



# Software engineering profession

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# Software engineering (SWE)

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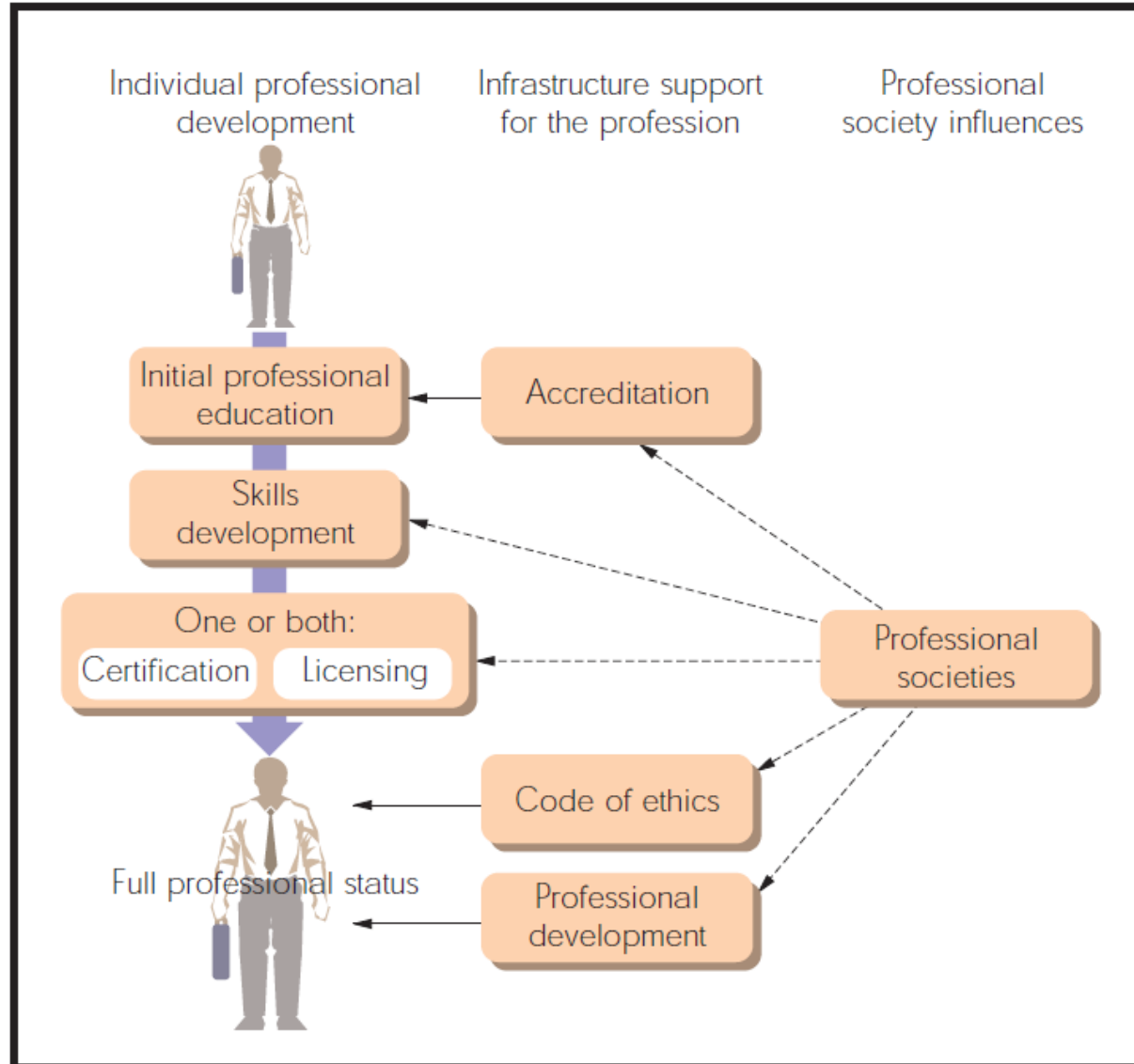
- ◆ the application of engineering to the development of software in a systematic method [ACM]
- ◆ the application of a systematic, disciplined, quantifiable approach to the development, operation, and maintenance of software; that is, the application of engineering to software [ISO/IEC/IEEE]
- ◆ an engineering discipline that is concerned with all aspects of software production [Sommerville]

# What is a Software Engineer?

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- ◆ a person who applies the principles of software engineering to the design, development, maintenance, testing, and evaluation of computer software [[wikipedia](#)]
- ◆ a specialized type of Engineer. Also known as: Software Developer, Software Architect, Software Development Engineer, Computer Software Engineer [[careereexplorer](#)]
- ◆ a licensed professional engineer who is schooled and skilled in the application of engineering discipline to the creation of software [[webopedia](#)]

