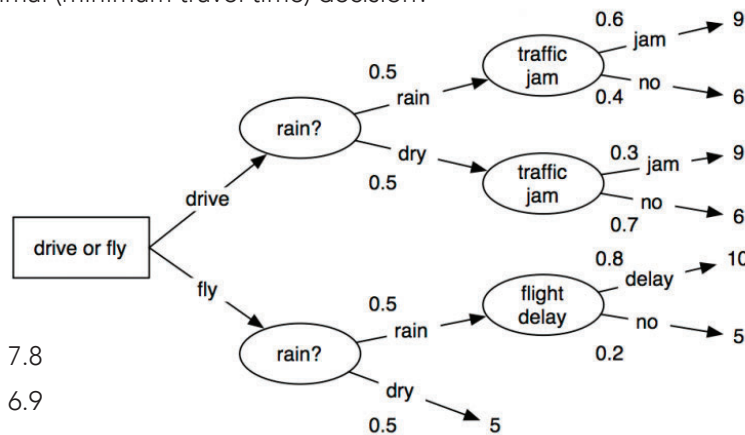
12. Two investors who have the same information about the stock market buy an equal number of shares of a stock. Which of the following statements MUST be true?
- a) The risks for the two investors are statistically independent.
 - b) Both investors are subject to the same risks.
 - c) Both investors are subject to the same uncertainty.
 - d) If the investors are optimistic, they should have borrowed, rather than bought the shares.
13. A project seeks to build a predictive data-mining model of customer profitability based upon a series of independent variables including customer transaction history, demographics, and externally purchased credit-scoring information. There are currently 100,000 unique customers available for use in building the predictive model. Which of the following strategies would reflect the BEST allocation of these 100,000 customer data points?
- a) Use 70,000 randomly selected data points when building the model, and hold the remaining 30,000 as a test dataset.
 - b) Build the model using all 100,000 data points.
 - c) Randomly partition the data into 4 datasets of equal size, build four models and take their average.
 - d) Use 1,000 randomly selected data points when building the model.
14. Conjoint analysis in market research applications can:
- a) give its best estimates of customer preference structure based on in-depth interviews with a small number of carefully chosen subjects.
 - b) only trade off relative importance to customers of features with similar scales.
 - c) allow calculation of relative importance of varying features and attributes to customers.
 - d) only trade off among a limited number of attributes and levels.
15. One of the main advantages of tree-based models and neural networks is that they:
- a) are easy to interpret, use, and explain.
 - b) build models with higher R squared than other regression techniques.
 - c) reveal interactions without having to explicitly build them into the model.
 - d) can be modeled even when there is a significant amount of missing data.
16. The monthly profit made by a clothing manufacturer is proportional to the monthly demand, up to a maximum demand of 1000 units, which corresponds to the plant producing at full capacity. (Any excess demand over 1000 units will be satisfied by some other manufacturer, and hence yield no additional profit.) The monthly demand is uncertain, but the average demand is reliably estimated at 1000 units. At this level of demand the monthly profit is \$3,000,000. Which of the following statements must be true of the expected monthly profit, P?
- a) P can have any positive value.
 - b) P is possibly greater than \$3,000,000.
 - c) P is equal to \$3,000,000.
 - d) P is less than \$3,000,000.



17. After building a predictive model and testing it on new data, an under prediction by a forecasting system can be detected by its:

- a) negative-squared.
- b) bias.
- c) mean absolute deviation.
- d) mean squared error.

18. All times in the decision tree below are given in hours. What is the expected travel time (in hours) of the optimal (minimum travel time) decision?



- a) 7.8
- b) 6.9
- c) 7.4
- d) 7.0

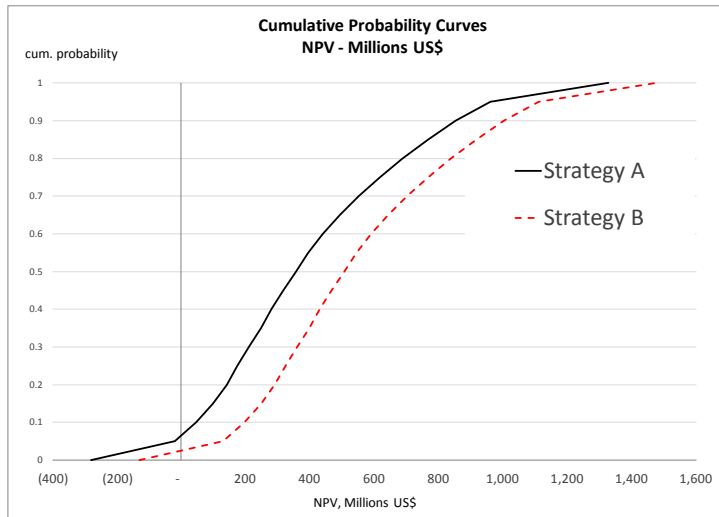
19. An analytics professional is responsible for maintaining a simulation model that is used to determine the staffing levels required for a specific operational business process. (Bf type is the new content; don't leave it as bf type!). Assuming that the operational team always uses the number of staff determined by the model, which of the following is the MOST important maintenance activity?

- a) Ensure that all the model input data items are available when needed.
- b) Determine if there has been a change in model accuracy over time.
- c) Ensure that all users are reviewing the model results in a timely fashion.
- d) Determine that the model's reports are understood by the users.

