

## A survey of senior practitioners regarding most desirable qualifications for hiring and advancement within forensic science



Catherine O. Brown<sup>\*</sup>, Barry K. Logan, Heather E. McKiernan

The Center for Forensic Science Research & Education, 2300 Stratford Ave, Willow Grove, PA, 19090, USA

### ARTICLE INFO

#### Article history:

Received 20 May 2019

Received in revised form

26 August 2019

Accepted 11 September 2019

Available online 12 September 2019

#### Keywords:

Forensic science

Undergraduate education

Graduate education

Laboratory survey

Educational requirements

### ABSTRACT

In today's environment in the field of forensic science where continual advancements in technology and analytical approaches are the norm, the need for forensic practitioners with more specialized and subject-specific knowledge is critical. An updated survey targeting the preferred educational requirements by senior practitioners, crime laboratory directors and managers for entry level applicants was conducted. Results underscored a preference for specialized coursework within specific disciplines in preparing the next generation of forensic scientists while maintaining a strong foundation in the natural sciences at the undergraduate level. Practitioners, regardless of discipline, are seeking applicants with exposure to advanced curriculum content in addition to refined professional skills and critical thinking capabilities. The results of this survey reflect a transition in the needs of crime laboratory employers from a general, broad based criminalistics curriculum as described under current accreditation guidelines, to a focused subject matter rich curriculum with additional management and professional content.

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### 1. Introduction

Practitioners and educators have long maintained a collaborative relationship in efforts to promote the continuous growth of the ever-evolving field of forensic science. It is understood that educational standards are vital in producing a strong workforce of scientists, supervisors and managers to service the criminal justice community. The academic community saw a proliferation of forensic science degree programs in the early 2000s corresponding with the glamorization of the field by the media and popularity of forensic television shows. Initially, in the absence of any guidelines or accrediting bodies, academic institutions could designate anything a forensic science degree, even in the absence of any foundation in natural sciences. In 2009, the National Academy of Sciences (NAS) report proposed a revision of undergraduate and graduate programs in forensic science to address the existing deficiencies in the comprehension of scientific principles and methods [1]. Subsequently, the forensic education community has continued to produce undergraduate and graduate program

offerings. A search of the Princeton Review returned 90 academic institutions with majors in forensic science and 147 offerings for criminology majors in the United States and Canada. A more thorough review of the curricula for these programs, however, demonstrates that despite the NAS report, a large percentage of “forensic science” programs still emphasize criminal justice courses in lieu of a strong foundation in the natural sciences. A lack of strong practitioner involvement in many of these startup programs has facilitated the promulgation of academic programs that do not prepare graduates for careers in forensic science. Unfortunately, the naiveté of incoming students about the field makes it difficult for them to assess the strengths and weaknesses of programs offered.

The Technical Working Group on Education and Training in Forensic Science (TWGED) was created by the National Institute of Justice (NIJ) in 1999, a decade prior to the release of the NAS report. The assembled group of forensic science educators, laboratory directors, and trainers were responsible for developing strategies to adequately meet the educational needs of the field. A detailed report including curricular recommendations for both undergraduate and graduate degree programs was published, specifically addressing the basis to support entry into a career in the field of criminalistics [2]. The sample curriculum for undergraduate degrees in forensic science included a natural science core, supplemented with forensic science-specific courses, suggesting a

<sup>\*</sup> Corresponding author.

E-mail addresses: [catherine.brown@frfoundation.org](mailto:catherine.brown@frfoundation.org) (C.O. Brown), [barry.logan@frfoundation.org](mailto:barry.logan@frfoundation.org) (B.K. Logan), [heather.mckiernan@frfoundation.org](mailto:heather.mckiernan@frfoundation.org) (H.E. McKiernan).

minimum of 46 credit hours and 15 credit hours, respectively. Corresponding recommendations were not made for graduate degree programs. Rather, a general list of topics covering multiple disciplines was provided.