# Professional development



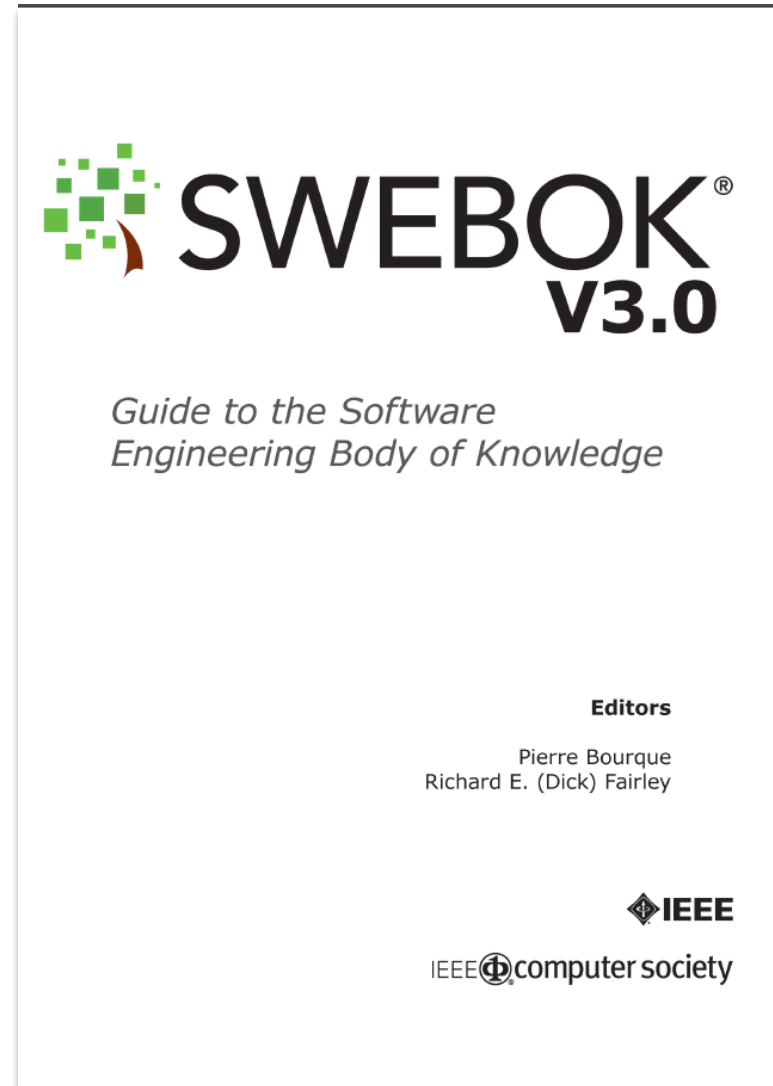
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# **SWE Book of Knowledge**

# SWE Book of Knowledge (SWEBOK) – Knowledge Areas

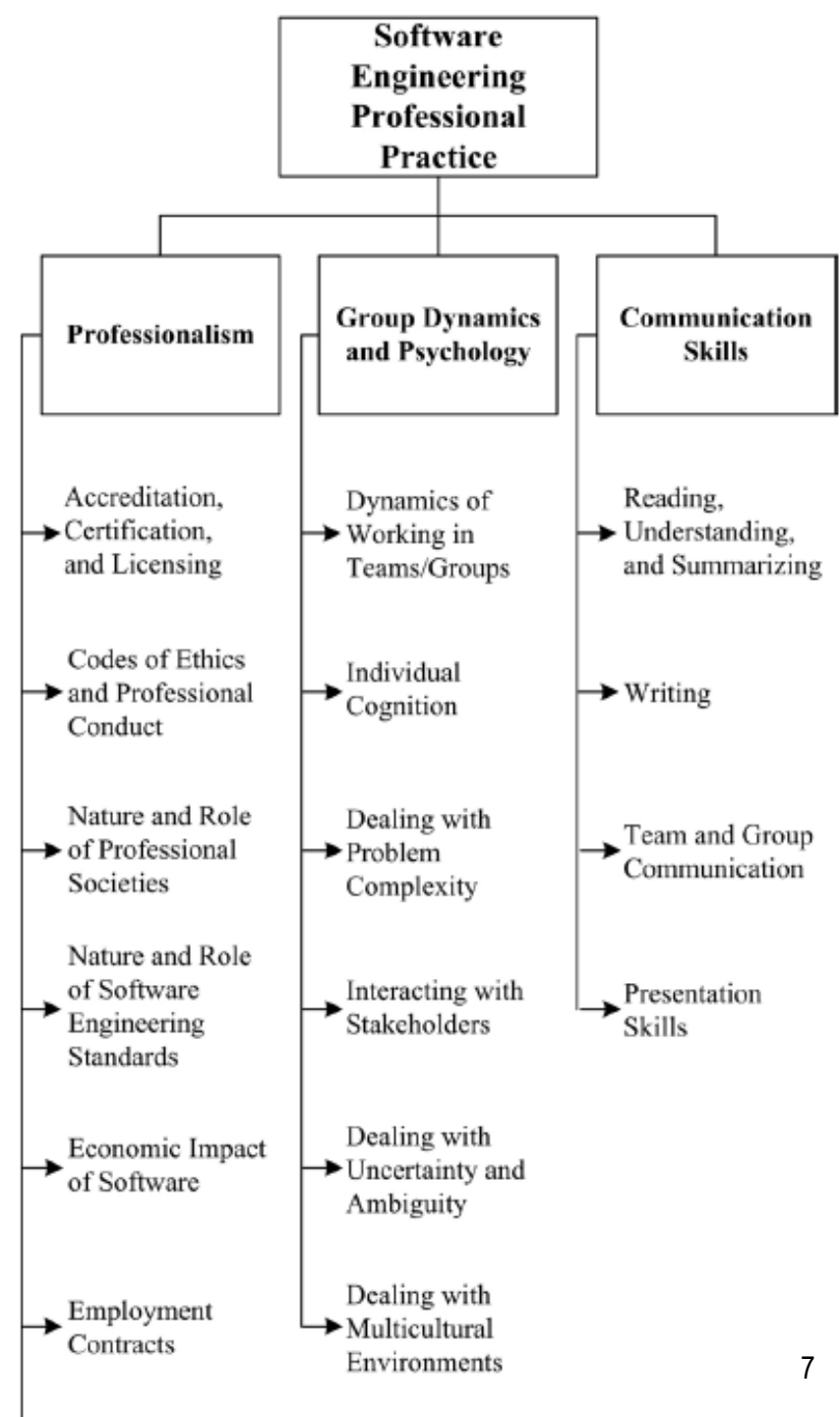
- ◆ Software Requirements
- ◆ Software Design
- ◆ Software Construction
- ◆ Software Testing
- ◆ Software Maintenance
- ◆ Software Configuration Management
- ◆ Software Engineering Management
- ◆ Software Engineering Process
- ◆ Software Engineering Models and Methods
- ◆ Software Quality
- ◆ Software Engineering Professional Practice
- ◆ Software Engineering Economics
- ◆ Computing Foundations
- ◆ Mathematical Foundations
- ◆ Engineering Foundations