20. A segmentation of customers who shop at a retail store may be performed using which of the following methods?

- a) Monte Carlo Markov Chain and ANOVA
- b) Clustering, factor and control charts
- c) Decision tree and recursive function analyses
- d) Clustering and decision tree

21. In the following diagram, what is true of Strategy B compared to Strategy A?



- a) Strategy B exhibits stochastic (probabilistic) dominance over Strategy A.
 - b) Strategy B has the same downside risk as Strategy A since the curves have the same shape.
 - c) Strategy B must have the same uncertainties impacting it as Strategy A because the curves are so similar in shape.
 - d) Strategy A exhibits stochastic (probabilistic) dominance over strategy B.
22. Each month you generate a list of marketing leads for direct mail campaigns. Which of the following should you do before the list is used?
- a) Exclude people who were on the list the previous month.
 - b) Retain x% of the leads as control for performance measurement.
 - c) Remove opt-outs.
 - d) Exclude people who were never on the list.
23. When analyzing responses of a survey of why people like a certain restaurant, factor analysis could reduce the dimension in which of the following ways?
- a) Collapse several survey questions regarding food taste, health value, ingredients and consistency into one general unobserved "food quality" variable.
 - b) Condense similar survey respondent answers into clusters of like-minded customers for market segment analysis.
 - c) Reduce the variability of individual subject ratings by centering each respondent's ratings around his or her average rating.
 - d) Decrease variability by analyzing inter-rater reliability on the question items before offering the survey to a wide number of respondents.



24. A preferred method or best practice for organizing data in a data warehouse for reporting and analysis is:
- a) transactional-based modeling.
 - b) multidimensional modeling.
 - c) relation-based modeling.
 - d) tuple-based modeling.

Correct answers:

1. d	7. c	13. a	19. b
2. a	8. a	14. c	20. d
3. b	9. a	15. c	21. a
4. d	10. b	16. d	22. c
5. d	11. d	17. b	23. a
6. c	12. c	18. d	24. b

(Note: None of these questions will appear in any CAP® examination. These sample questions are presented to candidates to demonstrate the format of questions that will be included in the actual exams.)

Distribution of sample questions per domain

Domain I: Business Problem Framing	Questions 6, 8, 10, 12
Domain II: Analytics Problem Framing	Questions 7, 14, 16, 20
Domain III: Data	Questions 1, 2, 5, 23, 24
Domain IV: Methodology (Approach) Selection	Questions 3, 4, 9, 11
Domain V: Model Building	Questions 13, 15, 18, 21
Domain VI: Deployment	Questions 17, 22
Domain VII: Model Lifecycle Management	Question 19

Rationale for Correct Answers

1. d) Information architecture **CORRECT:** Information architecture refers to the analysis and design of the data stored by information systems, concentrating on entities, their attributes, and their interrelationships. It refers to the modeling of data for an individual database and to the corporate data models that an enterprise uses to coordinate the definition of data in several (perhaps scores or hundreds) distinct databases.
2. a) have negligible impact upon the adjusted R-squared. **CORRECT:** The increase in size of the data will not impact the adjusted R-squared calculation because both samples are sufficiently large randomly selected subsets of data.
3. b) Logistic regression **CORRECT:** This type of classification model is often used to predict the outcome of a categorical dependent variable (response vs. no response) based on one or more predictor variables, so this is the most appropriate answer. The goal of the analytics in the stated problem is to determine who is most likely to respond, and the binary nature of this predicted outcome is provided by logistic regression.
4. d) Mixed integer programming (MIP) **CORRECT:** This is a mathematical optimization technique used when one or more of the variables are restricted to be integers. It is an effective optimization model.
5. d) if the data is skewed and, if so, in which direction. **CORRECT:** A box and whisker plot, sometimes just called a "box plot," was invented by John Tukey as a way to graphically display the distribution of data. The ends of the box are at the first and third quartiles, and there is a line somewhere in the box representing the median value. The whiskers extend either to the minimum and maximum values in the data set, or possibly less if they do not include points identified as outliers.
6. c) Business issue and project goal **CORRECT:** Understanding the business issue and project goal provides a sound foundation on which to base the project.
7. c) Variability in arrival and service times will tend to play a critical role in congestion. **CORRECT:** Arrival and service time distributions are inputs to a queuing model that would be used to model a checkout line and directly influence congestion.
8. a) Greater than \$5000 **CORRECT:** If we consider the profit from an individual vehicle to be the wholesale price minus the variable cost, we see that the profit from a Gasoline Technology vehicle is $\$25K - \$15K = \$10K$. Similarly, the profit from a "Green" Technology vehicle is $\$40K - \$35K = \$5K$. In order to make up for this difference in lost profit, the subsidy provided to the automaker would have to be at least \$5K (the difference between \$10K and \$5K). In addition, the subsidy would need to be greater than \$5000 so that the automakers would be able to recover their increased fixed costs at a reasonable level of demand.
9. a) Optimization **CORRECT:** The problem statement describes an optimization problem: the furniture maker's objective function is to maximize his profit. The decision variables are the amount of each item to produce, and the constraints are that he must meet demand and be within his budget. Optimization is the most appropriate technique to solve this problem.
10. b) present a histogram to show the distribution of various NPV estimates. **CORRECT:** Net Present Value (NPV) takes as input a time series of cash flow (both incoming and outgoing) and a discount