In 2001, the TWGED recommendations were adopted by the Forensic Education Programs Accreditation Commission (FEPAC) organized under the American Academy of Forensic Sciences (AAFS), to create a basis for the accreditation of forensic science degree programs. At the time of publication, 28 bachelor's in forensic science programs and 21 master's in forensic science programs have been accredited by FEPAC. Although the TWGED recommendations and formation of FEPAC were major steps toward advancement of standardization of educational requirements in forensic science, the scope of degree programs eligible for this distinction is narrow. Currently, programs offering a generalist approach (i.e., those requiring a broad spectrum, multidisciplinary program of study) can apply for FEPAC review and accreditation. These programs educate students on a variety of principles that can be applied to a broad range of career opportunities. In contrast, specialized academic programs focus on a specific topic or discipline with the aim of generating subject-matter experts in a narrow field.

The FEPAC guidelines allow institutions to offer an option for students to “track select” a concentration; enabling students to enroll in elective courses in a selected field. However, when specifically reviewing FEPAC accredited graduate programs, the degree designation and thus, majority of the curriculum (half of required credits) is still comprised of a wide range of generalist courses, prohibiting true depth of coverage in a given discipline which is atypical at the graduate level. With the exception of perhaps digital forensics, no other specialized programs at the graduate level has an active accrediting body. While a general understanding of forensic science as a multidisciplinary endeavor is critical, the operating model for the practice of forensic science continues to evolve from generalist to specialist. There is, however, a growing divide between general academic preparedness affording a basic level of understanding over a range of topics, and the need for a much greater depth of knowledge within specific disciplines expected in new hires within the practitioner community.

Over the past three decades, multiple reviews of forensic science education and degree program offerings have been published. A survey targeting strictly practitioners was conducted in 1988 [3], 1994 [4], and again in 1999 [5]. The consensus view was that a bachelor's of science (BS) in chemistry was the most desirable educational background for a successful career in forensic science, noting that a BS in forensic science frequently lacked basic but essential scientific knowledge critical to understanding forensic testing techniques [3,5–9]. As the number of institutions offering programs in forensic science increased, the variability observed in degree requirements at both the undergraduate and graduate level has become apparent.

This study was designed to collect information from the employers' perspective on the most desirable educational qualifications and skill sets of applicants for entry level forensic science jobs, over a range of disciplines, in order to better strengthen academic programs to meet these expectations and better prepare the incoming workforce for a successful career in the profession. In addition, the results of this study detail current emerging issues that go beyond the topics originally contemplated by TWGED, and how they should be addressed in educational programs. Finally, we make recommendations on how to improve accreditation practices and requirements to recognize programs designed to meet the needs identified by the management professionals hiring tomorrow's forensic scientists.

## 2. Methods

The research was performed through an electronic survey using SurveyMonkey® and solicited through a third party individual. Participants had access to the survey between October 2018 and December 2018. Participants were recruited via email distributed to the membership of the American Society of Crime Laboratory Directors (ASCLD) via their weekly Crime Lab Minute. As those directors and leaders in the community receiving this distribution forwarded this link to senior hiring managers from industry and research organizations, there is no way to ascertain the total number of individuals whom received the link to participate. No paper copies of the survey were circulated. The survey was designed to solicit information on educational requirements of entry level forensic scientist applicants, with the target audience being crime laboratory directors and senior practitioners.

A total of 58 surveys were completed, consistent with response numbers obtained in previously published papers on this topic [3–5]. Data from all respondents were compiled for this publication.

## 3. Results

### 3.1. Respondents' laboratory demographics

Of the 58 completed surveys, a majority (86%) of respondents represented a public crime laboratory, 7% represented a private laboratory, 3.5% of responses were from industry/manufacturer, and 3.5% of respondents were from research and development organizations (Fig. 1). For additional clarification on laboratory size, participants were asked to disclose the number of scientists employed by their organization. In 23 cases (40%), the laboratory employed over fifty forensic scientists. Nineteen respondents (33%) reported employing 11 to 30 scientists, 15% employed between 31 and 50 scientists, and only 12% reporting staffing 10 or fewer forensic scientists (Fig. 2). A majority (87%) of these institutions do not require applicants to complete a civil service test for employment.