# SWE Professional Practice KA

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- ◆ [SWEBOK chapter 11](#)
- ◆ *knowledge, skills, and attitudes that software engineers must possess to practice software engineering in a professional, responsible, and ethical manner.*



# Professionalism

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- ◆ *1.1. Accreditation, Certification, and Licensing*
- ◆ *1.2. Codes of Ethics and Professional Conduct*
- ◆ *1.3. Nature and Role of Professional Societies*
- ◆ *1.4. Nature and Role of Software Engineering Standards*
- ◆ *1.5. Economic Impact of Software*
- ◆ *1.6. Employment Contracts*
- ◆ *1.7. Legal Issues*
- ◆ *1.8. Documentation*
- ◆ *1.9. Tradeoff Analysis*



# Accreditation

- *Accreditation is a process to certify the competency, authority, or credibility of an organization.*
  - Performed by a government organization or by private membership association
  - Accredited schools or programs are assured to adhere to particular standards and maintain certain qualities.
- ◆ For example, University of Zagreb [ <http://accreditation.org/university> ]

Search by Degree Area

Aeronautical/Aerospace Engineering  
Agricultural/Food Engineering  
Architectural Engineering  
Automotive/Transportation Engineering  
Bioengineering/Biomedical Engineering/Biological Engineering  
Chemical Engineering  
Civil/Construction Engineering  
Communications/Information Engineering

Search

To select multiple degree areas, use the Ctrl key (or Cmd key on a Mac).

Search by Country

Country Croatia

City Zagreb

Accredited Degree Areas

Aeronautical/Aerospace Engineering  
Agricultural/Food Engineering  
Architectural Engineering  
Automotive/Transportation Engineering  
Bioengineering/Biomedical Engineering/Bi  
Chemical Engineering  
Civil/Construction Engineering  
Communications/Information Engineering  
Computer Engineering

Search

Search by University Name

University of Zagreb

Search

## Accrediting Organizations:

[8] ASIIN - Germany  
[40] EUR-ACE

### University Info

**University of Zagreb**  
Zagreb, Croatia  
[www.unizg.hr](http://www.unizg.hr)

### Accredited Programs

Civil Engineering (Masters) [8][40]  
Civil Engineering [8][40]  
Computing (Master) [8]  
Computing [8]  
Electrical Engineering and Information Technology (Masters) [8][40]  
Electrical Engineering and Information Technology [8][40]  
Information and Communication Technology [8][40]

# Certification

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- *The confirmation of a person's particular characteristics*
- ◆ professional certification
  - a person is certified as being able to complete an activity in a certain discipline at a stated level of competency
  - can also verify the holder's ability to meet professional standards
  - can also involve the verification of prescribed knowledge, the mastering of best practice and proven methodologies, and the amount of professional experience
- ◆ by passing an examination
  - often administered by nongovernmental organizations, such as professional societies