- rate and outputs a price. By showing a histogram (a graphical representation of the distribution of data), it is possible to see how likely various NPVs (beyond the given minimum and maximum) are to occur. This would be useful information to have when considering a decision, especially since the range of outcomes includes \$0, meaning the decision could result in a profit or a loss.
11. d) Discrete event simulation because there are a sequence of random events through time. **CORRECT:** The time to load shipments depends on the experience of the crew, products being shipped, and weather. Given that there is a sequence of random events through time, discrete event simulation is the most appropriate modeling approach.
 12. c) Both investors are subject to the same uncertainty. **CORRECT:** Both investors are subject to the same uncertainty regarding the stock market.
 13. a) Use 70,000 randomly selected data points when building the model, and hold the remaining 30,000 out as a test dataset. **CORRECT:** This split provides sufficient data to build the model and sufficient data to test the model. This is the best allocation of the customer data points, (A common 'rule of thumb' is to use about two thirds of the data to build the model and one third to test it.)
 14. c) allow calculation of relative importance of varying features and attributes to customers. **CORRECT:** Conjoint analysis by definition maps consumer preference structures into mathematical tradeoffs, and was designed to allow a marketer to compare the relative utility of varying features and attributes.
 15. c) reveal interactions without having to explicitly build them into the model. **CORRECT:** Tree-based models and neural networks are employed to find patterns in the data that were not previously identified (or input into the model building process).
 16. d) P is less than \$3,000,000. **CORRECT:** When the demand is 1000 or greater, the profit is \$3,000,000. But when the demand is less than 1000, the profit is less than \$3,000,000. Given this and that the average demand is 1000 units, the expected monthly profit must be less than \$3,000,000.
 17. b) bias. **CORRECT:** The bias measures the difference, including the direction of the estimate and the right answer. Depending on whether it's positive or negative, it will show whether there is an over or under estimate.
 18. d) 7.0 **CORRECT:** To answer this question, one needs to solve the decision tree using the "roll back" technique. Continuing back the bottom branch of the tree, the expected time if you fly is $(0.5)(9.0) + (0.5)(5) = 7.0$ hours. Now, when faced with the "drive or fly" decision, you should choose to fly (since 7.0 hours is less than 7.35 hours). Thus, answer d) 7.0 hours is the expected travel time of the optimal (or minimal travel time) decision.
 19. b) Determine if there has been a change in model accuracy over time. **CORRECT:** The most important maintenance activity for the analytics professional responsible for maintaining the simulation model is to monitor the accuracy of the model over time. If there has been a change in accuracy, the analytics professional may need to revisit the assumptions of the model.
 20. d) Clustering and decision trees **CORRECT:** Customer segmentation consists of dividing a customer base into groups of individuals that are similar in specific ways relevant to marketing, e.g., age, gender, interests, spending habits and so on. The purpose of customer segmentation is to allow a company to target specific groups of customers effectively and allocate marketing resources to best effect. Two ways to do this segmentation are clustering and decision trees.
 21. a) Strategy B exhibits stochastic (probabilistic) dominance over Strategy A. **CORRECT:** Because the cumulative probability curve for Strategy B is below (or to the right) of the corresponding curve for Strategy A, it can be said that Strategy B exhibits stochastic dominance (SD) over Strategy A. B stochastically dominates A when, for any good outcome x, B gives at least as high a probability of



receiving at least x as does A , and for some x , B gives a higher probability of receiving at least x . Since the curves do not cross, B stochastically dominates A .

- 22. c) Remove opt-outs. **CORRECT:** The list of marketing leads should not include people or organizations that have opted out.
- 23. a) Collapse several survey questions regarding food taste, health value, ingredients, and consistency into one general unobserved "food quality" variable. **CORRECT:** Factor analysis is a statistical method used to describe variability among observed variables in terms of a potentially lower number of unobserved variables called factors. The information gained about the interdependencies between observed variables can be used later to reduce the set of variables in a dataset.
- 24. b) multidimensional modeling. **CORRECT:** Multidimensional modeling is the optimum way to organize data in a data warehouse for analysis. It is associated with OLAP (On-line Analytical Processing). OLAP data is organized in cubes that can be taken directly from the data warehouse for analysis.

References

INFORMS subject matter experts compiled the following list of key references that may help you prepare for the CAP® exam. A select committee of subject matter experts who have earned the CAP® credential, have developed a Study Guide that can be used to help candidates prepare for the exam. The Study Guide is available on the CAP® website and has information relating to each of the Domain areas listed here.

Domain I – Business Problem (Question) Framing

Kirkwood CW (1997) Strategic Decision Making: Multiobjective Decision Analysis with Spreadsheets (Duxbury Press, Pacific Grove, CA).

Domain II – Analytics Problem Framing

Albright SC, Winston W, Zappe C (2011) Data Analysis and Decision Making, 4th ed. (South-Western Cengage Learning, Mason, OH).

Domain III – Data

Hubbard DW (2010) How to Measure Anything: Finding the Value of "Intangibles" in Business, 2nd ed. (John Wiley & Sons, Hoboken, NJ).

Hillier F, Hillier M (2013) Introduction to Management Science: A Modeling and Case Study Approach, 5th ed. (McGraw-Hill Higher Education, New York).

Vose D (2008) Risk Analysis: A Quantitative Guide, 3rd ed. (John Wiley & Sons, Chichester, UK).

Domain IV – Methodology (Approach) Selection

Neter J, Kutner M, Nachtsheim C, Wasserman W (1996) Applied Linear Statistical Models, 4th ed. (McGraw-Hill/Irwin, New York).

Domain V – Model Building and Domain VII – Model Life Cycle Management

Hillier FS, Lieberman GJ (2010) Introduction to Operations Research, 9th ed. (McGraw-Hill, New York).

Ross SM (2010) Introductory Statistics, 3rd ed. (Academic Press, Burlington, MA).

Clemen RT (1997) Making Hard Decisions: An Introduction to Decision, 2nd ed. (Duxbury Press, Pacific Grove, CA).

Law AM, Kelton DW (2006) Simulation Modeling and Analysis, 4th ed. (McGraw-Hill, New York).



Domain VI – Deployment

Laursen GHN, Thorlund J (2010) Business Analytics for Managers: Taking Business Intelligence Beyond Reporting (John Wiley & Sons, Hoboken, NJ).

For More Information

Bartlett R (2013) A Practitioner's Guide to Business Analytics: Using Data Analysis Tools to Improve Your Organization's Decision Making and Strategy (McGraw-Hill, New York).

Breeden J (2013) Tipping Sacred Cows: Kick the Bad Work Habits that Masquerade as Virtues (Jossey-Bass, San Francisco, CA).

Brohaugh W (2007) Write Tight: Say Exactly What You Mean With Precision and Power (Sourcebooks, Naperville, IL).

Cukier (2013) Big Data: A Revolution That Will Transform How We Live, Work, and Think (Houghton Mifflin, New York).

Davenport T, Harris J (2010) Analytics at Work: Smarter Decision, Better Results (Harvard Business Review Press, Boston).

Davenport T, Kim J (2013) Keeping up with the Quants: Your Guide to Understanding and Using Analytics (Harvard Business Review Press, Boston).

Duarte N (2012) HBR Guide to Persuasive Presentations (Harvard Business Review Press, Boston).

Eckerson W (2012) Secrets of Analytical Leaders: Insights from Information Insiders (Technics Publications, Westfield, NJ).