The testing services these institutions offer were evenly distributed over the range of common disciplines within a forensic laboratory including drug chemistry, serology, pattern analysis, toxicology, firearms analysis, genetic testing, arson, crime scene

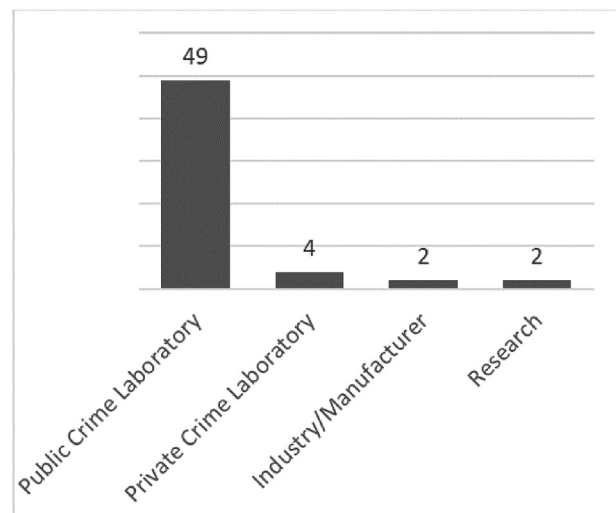


Fig. 1. Demographic of survey respondents.

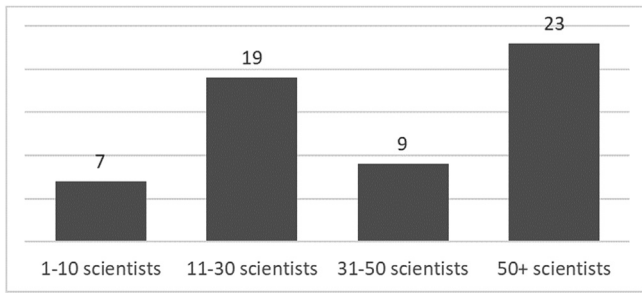


Fig. 2. Number of employees working at the responding organizations.

investigation, and research and development (Fig. 3).

### 3.2. Workforce readiness of forensic science degree graduates

In order to gauge current opinions concerning applicant educational qualifications, participants were asked a series of questions regarding the career-readiness of graduates from forensic science degree programs (both undergraduate and graduate). When asked if undergraduate academic programs in forensic science produce graduates that meet their needs for new hires within their organization, participants were on average 56% satisfied with the quality of students produced (median: 58, mode: 63). This satisfaction rating increased to 69% (median: 72, mode: 50) when asked if graduate programs in forensic science produce graduates that meet their needs for new hires within their organization. Survey participants responded that a master's degree is only 52% important for employees advancing to a supervisory position, when provided with a scale ranging from 1 to 100% (median: 52%, mode: 50%). When asked about their familiarity with FEPAC accreditation guidelines, 47% of respondents replied in the affirmative, 25% indicated they were somewhat familiar and 28% of respondents had no familiarity with FEPAC accreditation guidelines (Fig. 4).

When asked to select the two most important factors (out of 9 provided options) considered when selecting an employee for an entry level position, discipline specific coursework/advanced curriculum (n = 34) and laboratory experience (n = 29) were ranked

the highest by potential employers (Fig. 5). Interview performance (n = 22) and maturity/character of the applicant (n = 23) rated high among the available options. Performance on written assessment (n = 3), academic faculty reference (n = 1), and academic program's connection with a working crime lab (n = 1) were less frequently considered. No participants selected leadership experience or an applicant with a FEPAC accredited degree as deciding factors during the hiring process. When asked what they would prefer in a graduate level forensic science degree program, the majority of participants (78%) preferred candidates and thus, degree programs that offered a greater depth of coverage with focus in a specific discipline as opposed to applicants with a graduate degree that provided a wider breadth of coverage across all forensic disciplines. These were the only two answer selections provided to participants.

Survey participants were then asked in regard to the current applicants with a graduate degree seeking an entry level position within their laboratory what areas of workforce preparation are currently the weakest (Fig. 6). Participants were able to select as many answer options as they pleased. A total of eight choices were provided with the option for write-in response. A lack of professional skills (*i.e.*, effective communication, conflict management, financial management, strategic management, etc.) was most frequently cited (n = 33) as a desired qualification lacking in current job applicants. A lack of hands-on experience with instrumentation (n = 30) and poor testimony training (n = 26) followed closely. Employers also expressed that applicants are often deficient in quality assurance/quality control (n = 18), technical training (n = 13), and mathematical understanding (n = 13). A lack of, or poor quality internship and research experiences, rounded out the list of areas for improvement, each receiving 10 responses.

