



Welcome and What's New for the Software Solutions Division and the SEI

August 2, 2022

SEI Software Engineering Workshop for Educators

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Welcome!

Great to see you all and great to see the strong interest of this community (over 85 registrants)!

Excited to provide a “What’s New” update for the Software Solutions Division (SSD) and the SEI, including the National Agenda for Software Engineering Study, and updates for the CERT and AI Divisions.

A purple banner with a faint grid pattern. The text is white and centered. The main title is 'Software Engineering Workshop for Educators' and the subtitle is 'AUGUST 2-4, 2022 | HYBRID (IN-PERSON OR ONLINE)'.

Software Engineering Workshop for Educators

AUGUST 2-4, 2022 | HYBRID (IN-PERSON OR ONLINE)

What's New in SSD?



Architecting the Future of Software Engineering Study released November 2021.

Available online at <https://www.sei.cmu.edu/go/national-agenda>

Study Focus: Redefining How Software Is Developed

- Our ever-growing **dependence on software** systems makes it **imperative to maintain our nation's leadership and strategic advantage** in software engineering.
- **Future systems** and **fundamental shifts** in software engineering **require new research focus**.
 - Rapidly deploying software with confidence requires fundamental shifts in software engineering.
 - Greater **speed in translating technology into fielded capability** is where we can achieve and maintain our **technological edge**.
- New types of systems will continue to push beyond the bounds of what current software engineering theories, tools, and practices can support, therefore **CMU SEI led a study to help redefine how software is developed**.

The study was guided by an Advisory Board of visionaries and senior thought leaders.

CMU SEI served as a catalyst for the software engineering community in creating a multi-year research and development vision, strategy, and roadmap for engineering next-generation software-reliant systems.

Focus of National Agenda for Software Engineering

Software is vital to America's **global competitiveness**, **innovation**, and **national security**. The economy, the nation's infrastructure, education, and healthcare all depend on software.



This study was a community effort to:

1. **Identify future challenges** in engineering software-reliant systems.
2. Develop a **research roadmap** that will drive advances in **foundational software engineering principles** across system types such as intelligent, autonomous, safety-critical, and data intensive systems.
3. Raise the **visibility** of software to the point where it receives sustained recognition commensurate with its importance to national security and competitiveness.
4. Enable strategic partnerships and collaborations to **drive innovation among industry, academia, and government**.

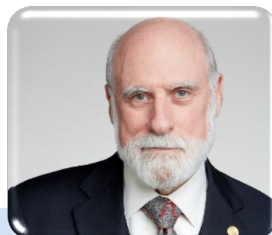
Guided by an Advisory Board of Visionaries and Senior Thought Leaders



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Chief Technology Officer,
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Mr. Tim McBride
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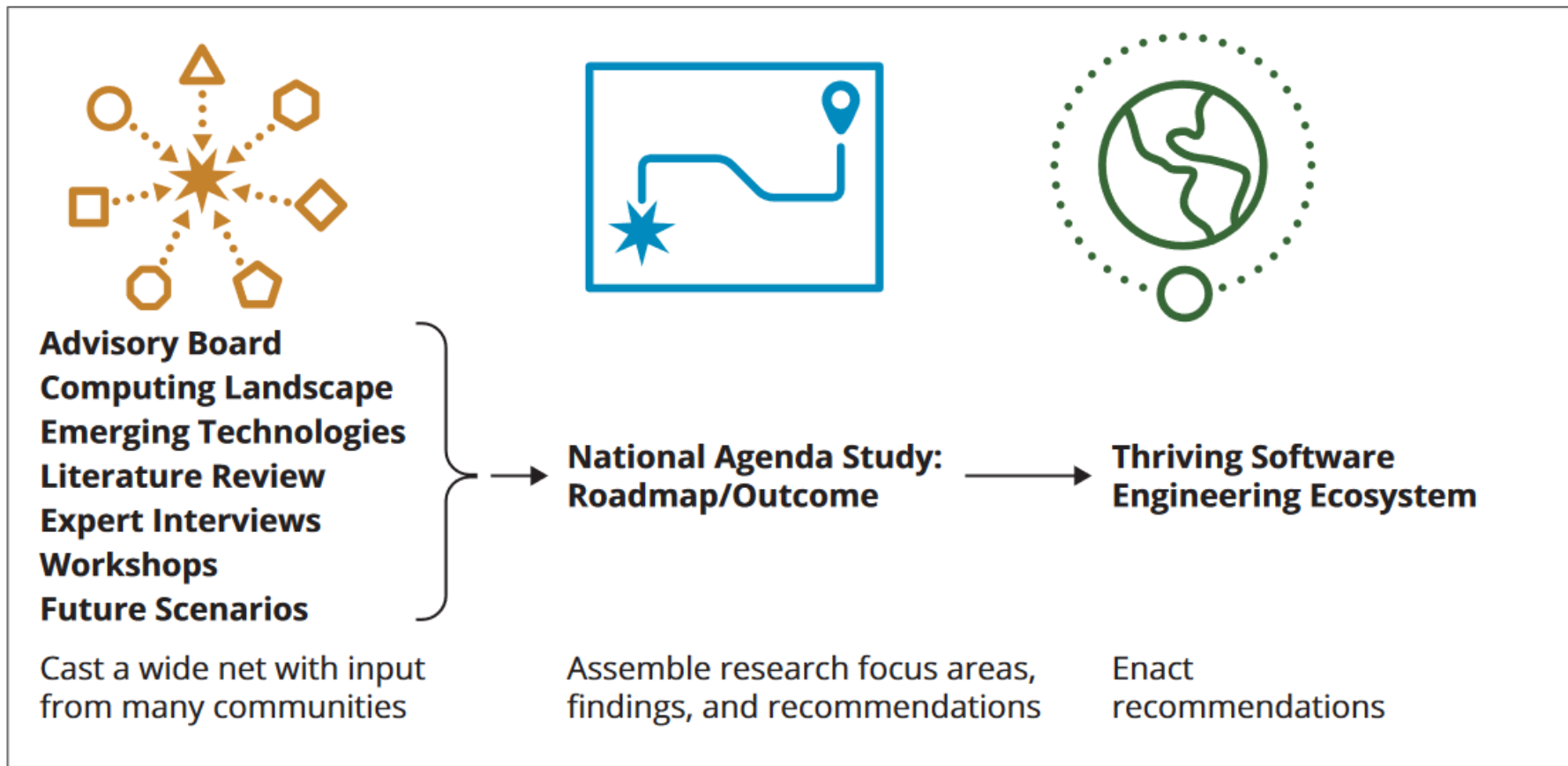