# Certification in SWE

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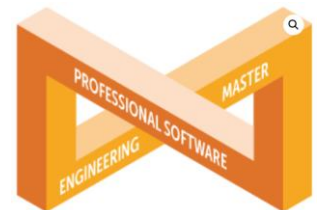
## ◆ IEEE Computer Society

- Certified Software Development Associate (CSDA)
- Certified Software Development Professional (CSDP)
  - CSDA and CSDP were retired in 2016, but still recognized and honored by the IEEE CS
- Associate Software Developer
- Professional Software Developer
- Professional Software Engineering Master
  - Part 1: 3 hours, 160 questions, online + Part 2: C language, 3 hours, online



## ◆ Technology vendors

- e.g. Microsoft, Oracle, ...



# Licensing

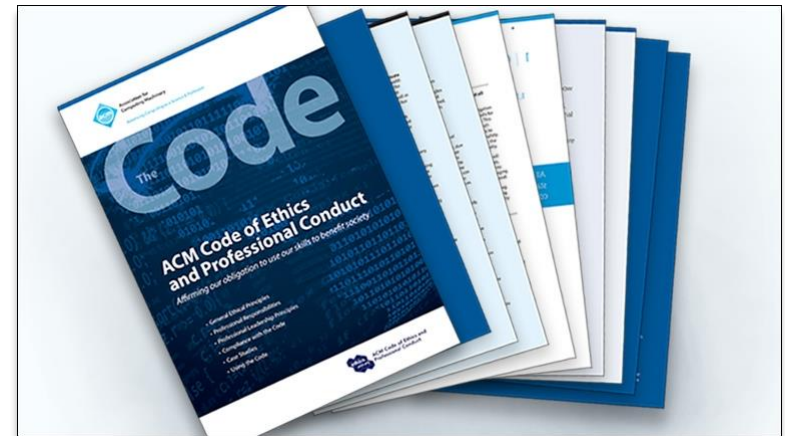
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- *the action of giving a person the authorization to perform certain kinds of activities and take responsibility for resultant engineering products*
- ◆ Issued by governmental authorities or statutory bodies
  - For “practice of professional engineering”
  - *In the US and many other countries, the services of a licensed engineer are required when a product might affect public safety, health, and welfare as opposed to affecting merely the pocketbook of the client.*
  - In fact, Texas and Canada
  - NCEES Professional Engineer exam – ended due to lack of participation



# ACM Code of Ethics and Professional Conduct

- *the values and behavior that an engineer's professional practice and decisions should embody*
  - *expresses the conscience of the profession*
- 
- ◆ Principles supplemented by guidelines
    - General ethical principles
    - Professional responsibilities
    - Professional leadership principles
    - Compliance with the code
- 
- ◆ A computing professional should ...
  - ◆ Individual responsibility



# Professional Societies

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- Mix of practitioners and academics
- IEEE Computer Society, <https://www.computer.org/>
- Association for Computing Machinery, <https://www.acm.org/>
- Computing Research Association, <https://cra.org/>
- ...



## ◆ Activities

- establishing and promulgating a body of generally accepted knowledge
- accrediting, certifying, and licensing
- dispensing disciplinary actions
- advancing the profession through conferences
- training, and publications



## ◆ Memberships

- Student, Professional, Senior, Retired + digital library + interest groups



# Software engineering standards (SWEBOK Appendix B)

- guidelines for the practice of software engineering and processes to be used during development, maintenance, and support of software

## ◆ ISO/IEC JTC 1/SC 7 - Software and systems engineering – two hundred

- **International Standards** - requirements to be satisfied to claim conformance
- **Technical Specifications** - preliminary manner documents while work continues
- **Technical Reports** – unsuited to be standards, descriptive rather than prescriptive

## ◆ IEEE – about fifty

- **Standards**, with a preponderance of the verb “shall”
- **Recommended Practices**, with a preponderance of the verb “should”
- **Guides**, with a preponderance of the verb “may.”

## ◆ Where to obtain

- <https://standards.iso.org/ittf/PubliclyAvailableStandards/index.html>
- [www.computer.org/sevocab](http://www.computer.org/sevocab)
- <http://ieeexplore.ieee.org/> , [www.iso.org/iso/store.htm](http://www.iso.org/iso/store.htm)