When asked for the preferred area of study for an entry level scientist, 8 times as many participants preferred a bachelor's of science in a natural science (n = 36) over a bachelor's of science in forensic science (n = 5). With regard to an advanced degree, however, twice as many respondents preferred a master's of science in forensic science (n = 10) over a master's of science in a natural science (n = 5).

Lastly, when asked if management experience as part of a degree program, such as that found within a professional science

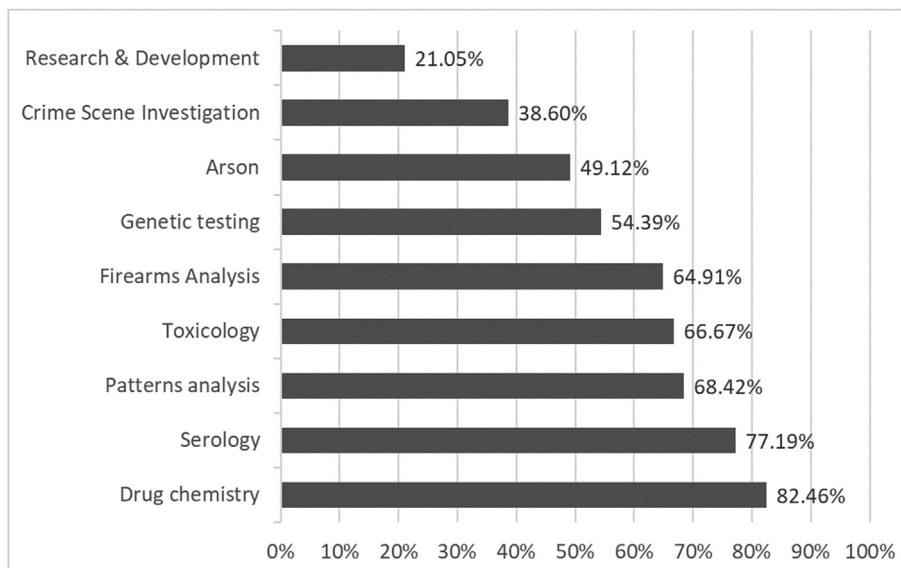


Fig. 3. Testing services offered by survey participant organizations.

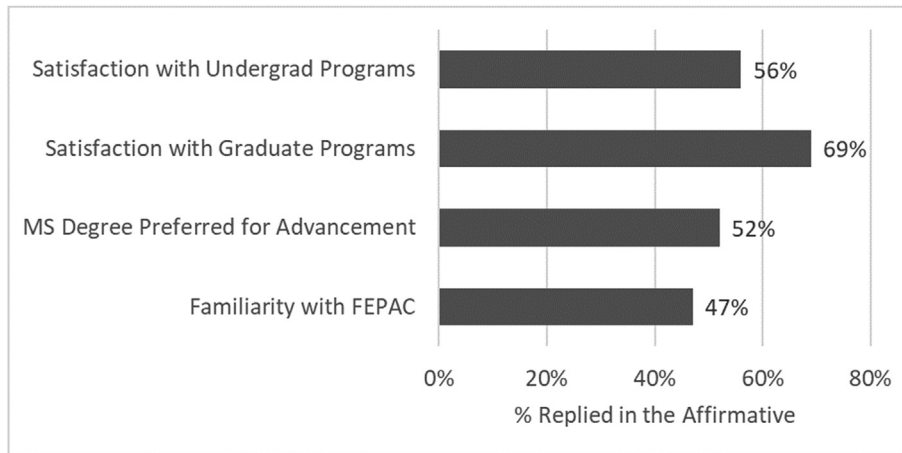


Fig. 4. Participant responses regarding workforce readiness of current graduates entering the field of forensic science.