Ms. Nancy Pendleton
Vice President and
Senior Chief Engineer,
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Dr. William Scherlis
Director, DARPA
Information
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Approach



Summary of Study Findings

- 1. Maintaining national software engineering proficiency is a strategic advantage.** Software engineering affects everything, because software is everywhere.
- 2. Maintaining national software engineering proficiency requires sustained research.** New types of systems will continue to push beyond the bounds of what current software engineering theories, tools, and practices can support.
- 3. Maintaining national software engineering proficiency requires fostering strategic partnerships.** We need to enable strategic partnerships and collaborations to drive innovation in software engineering research among industry, research laboratories, academia, and government.
- 4. Maintaining national software engineering proficiency requires sustained investment.** We must ensure policy makers recognize the benefits of software engineering as a critical national capability.
- 5. The vision of software engineering needs to change.** The current notion of a software development pipeline will be replaced by one where AI and humans collaborate to continuously evolve the system based on programmer intent.
- 6. Focusing on re-assuring systems will enable continuous and rapid incorporation of new capability.** Because software is ubiquitous there is an increasing need for software to continuously evolve to include new capability.
- 7. New design principles are needed for societal-scale systems.** The growing recognition of software's impact is generating new quality attribute requirements for which better design approaches are needed.
- 8. The software engineering workforce needs to be (re-)conceived.** We need to better understand the nature of the needed workforce and what to do to foster its growth.

New System Types Require New R&D

New types of systems

- very adaptive defense mission systems
- systems that perform data fusion at a huge scale
- highly engineered business enterprises
- personal digital assistants—that really assist
- dynamically integrated healthcare
- smart cities, buildings, roads, cars, and transport

Trends

- scale motivating the need for safe and resilient software composition
- rapid and assured continuous software evolution
- addressing workforce gaps in software talent
- artificial intelligence (AI)-inspired automation
- evidence-based assurance that a system behaves as intended
- impact of cyber-social platforms on social behavior, creating societal scale impact
- primacy of data (data has become as important as code)



Emerging Vision of the Future of Software Engineering

The current notion of software development will be replaced by one in which **humans and AI are trustworthy collaborators that rapidly evolve systems based on programmer intent.**

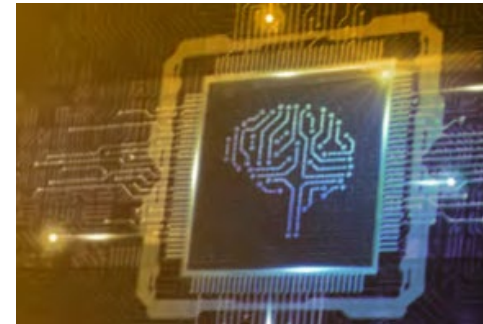
Advanced development paradigms lead to efficiency & trust at scale.