Franks B (2012) Taming the Big Data Tidal Wave: Finding Opportunities in Huge Data Streams with Advanced Analytics (John Wiley & Sons, Hoboken, NJ).

Jarman K (2013) The Art of Data Analysis: How to Answer Almost Any Question Using Basic Statistics (John Wiley & Sons, Hoboken, NJ).

Phillips J (2013) Building a Digital Analytics Organization: Creating Value by Integrating Analytical Processes, Technology, and People into Business Operations (Pearson, Upper Saddle River, NJ).

Provost F, Fawcett T (2013) Data Science for Business: What You Need to Know About Data Mining and Data-Analytic Thinking (O'Reilly Media, Sebastopol, CA).

Redman T (2001) Data Quality: The Field Guide (Digital Press, Woburn, MA).

Sashihara S (2011) The Optimization Edge: Reinventing Decision Making to Maximize All Your Company's Assets (McGraw-Hill, New York).

Savage S (2012) The Flaw of Averages: Why We Underestimate Risk in the Face of Uncertainty (John Wiley & Sons, Hoboken, NJ).

Saxena R, Srinivasan A (2012) Business Analytics: A Practitioner's Guide (Springer, New York).

Shmueli (2012) Practical Time Series Forecasting: A Hands-On Guide (Springer, New York).

Siegel E (2013) Predictive Analytics: The Power to Predict Who Will Click, Buy, Lie, or Die (Wiley, New York).



Silver N (2012) *The Signal and the Noise: Why Most Predictions Fail but Some Don't* (Penguin Press, New York).

Soares S (2013) *Big Data Governance: An Emerging Imperative* (MC Press Online, Boise, ID).

Spitzer DR (2007) *Transforming Performance Management: Rethinking the Way We Measure and Drive Organizational Success* (AMACOM, New York).

Taylor J (2011) *Decision Management Systems: A Practical Guide to Using Business Rules and Predictive Analytics* (Pearson Education, Boston).

Continuing Education and Training Courses

Along with the above-mentioned references, there are also many analytics-related continuing education and training courses available from many suppliers. INFORMS Continuing Education Department has information on those courses provided by INFORMS, at www.informs.org/Continuing Education.

INFORMS also provides a list of Recognized Analytics Continuing Education Providers (RACEP) on our website for the convenience of candidates at www.informs.org/RACEP. INFORMS does not endorse any of these courses or ensure the accuracy of the listings.

Completion of preparatory courses is **not** a requirement for eligibility to sit for the CAP® examination.

TAKING THE EXAMINATION

Exam Site Requirements and Instructions

Check-in Procedure

Candidates should arrive at the test site at least 30 minutes before the scheduled examination time. Candidates must bring two forms of ID; one must be a government-issued photo ID (e.g., passport, driver's license). Candidates will not be permitted to take the examination without proper identification.

NOTE: When completing the application, candidates are encouraged to use the name that appears on their government-issued photo ID. Using different names may result in candidate not being permitted to take the exam.

Prohibited Items in the Testing Room

Candidates may not bring any of the following items to the test center: If there is no designated secure storage, candidates may bring the items into the testing room but they will be placed in an inaccessible location within the room during the examination.

- calculators
- cell phones/smartphones
- laptops
- iPads or similar devices
- tape recorders
- book bags



- pagers
- notes of any kind
- books
- newspapers

Testing Aids

All candidates at paper and pencil test sites will be provided with pencils, scrap paper, and a simple four-function calculator. Candidates taking the exam at a computer-based testing site will have the calculator embedded in the exam.

Disciplinary Policy and Procedures

Candidates are expected to conduct themselves in a professional manner in the test center. Any violation may be subject to disciplinary action from the INFORMS Certification Department up to and including dismissal from the examination site.

Grounds for termination of the examination and dismissal from the test center include the following:

- Having or attempting to have another individual take the examination
- Failing to provide the proper identification
- Using any prohibited test aids/materials
- Communicating in any manner with other candidates during the administration of the examination
- Leaving the test room or center without permission
- Engaging in cheating or any other dishonest or unethical conduct
- Failing to follow any of the test administration rules as stipulated by INFORMS

AFTER THE EXAMINATION

Examination Score Reports and the Scoring Process

INFORMS uses a criterion-referenced methodology for determining the passing score for its examinations. There is no grading on a “curve,” and candidates are not competing with each other. The specific methodology used is the modified Angoff technique, which relies on the judgments of SMEs to determine an acceptable level of knowledge, skill, and ability in analytics.

INFORMS may at times include pretest items in some examination forms. These items are used for developing future examinations and, accordingly, are not scored and have no impact on a candidate’s pass/fail status.

Each candidate will receive an examination report in the form of a pass/fail letter including additional information on certification status. This letter will be sent by postal mail or email.

The letters for failing candidates will include additional information on performance by domain. Pass/fail letters will not include raw scores. Pass/fail letters will be sent to all candidates within 20 business days.

Raw examination scores are confidential. INFORMS will not disclose examination scores to anyone unless INFORMS is required by court order or subpoena. Unless otherwise requested, INFORMS will publish the names of all individuals who have passed the examination and who maintain current certification status.

Hand Scoring

Candidates who wish to have their examination results hand scored after the initial scoring process may request this service by contacting INFORMS certification staff and paying a \$75 fee. Requests for hand scoring



of answer sheets must be received no later than 30 business days following the release of examination results. Requests received after 30 business days will not be processed.

Reexamination

Candidates who do not pass their initial examination have the option of retaking this examination up to two (2) additional times during the first year following the approval of their application. Candidates who take the examination a second or third time will be expected to pay the reexamination fee cited in the “Fees and Refunds” section, each time.

Candidates who fail the examination three (3) times will be required to wait one year from the date of their last attempt to reapply for certification. Reapplying under these circumstances involves a complete new submission of all application materials. Candidates who fail the examination three times are encouraged to pursue a program of education/training prior to reapplying for certification.