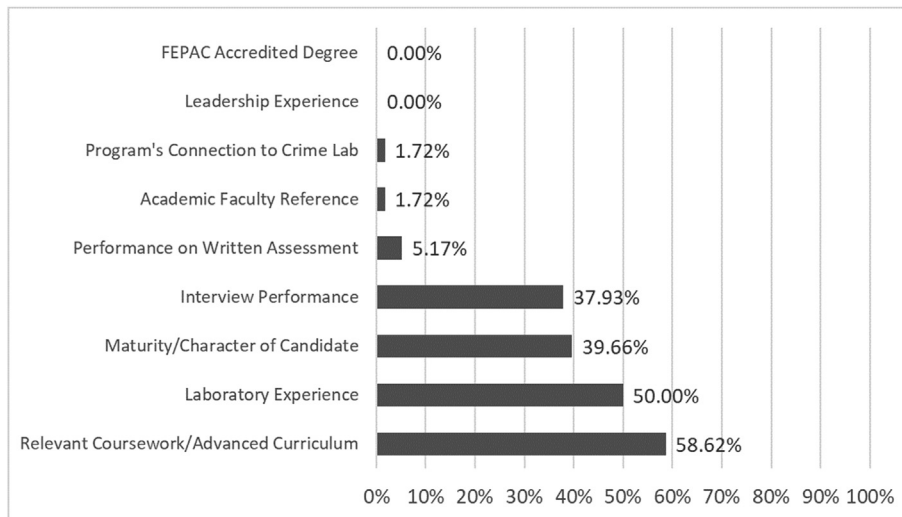


Fig. 5. Factors most greatly considered when selecting an employee for an entry level position with no previous relevant work history.

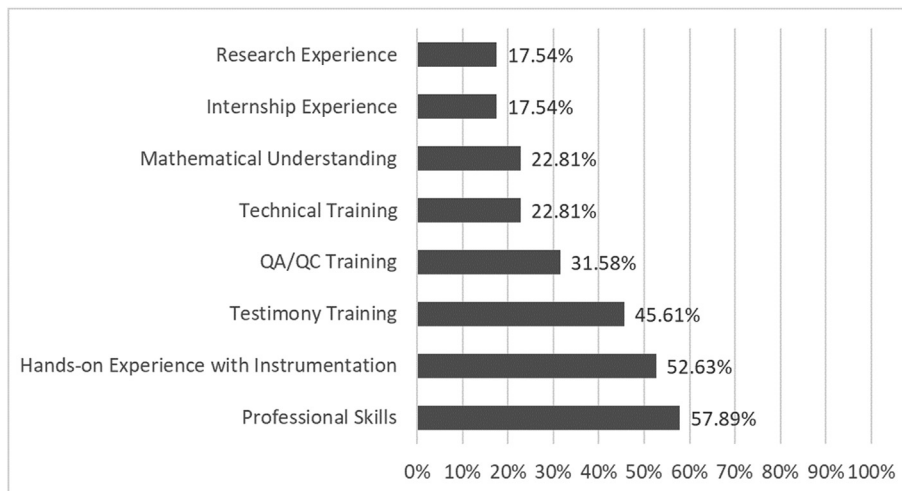


Fig. 6. Workforce preparation characteristics that are currently weakest in applicants with a graduate degree seeking an entry level position.

**Table 1**

Degree recommendations for applicants seeking a drug chemistry position. Recommended number of credits are reported by the Scientific Working Group for the Analysis of Seized Drugs (SWGDRUG).

DRUG CHEMISTRY	Recommended Number of Credits	% Respondents in Agreement with Recommendations	% Respondents Advocating for Additional Credits
General Chemistry	6	82%	18%
Organic Chemistry	6	76%	24%
Analytical Chemistry	3	47%	53%
Physical Chemistry	0	11%	89%
Inorganic Chemistry	0	12%	88%
Biochemistry	0	38%	62%
Pharmacology	0	15%	85%
Statistics	0	10%	90%
Crime Scene Investigation	0	73%	27%
Patterns Analysis	0	92%	8%
Microscopy & Materials Analysis	0	22%	78%
Forensic Biology	0	78%	22%

degree, was considered for promotion to supervisory/management positions, the majority of participants (84%) desired this type of academic management experience while 16% of respondents indicated that this type of academic management experience would not be considered during promotion review.

### 3.3. Review of curricular requirements

Participants were asked to provide their preferred number of credits for various courses for applicants seeking entry level positions in drug chemistry, toxicology, and serology/DNA. Following a traditional semester-based model, participants were allowed to select 0 credits (no courses recommended), 3 credits (42 contact hours), 6 credits (84 contact hours), or 9 credits (126 contact hours) for each subject matter listed. Courses included in the questions were representative of forensic science course offerings for both accredited and non-accredited degree programs at the undergraduate and graduate level. Responses were compared to the minimum education requirements established for each of these fields. The Scientific Working Group for the Analysis of Seized Drugs (SWGDRUG) Recommendations [10] were referenced for drug chemistry (Table 1). The Scientific Working Group for Forensic Toxicology (SWGTOX) Standard for Laboratory Personnel [11] was referenced for toxicology (Table 2). The FBI's Quality Assurance Standards [12] were referenced for serology/DNA analysis (Table 3).