B-28 SWEBOK Guide V3.0

SUMMARY LIST OF THE STANDARDS

Number and Title (listed in order of number)	Most Relevant KA
IEEE Std. 730-2002 Standard for Software Quality Assurance Plans	SW Quality
IEEE Std. 838-2012 Standard for Configuration Management in Systems and Software Engineering	SW Configuration Management
IEEE Std. 829-2008 Standard for Software and System Test Documentation	SW Testing
IEEE Std. 982.1-2005 Standard for Dictionary of Measures of the Software Aspects of Dependability	SW Quality
IEEE Std. 1008-1987 Standard for Software Unit Testing	SW Testing
IEEE Std. 1012-2012 Standard for System and Software Verification and Validation	SW Quality
IEEE Std. 1016-2009 Standard for Information Technology—Systems Design—Software Design Descriptions	SW Design
IEEE Std. 1028-2008 Standard for Software Reviews and Audits	SW Quality
IEEE Std. 1044-2009 Standard for Classification for Software Anomalies	SW Quality
IEEE Std. 1061-1998 Standard for Software Quality Metrics Methodology	SW Quality
IEEE Std. 1062-1998 Recommended Practice for Software Acquisition Management	SW Engineering Management
IEEE Std. 1074-2006 Standard for Developing a Software Project Life Cycle Process	SW Engineering Process
IEEE Std. 1173.1-2002 Guide for CASE Tool Interconnections—Classification and Description	SW Engineering Models and Methods
IEEE Std. 1173.2-2006 Recommended Practice for CASE Tool Interconnection—Characterization of Interconnections	SW Engineering Models and Methods
IEEE Std. 1173.3-2004 Standard for CASE Tool Interconnections—Reference Model for Specifying Software Behavior	SW Engineering Models and Methods
IEEE Std. 1173.4-2008 Standard for CASE Tool Interconnections—Reference Model for Specifying System Behavior	SW Engineering Models and Methods
IEEE Std. 1220-2005 (a.k.a. ISO/IEC 26702:2007) Standard for Application and Management of the Systems Engineering Process	SW Engineering Process
IEEE Std. 1228-1994 Standard for Software Safety Plans	SW Quality
IEEE Std. 1320.1-1998 Standard for Functional Modeling Language—Syntax and Semantics for IDEF0	SW Engineering Models and Methods
IEEE Std. 1320.2-1998 Standard for Conceptual Modeling Language—Syntax and Semantics for IDEF1X97 (IDEFobjec)	SW Engineering Models and Methods
IEEE Std. 1490-2011 Guide—Adoption of the Project Management Institute (PMI®) Standard, A Guide to the Project Management Body of Knowledge (PMBOK® Guide)—Fourth Edition	SW Engineering Management
IEEE Std. 1517-2010 Standard for Information Technology—System and Software Life Cycle Processes—Reuse Processes	SW Engineering Process

- Patents: [PATENTSCOPE](#)
- Trademarks: [Global Brand Database](#)
- Designs: [Global Design Database](#)
- Laws and Treaties: [WIPO Lex](#)
- Statistics: [WIPO IP Statistics Data Center](#)

- ◆ Standards - part of organizational policies
- ◆ Trademarks - names/logos/slogans/shapes, „indicate source or origin”
  - protected as IP, World Intellectual Property Organization (WIPO), [wipo.int](http://wipo.int)
- ◆ Patents - SW is usually not patentable, although algorithms may be
- ◆ Copyrights - software license, EULA, copyleft
- ◆ Trade secrets - a type of IP in the form of a formula, practice, ...
- ◆ Professional Liability - related to product liability (negli., strict, privity)
- ◆ Legal Requirements - local, national, and international frameworks
- ◆ Trade Compliance - restrictions on import, export, or reexport
- ◆ Cybercrime - a crime that involves a computer and a network



# Professionalism – other topics

- ◆ Documentation - compliant with accepted standards and guidelines
- ◆ Economic Impact of Software – individual / business / societal level
- ◆ Employment Contracts – working location & hours, limitations, NDA
  - IP ownership [https://www.wipo.int/about-ip/en/universities\\_research/ip\\_policies/](https://www.wipo.int/about-ip/en/universities_research/ip_policies/)
- ◆ Tradeoff Analysis – alternatives, feasibility, risks, costs and benefits

## Database of Intellectual Property Policies from Universities and Research Institutions

Query:  
Croatia

4 record(s) found.

Country / Territory	Language	Name of institution
Croatia	Croatian	<a href="#">Institut za Fiziku</a>
Croatia	Croatian	<a href="#">Ruđer Bošković Institute (RBI)</a>
Croatia	Croatian	<a href="#">University of Rijeka</a>
Croatia	Croatian	<a href="#">University of Split</a>

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# Professional development

# Steps to becoming a Software engineer

## ◆ Education

- Coding bootcamp (8 to 12 weeks)
- Associate degree (2 years)
- **Bachelor's degree (min 4 years)**
  - SE2014 Software Engineering Curriculum - IEEE CS and ACM joint task force on CC
  - Undergraduate degree programs, 4 years – B.SE or B.Sc. in SWE
  - Europe (Bologna) – 5 years – Magister, Mag.ing., ...
- Master's degree, Specialisation (2 years)
  - M.Sc., Univ. spec., ...