Security and Confidentiality

All test-related materials including the examination form, test questions, worksheets, and graphics included in test items are the exclusive intellectual property of INFORMS. Accordingly, none of these confidential materials is available for review by any persons other than the INFORMS certification staff and INFORMS Analytics Certification Board.

All certification candidates sign an application agreement stating that they will not discuss or share the specific content of any INFORMS certification examinations with anyone. Any violation of this provision could result in potential sanctions up to and including revocation of certification status.

APPEALS OF CERTIFICATION DECISIONS

Appeals Eligibility

Appealable decisions include the following:

- Denial of eligibility for certification
- Denial of certification
- Denial of renewal
- Revocation of certification

Appeals Process

Applicants, candidates, or certificants wishing to appeal a decision must submit written documentation within thirty (30) days of the receipt of the written decision by INFORMS. The written documentation should specify the grounds on which the appeal is based. A nonrefundable fee of \$150 drawn on a U.S. bank in U.S. dollars must be submitted with the letter of appeal.

Appeals Panel

INFORMS will appoint an appeals panel consisting of one (1) current member of the INFORMS Board of Directors and one (1) current/former member of INFORMS Analytics Certification Board.

None of these individuals shall have had any affiliation (business, professional, or personal) with the individual filing the appeal. The appeals panel members will conduct their work and render a written decision within 60 business days of their appointment.



Appeals Decisions

The appeals panel shall render a decision on any allegations of procedural error or in the making of a decision with insufficient evidence to support it. Appeals regarding required compliance with existing and published testing standards or program requirements are not accepted. The appeals panel may render a decision to uphold the INFORMS decision, grant the appeal requested by the appellant, or refer the matter back to the INFORMS Analytics Certification Board for reconsideration. A written copy of the appeals panel decision shall be sent to the INFORMS Analytics Certification Board and to the appellant.

DISCIPLINARY PROCESS

Certificants are required to comply with all existing and future rules, regulations, and administrative ethical standards for certification established by INFORMS. Certificants are responsible for demonstrating compliance, and failure to do so may lead to disciplinary actions, including but not limited to the denial of eligibility, nonrenewal of a certification, revocation of certification, probation or suspension, issuance of a letter of censure, or issuance of a written reprimand.

Individuals may report alleged violations of INFORMS rules or regulations in writing to INFORMS. Written documentation should include the identity of the individual involved in the alleged misconduct and the nature of the misconduct described in as much detail as possible, and the signature of the individual filing the complaint.

INFORMS has the authority to initiate a disciplinary action without receiving a complaint or notification of inappropriate conduct. INFORMS reserves the right to pursue any and all civil and legal remedies available under the law.

Grounds for disciplinary action include, but are not limited to, the following:

1. Conviction of any felony involving moral turpitude.
2. Conviction of any other criminal offense which reasonably calls into question the certificant's ability to provide professional analytics services.
3. Engaging in, authorizing, or aiding or abetting fraud, deceit, misrepresentation of materials/facts, provision of false or forged evidence, or bribery in connection with any application for a certificate or registration.
4. False statements made in any initial or renewal application materials.
5. Obtaining or attempting to obtain certification or renewal by any fraudulent means.
6. Failure to meet renewal requirements.
7. Use of expired credentials or false or unauthorized use of any INFORMS credentials.
8. Unauthorized possession or distribution of INFORMS examination or testing materials.
9. Unauthorized use of any registered trademark of INFORMS.

INFORMS shall have the authority to establish procedures for hearings and potential reinstatement upon satisfactory assurance of proper conduct.

Individuals who wish to report a possible certification violation may send a written letter of complaint to:

INFORMS
Attn: Certification Manager
5521 Research Park Drive, Suite 200
Catonsville, Maryland 21228 USA

email: certification@informs.org



CODE OF ETHICS/CONDUCT

INFORMS has developed the Code of Ethics/conduct for all Certified Analytics Professionals [see below]. All candidates and certificants participating in the certification process are required to agree to comply with the current and future provisions of this code.

Code of Ethics for Certified Analytics Professionals

Prepared by the INFORMS Certification Task Force

Background. The Institute for Operations Research and the Management Sciences (INFORMS) does not have an established code of ethics or guidelines for ethical practice that applies to the general membership. However, Article 1, Paragraph 2.v., of the INFORMS constitution states, "The Institute will strive to promote high professional standards and integrity in all work done in the field."

Applicability. This Code of Ethics applies specifically to those seeking (re)-certification as a Certified Analytics Professional (CAP®), but may be useful to other practitioners who use analytics. Clients, employers, researchers, policymakers, journalists, students, and the public should expect analytical practice by CAP® certified individuals to be conducted in accordance with these guidelines. Application of these or any other ethical guidelines generally requires good judgment and common sense.

Purpose. This Code exists to clarify the ethical requirements that are important; to inform the individual regarding rules and standards; to hold the profession accountable; to aid analytics professionals in making and communicating ethical decisions; to help deter unethical behavior and promote self-regulation; and to list possible violations, sanctions, and enforcement procedures.

General. Analytics professionals participate in analysis that aids decision makers in business, industry, academia, government, military, i.e. all facets of society; therefore, it is imperative to establish and project an ethical basis to perform their work responsibly. Furthermore, practitioners are encouraged to exercise "good professional citizenship" to improve the public climate for, understanding of, and respect for the use of analytics across its range of applications. In general, analytics professionals are obliged to conduct their professional activities responsibly, with particular attention to the values of consistency, respect for individuals, autonomy for all, integrity, justice, utility, and competence.

Responsibilities. This Code recognizes that analytics professionals have obligations to a variety of groups, including: society, employers and clients, colleagues, research subjects, INFORMS, and the profession in general. Responsibilities regarding each of these groups are further described next.

Society. All professionals have societal obligations to perform their work in a professional, competent, and ethical manner. Professionals should adhere to all applicable laws, regulations, and international covenants.