- Humans leverage trusted AI as a workforce multiplier for all aspects of software creation & sustainment.
- Formal assurance arguments are combined & analyzed to assure & efficiently (re)assure continuously evolving software.
- Enhanced software composition mechanisms enable predictable construction of systems at increasingly large scale.

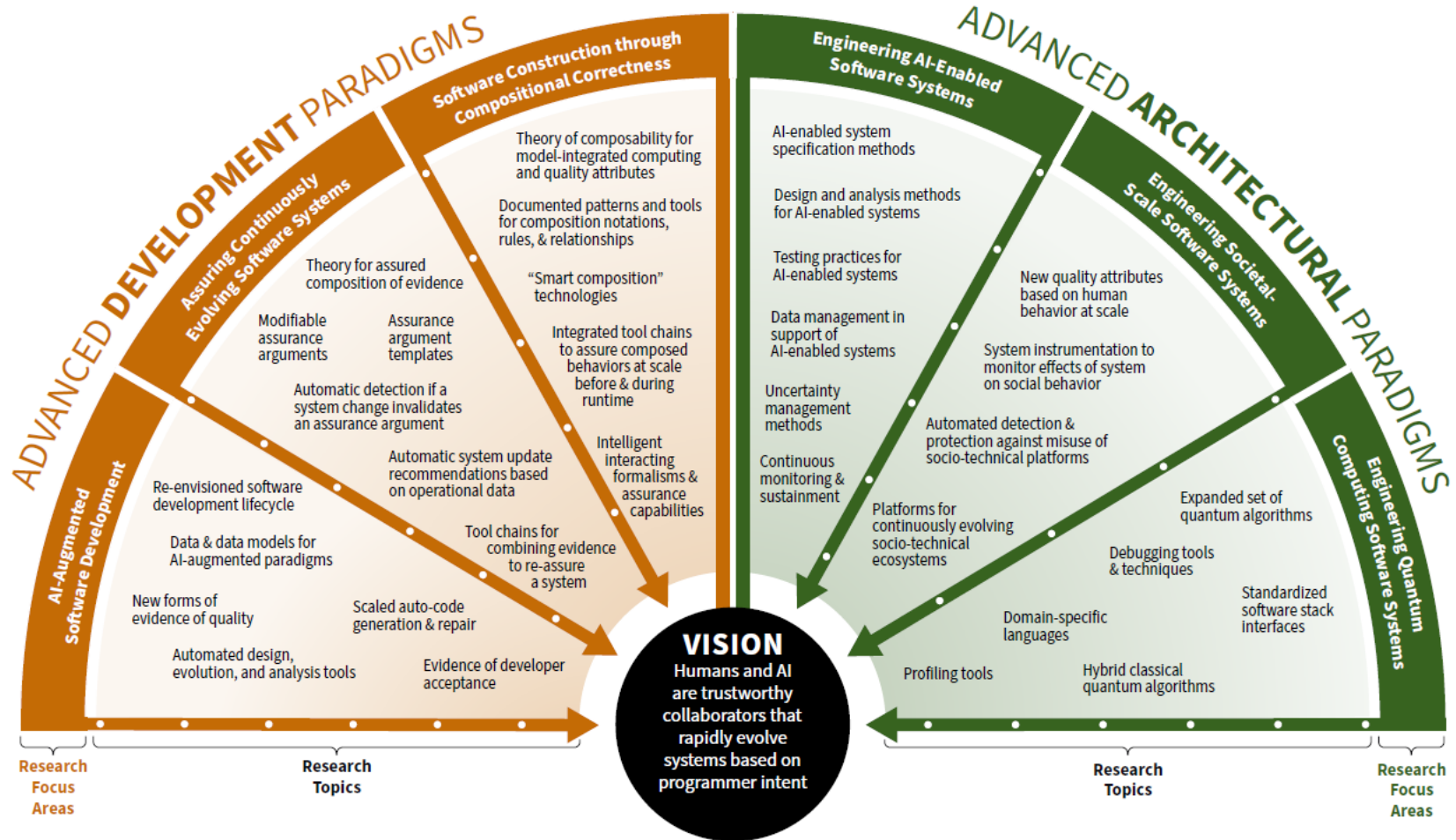


Advanced architectural paradigms enable the predictable use of new computational models.

- Theories & techniques drawn from social sciences are used to design large-scale socio-technical systems, yielding more predictable outcomes.
- AI & non-AI components interact in predictable ways to achieve enhanced mission, societal, & business goals.
- New analysis & design methods facilitate the development of quantum-enabled systems.