Overall, senior practitioners and laboratory directors are satisfied with general education requirements (*i.e.*, general biology and general chemistry) recommended by those organizations listed above, however, respondents consistently desired greater depth of

knowledge in the form of more advanced subject-relevant electives than what is currently recommended (Tables 1–3). Furthermore, the inclusion of general criminalistics coursework (*i.e.*, patterns analysis and crime scene investigation) was largely not considered valuable by directors and senior practitioners during applicant review. Instead, a truly specialized degree program with emphasis on multiple advanced courses in a given area of study that builds upon a natural science underpinning would better serve students for preparation in the desired forensic discipline.

## 4. Discussion and conclusion

With continuous developments in technology and analytical approaches forcing changes and creating new opportunities in the practice of forensic science, the need for specialists with more advanced and in-depth knowledge is clearly needed. While there still may be a place in the profession for the true “generalist” (*e.g.*, small crime laboratories, legacy laboratories with seasoned professionals), today's highly technical, externally regulated, ISO accredited environment and the complexity of testimony demands ever-increasing levels of expertise and specialization. Forensic science educators have a role to play in ensuring that the needs of the profession are heard and reflected in graduate level curricular requirements. The distinction between education and training, however, must be maintained. Specialization in an academic sense necessitates a greater depth of understanding and critical thinking within a specific discipline which is not analogous to awareness and training on *how* to complete job specific tasks while lacking the understanding of *why*.

**Table 2**

Degree recommendations for applicants seeking a toxicology position. Recommended number of credits are reported by the Scientific Working Group for Forensic Toxicology (SWGTOX).

TOXICOLOGY	Recommended Number of Credits	% Respondents in Agreement with Recommendations	% Respondents Advocating for Additional Credits
General Chemistry	6	92%	8%
Organic Chemistry	6	88%	12%
Analytical Chemistry	3	44%	56%
Physical Chemistry	0	15%	85%
Inorganic Chemistry	0	8%	92%
Biochemistry	0	16%	84%
Pharmacology	3	59%	41%
Statistics	3	93%	7%
Crime Scene Investigation	0	87%	13%
Patterns Analysis	0	88%	13%
Forensic Biology	0	63%	38%
Microscopy & Materials Analysis	0	64%	36%



**Table 3**  
Degree recommendations for applicants seeking a serology/DNA analysis position. Recommended number of credits are reported by the FBI's Quality Assurance Standards.

DNA ANALYSIS/SEROLOGY	Recommended Number of Credits	% Respondents in Agreement with Recommendations	% Respondents Advocating for Additional Credits
General Chemistry	6	48%	52%
Organic Chemistry	6	58%	42%
General Biology	6	42%	58%
Genetics	3	55%	45%
Serology	0	12%	88%
Molecular Biology	3	54%	46%
Immunology	0	46%	54%
Biochemistry	3	55%	45%
Statistics	3	62%	38%
Crime Scene Investigation	0	63%	38%
Patterns Analysis	0	83%	17%
Microscopy & Materials Analysis	0	40%	60%
Drug Chemistry/Toxicology	0	96%	4%

Regular updates from the practitioner community regarding the most highly desirable qualifications in new hires should be heavily considered by academics. Trends in responses from the profession should help to shape the future of educational programs in forensic science, ensuring a stronger workforce ready to face the challenges of the rapidly evolving field that is modern forensic practice. Based on the responses obtained through this survey, the importance of specialized education at the graduate level in the preparation for the next generation of forensic scientists cannot be overstated.

#### Declarations of interest

None.

#### Funding

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

#### Acknowledgements

The authors wish to thank ASCLD for their input in the design of this survey and for its distribution. They would also like to thank all of the other senior practitioners and hiring managers from the public and private sector who were contacted and responded to this survey.

#### Appendix A. Supplementary data

Supplementary data to this article can be found online at

<https://doi.org/10.1016/j.fsisyn.2019.09.004>.

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