Employers and Clients. In general, it is the practitioner's responsibility to assure employers and clients that an analytical approach is suitable to their needs and resources, and include presenting the capabilities and limitations of analytical methods in addressing their problem. Analytics professionals should clearly state their qualifications and relevant experience. It is imperative to fulfill all commitments to employers and clients, guard any privileged information they provide unless required to disclose, and accept full responsibility for their performance. Where appropriate, present a client or employer with choices among valid alternative approaches that may vary in scope, cost, or precision. Apply analytical methods and procedures scientifically, without predetermining the outcome. Resist any pressure from employers and clients to produce a particular "result," regardless of its validity.

Colleagues. Analytics professionals have a responsibility to promote the effective and efficient use of analytical methods by all members of research teams and to respect the ethical obligations of members



of other disciplines. When possible, professionals share nonproprietary data and methods with others; participate in peer review, focusing on the assessment of methods not individuals. Respect differing professional opinions while acknowledging the contributions and intellectual property of others. Those professionals involved in teaching or training students or junior analysts have a responsibility to instill in them an appreciation for the practical value of the concepts and methods they are learning. Those in leadership and decision-making roles should use professional qualifications with regard to analytic professionals' hiring, firing, promotion, work assignments, and other professional matters. Avoid harassment of or discrimination based on professionally irrelevant bases such as race, color, ethnicity, gender, sexual orientation, national origin, age, religion, nationality, or disability.

Research Subjects. If a project involves research subjects, including census or survey respondents, an analytics professional will know and adhere to the appropriate rules for the protection of those human subjects. Be particularly aware of situations involving vulnerable populations that may be subject to special risks and may not be able to protect their own interests. This responsibility includes protecting the privacy and confidentiality of research subjects and data concerning them.

INFORMS and Profession. Analytics professionals will strive for relevance in all analyses. Each study or project should be based on a competent understanding of the subject-matter issues, appropriate analytical methods, and technical criteria to justify both the practical relevance of the study and the data to be used. Guard against the possibility that a predisposition by investigators or data providers might predetermine the analytic result. Remain current in constantly changing analytical methodology, as preferred methods from yesterday may be barely acceptable today and totally obsolete tomorrow. Disclose conflicts of interest, financial and otherwise, and resolve them. Provide only such expert testimony as you would be willing to have peer reviewed. Maintain personal responsibility for all work bearing your name; avoid undertaking work or coauthoring publications for which you would not want to acknowledge responsibility.

Alleged Misconduct. Certified Analytics Professionals will strive to avoid condoning or appearing to condone careless, incompetent, or unethical practices. Misconduct broadly includes all professional dishonesty, by commission or omission, and, within the realm of professional activities and expression, all harmful disrespect for people, unauthorized or illegal use of their intellectual and physical property, and unjustified detraction from the reputation of others. Recognize that differences of opinion and honest error do not constitute misconduct; they warrant discussion, but not accusation. Questionable scientific practices may or may not constitute misconduct, depending on their nature and the definition of misconduct used. Do not condone retaliation against or damage to the employability of those who responsibly call attention to possible scientific error or misconduct.

References.

1. Saul I. Gass, Ethical guidelines and codes in operations research, (2009), 1044–1050.
2. American Statistical Association, Ethical Guidelines for Statistical Practice, August 7, 1999.
3. U.S. federal regulations regarding human subjects protection are contained in Title 45 of the Code of Federal Regulations, Chapter 46 (45 CFR 46).

CERTIFICATION RENEWAL PROCESS

One of the hallmarks of a strong professional certification program is the implementation of a process to help ensure the continuing competence of certificants in the discipline. INFORMS will use a Professional Development Unit (PDU) system similar to those used in other professional certifications.

All certificants must participate in an ongoing formal renewal process to maintain their certification status. Certificants must demonstrate compliance with renewal requirements during their three-year certification cycles.



Professional Development Unit (PDU) Requirements

All CAP® certificants will be required to achieve a minimum of 30 PDUs in a three (3)-year renewal period. The table following describes various options for achieving the required PDUs along with any required minimum or maximum PDUs specified in each category.

PDU category	Description of policy	PDU points allowed
Participation as a student in formal education/training programs provided on analytics topics	This option includes courses, seminars, and workshops on analytics-related issues.	One (1) PDU per each hour of instruction. Certificants must achieve at least 8 PDUs in this category during the three-year renewal period.
Self-directed learning	This category includes reading articles and books or watching instructional videos on analytics issues.	One (1) PDU per each hour of self-directed learning. Certificants may earn a maximum of 10 hours in this category in a three-year period.
Creating new analytics knowledge or content including serving as faculty at learning events	Examples in this category include authoring articles, books, newsletters, etc. PDUs are also awarded for serving as faculty at various learning events.	One (1) PDU is awarded for each hour of activity spent in these activities.
Volunteer service	Examples in this category include serving as a volunteer for INFORMS or its regional chapters, working on analytics meetings, or assisting the certification process.	One (1) PDU is awarded for each hour of volunteer service. Certificants may earn a maximum of 10 hours in this category in a three-year period.
Analytics professional work experience	Full-time employment as an analytics professional for a minimum of one (1) year.	Five (5) PDUs are awarded for each full year of employment as an analytics professional.

All claimed PDUs must be submitted/verified to INFORMS prior to the conclusion of a certificant's three-year renewal cycle. Certificants are reminded that they will not be able to claim more than the maximum PDUs allowed in any specific category.

Recording PDUs and the Audit Process

Certificants are required to keep accurate records of all professional development activities including all certificates/letters confirming attendance and/or participation in approved education/training programs. Certificants must present all required PDU records to INFORMS before certification renewal will be granted. Certificants can input their PDUs as they are earned on the INFORMS website at <https://certifiedanalytics.org>.

INFORMS will periodically audit a sample of certificants to verify the PDUs claimed in their renewal application.

Transfer of Excess PDUs to the Next Renewal Cycle

Certificants earning more than the required 30 PDUs in their three-year renewal cycle may transfer a maximum of five (5) PDUs to their next renewal cycle. The transferred PDUs may be from any category.

Changes in the Name and Address of Certificants

All candidates and certificants must notify INFORMS immediately of any change in their name or address used for purposes of commutation regarding certification matters.