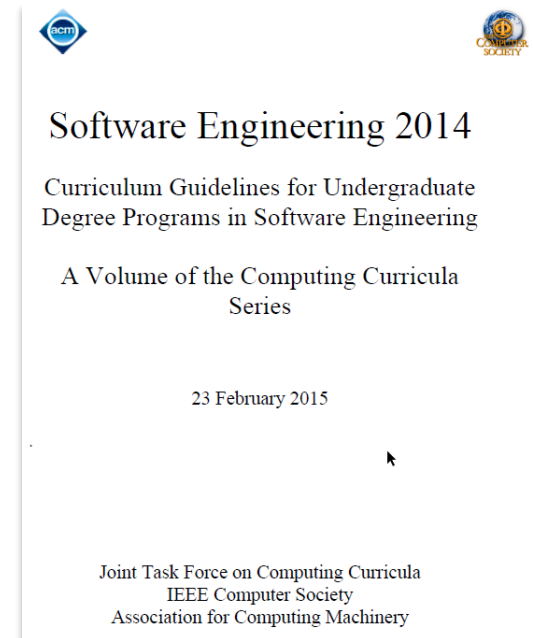
## ◆ Internship

## ◆ Entry level employment

## ◆ Certification

## ◆ Conferences

◆ ...



# Profession

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- ◆ European Engineer (Eur Ing, or Eur-Ing.) professional title
  - pre-nominal, registered in own country, accepted by FEANI
  - FEANI (Fédération Européenne d'Associations Nationales d'Ingénieurs / European Federation of National Engineering Associations), <https://feani.org/>
- ◆ EurEta Registered Engineer (Ing. EurEta)
  - pre-nominal, registered with EurEta, valid in Europe
  - EurEta "European Higher Engineering and Technical Professionals Association, <https://eureta.org>
- ◆ Canada - Professional Engineer (P.Eng) designation and/or the Information Systems Professional (I.S.P.) designation



# What does a Software Engineer do?

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- *applies mathematical analysis and the principles of computer science in order to design and develop computer software*
- ◆ Applications Engineers
  - create or adapt applications for businesses and organizations by analyzing the end user's needs
  - design, build, install, and maintain these applications or programs
- ◆ Systems Engineers
  - coordinate the creation, maintenance and growth of a business or organization's computer systems
  - coordinate each department's needs, suggest technical direction, and set up any networks that link up computers with the company

# Possible career path

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- ◆ Junior [Web] Developer
  - HTML, CSS, JavaScript, and jQuery
  - writing simple scripts
  - basic understanding of database and application services
  
- ◆ Software [Web] Developer, Sr. Software [Web] Developer
  - several years of professional programming experience
  - can write complex code
  - a thorough understanding of DBs, application services and application LC
  - proficient at creating entire applications

## Possible career path (2)

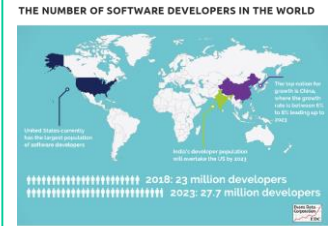
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- ◆ Lead Software Engineer, Technical Architect
  - additional responsibility and challenge, but not team management
  - **Lead engineers** - guidance, expertise in a specific subject, planning and building
  - **Architects** – technical role, designing complex systems
- ◆ Development Team Lead, Software Development Manager
  - mid-level management
  - managing dev. teams, managing large-scale projects, hiring and firing developers
- ◆ Director, Vice President, Chief Technology Officer
  - senior management
  - oversee the work of other managers
  - developing strategies

# Trends & New careers

- ◆ Microservices
  - ◆ Serverless technology
  - ◆ Machine learning, AI
  - ◆ Blockchain technology
  - ◆ Progressive web apps
  - ◆ Evolution of Mixed Reality
  - ◆ Low-code development
  - ...
- ◆ Mobile
  - ◆ [Information, Cyber] Security
  - ◆ Big data
  - ◆ Internet of Things (IoT)
  - ◆ Robotics
  - ◆ Cloud computing
  - ◆ Health informatics
  - ...

- ◆ Employment of computer and IT occupations is projected to grow 13 % from 2016 to 2026
- ◆ From 23 M developers in 2018 to 27,7 in 2023





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## **Social and human aspects**

# Top 10 characteristics of a great SW engineer

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- ◆ Time management
- ◆ Team player
- ◆ Continuous learning
- ◆ Readiness to teach and help
- ◆ Accurate judgment of problems
- ◆ Independence
- ◆ Curiosity to know how things work
- ◆ Passion for quality work
- ◆ Clear-headedness
- ◆ Love for programming