Notify INFORMS in one of the following methods:

1. Email notification to info@certifiedanalytics.org.
2. Call INFORMS certification staff at +1-443-757-3500 or 1-800-446-3676.
3. Fax notification to INFORMS at +1-443-757-3515.
4. Enter changes to your record online.

USE OF THE CAP® CREDENTIAL

Once certificants receive written confirmation from INFORMS regarding their new certification status, they may use the CAP® mark after their name. Always list the designation in block (capital) letters. The CAP® designation may only be used in conjunction with a certificant's name. The CAP® designation should not be used in reference to a company or organization. The CAP® logo may also be used on letterhead and personal websites with INFORMS approval.

INFORMS will send new certificants a packet of materials including the following:

- Letter conferring certification status
- Information on the dates of the certification cycle for renewal purposes
- A unique certification number
- A certification certificate

Unless otherwise requested, INFORMS will publish an official list/registry of all current CAP®s on its website at <http://certifiedanalytics.org>

CONTACT INFORMS

For more information about the CAP® program and its policies, please contact us:

INFORMS

ATTN: Certification Manager

5521 Research Park Drive, Suite 200

Catonsville, Maryland 21228 USA

Phone: +1-443-757-3500 or 1-800-446-3676

Fax: +1-443-757-3515

Email: certification@informs.org

Web: www.informs.org/Build-Your-Career/Analytics-Certification



CAP® Certification Application and Agreement

Please **PRINT** the following information.



1 Personal Information

INFORMS Membership ID # (if applicable)

First name Middle initial Last name

Job title Company/organization name

Address ☐ work ☐ home

City State Zip/Postal Country

Phone ☐ office ☐ home ☐ cell

E-mail

Please do not include me in:

- ☐ Non-INFORMS mail lists
- ☐ Non-INFORMS email lists
- ☐ INFORMS email

Primary Employment Classification

- ☐ Academic
- ☐ Government
- ☐ Business
- ☐ Consulting
- ☐ Retired, unemployed, other

☐ I prefer to be excluded from the online certification registry.

2 Education

Accredited
Institution: _____

Highest degree attained: (circle one)

PhD Master's Bachelor's

Year graduated: _____

Field of Study

- ☐ Analytics
- ☐ Operations research
- ☐ Management science
- ☐ Statistics
- ☐ Engineering
- ☐ Logistics
- ☐ Business (and directly related areas such as marketing, finance, etc.)

Reason for Applying

What is your reason for applying for the CAP® certification?

- ☐ Professional development
- ☐ Employer suggestion
- ☐ Employer requirement
- ☐ Other (please specify)

- ☐ Applied or theoretical mathematics
- ☐ Information technology
- ☐ Computer science
- ☐ Decision science
- ☐ Marketing science
- ☐ Data science
- ☐ Other (please specify)

Note: At least seven (7) years of analytics-related work experience is required for individuals holding a BS/BA degree or higher in an education area unrelated to analytics.

All applicants are required to submit either a photocopy or an official version of their final college or university transcript indicating the date of graduation and degree title. **If application is incomplete at the time of examination, applicants will have 90 days to complete the application and be awarded the CAP®.**

CAP® Certification Application and Agreement (cont.)

Please PRINT the following information in your certificate application.

3

Professional Analytics-Related Experience

Job Title	Employer			
Employer Street Address	City	State/Province/Territory	Zip/Postal	Country
Employer Phone number				
Years of analytics experience (overall)	Dates of experience			
Description of analytics role/responsibilities				

Primary contact who is not a close relative for verification purposes on professional analytics experience:

First name	Last name
Relationship (circle one) Supervisor Project sponsor Project manager Client Other (please specify)_____	
Email address	Phone number

Note: All applicants must have a current or previous employer/supervisor or client who is not a close relative of applicant submit the Confirmation Statement on Analytics Soft Skills to INFORMS before certification status can be granted. A copy of this Statement is provided in the Candidate Handbook. Candidates may apply for certification and take the certification examination prior to the receipt of this statement by INFORMS, but final certification status cannot be granted until all application documents, including an official signed statement are received by INFORMS.

Special Accommodations Request

_____ Please check here if you are requesting special accommodations for your examination. Please submit the Certification Special Accommodations form found in the Appendix of this handbook. All supporting documentation must be included with your application and submitted within the required time frame in advance of your anticipated examination date.

INDUSTRY CLASSIFICATION

Indicate ALL areas of your professional analytics and OR/MS activities.

- | | | | |
|---|--|--|---|
| <input type="checkbox"/> Agriculture, Forestry, Fishing | <input type="checkbox"/> eCommerce | <input type="checkbox"/> Law Enforcement | <input type="checkbox"/> Pharmaceuticals |
| <input type="checkbox"/> Analytics | <input type="checkbox"/> Environmental | <input type="checkbox"/> Manufacturing | <input type="checkbox"/> Real Estate |
| <input type="checkbox"/> Arts and Entertainment | <input type="checkbox"/> Finance/Insurance | <input type="checkbox"/> Marketing | <input type="checkbox"/> Retail |
| <input type="checkbox"/> Chemical/Process | <input type="checkbox"/> Govt (non-military) | <input type="checkbox"/> Military | <input type="checkbox"/> Telecommunications |
| <input type="checkbox"/> Construction | <input type="checkbox"/> Healthcare | <input type="checkbox"/> Mining, Oil/Gas | <input type="checkbox"/> Transportation/Warehousing |
| <input type="checkbox"/> Education | <input type="checkbox"/> Info Systems & Tech | <input type="checkbox"/> Nonprofit | <input type="checkbox"/> Utilities, Water/Power |

4

Payment Information

Certification/examination fees (payable in U.S. dollars)

EXAM FORMAT	MEMBER	NON-MEMBER
Paper & Pencil	\$495	\$695
Computer Based	\$495	\$695

Note: Member rates **apply only** to current INFORMS members in good standing as of the date this application has been submitted, or certification partners.

Payment method:

_____ Check Enclosed (Make payable to INFORMS and must be drawn on U.S. bank in U.S. dollars.)
_____ MasterCard _____ Visa _____ American Express _____ Discover

Please send completed forms to either
certification@informs.org,
fax to 443.757.3515, or mail to:

Certification Manager
INFORMS
5521 Research Park Drive, Suite 200
Catonsville, MD 21228

Card # (15 digits)	Expiration date
Signature	

CAP® Certification Application and Agreement (cont.)



- 1 I agree to comply with and conduct myself in accordance with all INFORMS certification program policies and requirements. In addition, I agree not to discuss, debrief, or disclose, in any manner, the specific content of INFORMS examination questions and answers to any individual.
- 2 I agree to notify INFORMS in a timely manner regarding changes concerning the information provided, including my current name, address, email address, and telephone number.
- 3 I agree that INFORMS has the right to communicate with any person, government agency, or organization to review or confirm any of the information submitted in conjunction with my application for certification. Furthermore, I agree to and authorize the release of any information requested by INFORMS for such review and confirmation.
- 4 I agree that all materials that I submit to INFORMS become the property of INFORMS and that INFORMS is not required to return any of these materials to me.
- 5 I agree that upon achieving certification status, my name may be posted on the INFORMS certification website as part of an online registry to be created and maintained by INFORMS.
- 6 I agree that all disputes relating to my application or certification status will be resolved solely and exclusively in accordance with INFORMS certification policies, procedures, and appeals processes.
- 7 INFORMS reserves the right to suspend or revoke the certification of any individual who is determined to have failed to uphold or otherwise breached this agreement.
- 8 I agree to return my certificate to INFORMS if for any reason I fail to maintain certification status or if my certificate is revoked for cause.
- 9 I release and indemnify INFORMS from all liability and claims that may arise related to my analytics activities.
- 10 I hereby release, discharge, and indemnify INFORMS, its directors, officers, members, staff, and representatives/agents from any actions, suits, obligations, damages, claims, or any other action taken in connection with this application and my examination.

_____ I have read and understand all of the policies and procedures described in the Candidate Handbook.

_____ I have read, understand, and agree to the policies and procedures described in the CAP® Code of Ethics.

_____ I have read and accept the terms and responsibilities outlined in the INFORMS Certification Application and Agreement.

_____ I declare that all of the information I have provided is accurate and true. Furthermore, I understand that any misrepresentation or incorrect information provided to INFORMS can result in disciplinary action, up to and including the suspension of my eligibility for certification.

Name (please print)

Signature

Date

Confirmation Statement on Analytics Soft Skills

Certified Analytics Professional (CAP®) Credential



For further information on the CAP® credential, please visit www.INFORMS.org/certification

The bottom of this form must be signed (by hand) by a contact who is familiar with your analytics work. The completed and signed form must be returned to INFORMS by the contact in one of the two methods:

1. The preferred method is for your employer to scan the completed signed form and send it as PDF to the INFORMS Certification Manager at certification@informs.org.
2. A secondary method is to return the completed signed form to INFORMS by postal mail. Please send completed forms to
Certification Manager
INFORMS
5521 Research Park Drive, Suite 200
Catonsville, Maryland 21228 USA

Candidates should request that their contact notify them by email when the completed signed form has been returned to INFORMS.

Please **PRINT** the following information.

TO BE COMPLETED BY CERTIFICATION APPLICANT

Applicant first name	Middle initial	Last name
Applicant job title		Company/organization name
Applicant email		Phone number

SOFT SKILLS CONFIRMATION STATEMENT

As a contact for the above applicant for the Certified Analytics Profession (CAP®) credential, it is my opinion that the applicant possesses and demonstrates an acceptable level of analytical "soft skills" noted below to adequately perform the job of an analytics professional.

- ☐ Partnering with Business Clients: Ability to identify, establish professional relationship, and communicate with analytics clients in order to understand business needs.
- ☐ Framing Problems with Stakeholders: Ability to research and construct problem frames in order to understand the analysis context and scope that will provide timely, useful results.
- ☐ Working in Project Teams: Ability to lead and participate in multidisciplinary analytics project teams.
- ☐ Interviewing Subject Matter Experts: Ability to plan and conduct individual interviews with experts to gain valid information and data needed for analysis.
- ☐ Eliciting Information from Groups: Ability to plan and conduct group elicitation sessions with committees or other working groups to develop and assess alternatives, uncertainties, and value and risk preferences.
- ☐ Communicating Results to Decision Makers: Ability to explain the results and conclusions of the analytics process in both written and oral presentation formats.
- ☐ Delivering Value: Ability to create recommendations that are practical, actionable, and have material impact, in addition to being well-supported by analytical models and data.

TO BE COMPLETED BY CONTACT

Contact name (please print)	_____	
Contact signature	_____	
Title/position of contact	_____	
Company/organization of contact	_____	
Date of signature	_____	
Business telephone number	_____	
Email address	_____	
Dates of applicant employment	Start _____	Finish _____

Please return this signed form to INFORMS as soon as possible in one of the methods noted above. Thank you very much for your assistance in helping confirm the eligibility of an applicant for the Certified Analytics Professional (CAP®) credential.

Certification Examination Special Accommodations Form

Certified Analytics Professional (CAP®) Credential

Please PRINT the following information.

TO BE COMPLETED BY CERTIFICATION APPLICANT

First name Middle initial Last name

Email

Phone number



For further information on the CAP® credential, please visit www.INFORMS.org/certification

Please describe the disability that significantly impairs your ability to complete the CAP® examination.

Please list the specific testing accommodation requested.
Feel free to use additional separate sheets if needed.

Note: You must also provide the INFORMS Certification Department with written documentation from a licensed/certified healthcare provider supporting the need for the accommodation requested. This documentation should include a statement describing your disability, diagnosis of your health condition, and a specific recommendation for the type of accommodation requested.

INFORMS will not be able to process any request for an accommodation related to compliance with the Americans with Disabilities Act of 1990 until both this Accommodation Request form and the required healthcare provider documentation have been submitted to INFORMS.

Signature

Date