# Pros and cons of being a Software engineer

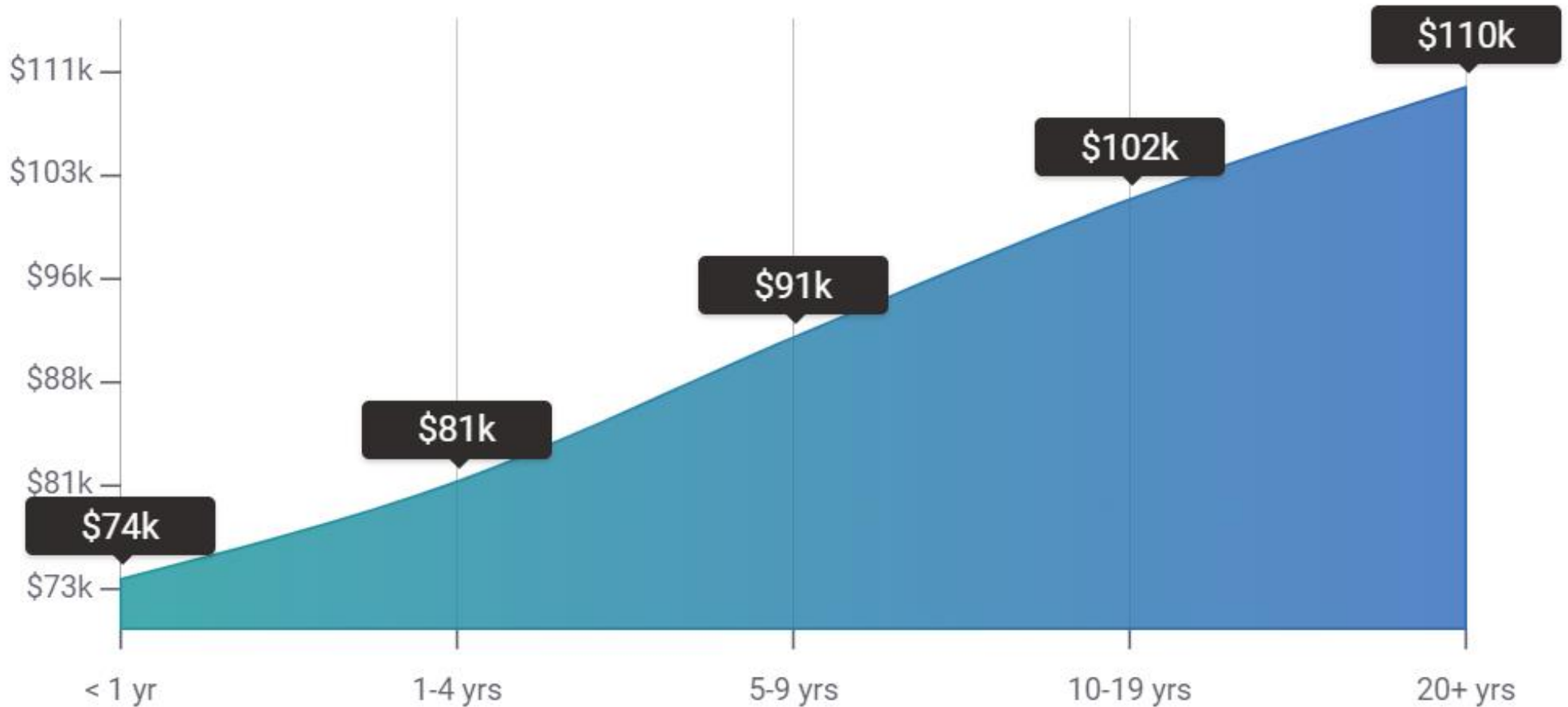
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- ◆ Pay rate
- ◆ Transferable skills
- ◆ Work anywhere
- ◆ Comfortable working environment
- ◆ Constant learning curve
- ◆ Creativity
- ◆ Can be [mentally] exhausting
- ◆ Ideosyncracies?
- ◆ Stress
- ◆ Long hours, tight deadlines and no personal and social life
- ◆ Potential injuries
- ◆ Commuting
- ◆ Problematic clients
- ◆ Age discrimination?

# Average software developer salaries in the world



# Pay by Experience Level for Software Engineer



# Popular Skills for Software Engineer

## Avg. Salary

## Popularity

**Java**

\$84,149



19,099 responses

**JavaScript**

\$83,501



17,409 responses

**SQL**

\$80,524



13,151 responses

**C# Programming Language**

\$77,706



12,326 responses

**C++ Programming Language**

\$81,503



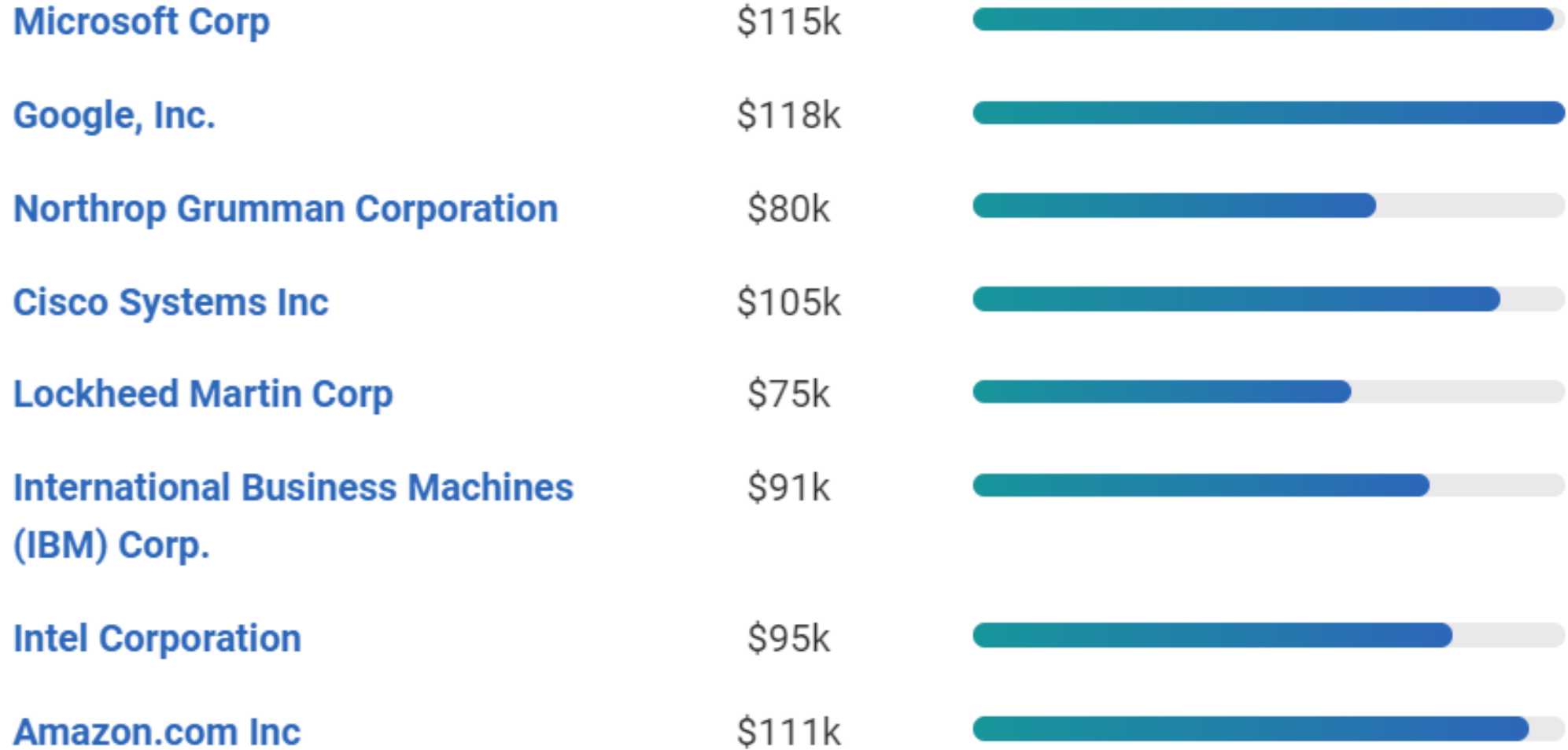
11,462 responses

# The Highest Paying IT Jobs in 2019

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◆ Big data engineer	\$155.500
◆ Mobile application developer	\$143.500
◆ IS security manager	\$140.000
◆ Applications architect	\$137.750
◆ Data architect	\$133.500
◆ Database manager	\$129.500
◆ Data security analyst	\$125.250
◆ Software engineer	\$124.500
◆ Data scientist	\$121.500
◆ Senior web developer	\$119.500

# Popular Employer Salaries for Software Engineer





# Perks

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- ◆ AirBNB: \$2,000 travel bonus
- ◆ Ask.com: Open vacation policy
- ◆ Moz: \$3,000 vacation travel expenses
- ◆ Facebook: 4 months paid parental leave
- ◆ Intuit: On-site fitness facilities
- ◆ Pinterest: Unlimited Apple products
- ◆ Cisco: Telecommuting technology to work from home
- ◆ Zynga: Arcade access
- ◆ Foursquare: Unlimited food and snacks

# References

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- McConnell S., Tripp L., Professional software engineering: fact of fiction?, IEEE Software, 16(6), Nov/Dec 1999, pp 13-18, <https://ieeexplore.ieee.org/stamp/stamp.jsp?arnumber=805468>
- <http://www.swebok.org/>
- [https://en.wikipedia.org/wiki/Software\\_engineering#Profession](https://en.wikipedia.org/wiki/Software_engineering#Profession)
- <https://www.acm.org/binaries/content/assets/about/acm-code-of-ethics-and-professional-conduct.pdf>
- <https://www.computer.org/education/certifications>
- [https://en.wikipedia.org/wiki/Regulation\\_and\\_licensure\\_in\\_engineering](https://en.wikipedia.org/wiki/Regulation_and_licensure_in_engineering)
- <https://www.computerscienceonline.org/careers/software-engineering/>
- <https://www.careerexplorer.com/careers/software-engineer/>
- <https://www.learnhowtobecome.org/computer-careers/software-engineering/>

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**No questions asked 😊**