Software Engineering Research Roadmap (10-15 Year Horizon)



Incredibly Positive and Enthusiastic Reaction to the Study...



Several meetings underway with Ansys to establish joint research collaborations.



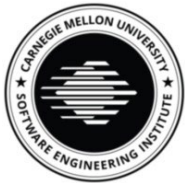
Reaction from the global community to incorporate the roadmap as part of graduate and PhD curricula.



Accenture requested SEI for their Accenture Luminary Program.



Roadmap articles invited for IEEE Computer, and recently published in IEEE Security and Privacy



SEI has launched a major research program in software assurance based on agenda



Briefed study at DoE Workshop on the Science of Scientific-Software Development and Use (was modeled after the 2020 workshop conducted with SEI-DARPA).



We developed and delivered an assurance/ architecture proposal for OSD R&E (5 Years/\$50 M)



Many keynote presentations already given on the study: FAA, NOAA, IEEE Computer Society, DoE ...etc.



School of Engineering and School of Computer Science at Carnegie Mellon University incorporating important agenda points

...But Still Lots To Do!

- ❑ Inform SEI technical strategies based on the study (research plans and directorate strategies)
- ❑ Initiate strategic engagement and enactment: Outreach to influence the world and create broader action
 - White paper “*A National Priority for Investing in Software Engineering*” provides recommendations to Congress and U.S. policy organizations to build our nation’s ability to innovate and field critical capabilities through software engineering
- ❑ Establish collaborations to advance themes inspired by the study
 - Co-sponsor software engineering grand challenge
 - Host technical workshop on one or more study research focus areas.
- ❑ “Influence the influencers”: Create more focus and attract more research funding on foundational topics in software engineering
 - For example, a collaboration is underway with the Networking and Information Technology Research and Development (NITRD) Working Group

NITRD coordinates Federal R&D to identify, develop, and transition into use the secure, advanced IT, high-performance computing, networking, and software capabilities needed by the Nation, and to foster public-private partnerships that provide world-leading IT capabilities) NITRD is a part of the U.S. White House Office of Science and Technology Policy (OSTP)



Recommendations

Our goal is to catalyze change that advances software engineering, which in turn will lead to more trustworthy and capable software-reliant systems in the future. Advancing software engineering requires supportive policy, research funding, researchers, practitioners, and cross-fertilization with other research communities.

Research recommendations are necessary to catalyze change.

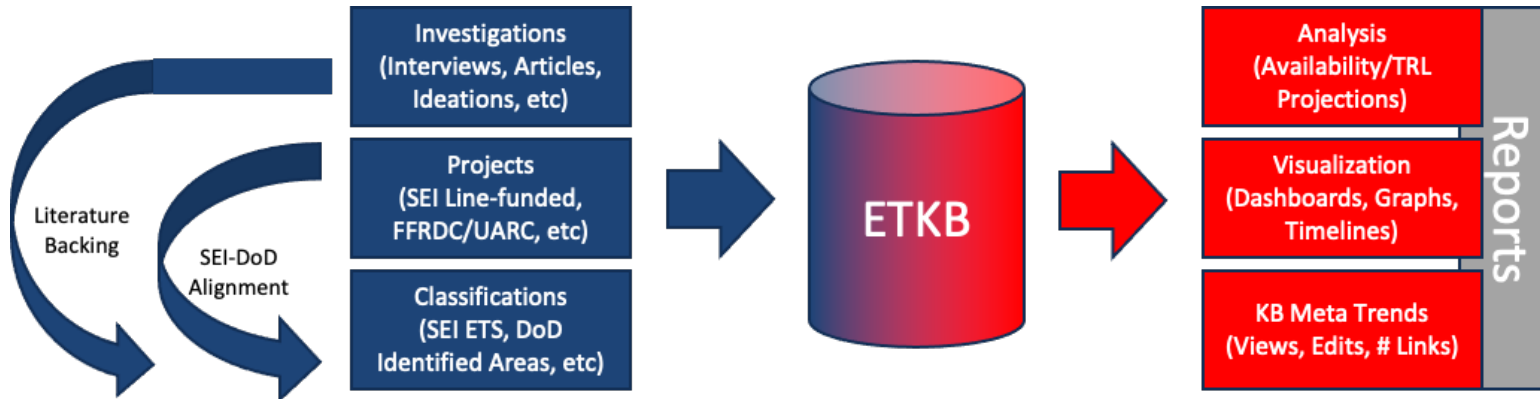
1. Enable AI as a reliable system capability enhancer.
2. Develop a theory and practice for software evolution and re-assurance at scale.
3. Develop formal semantics for composition technology.
4. Mature the engineering of societal-scale socio-technical systems.
5. Catalyze increased attention on engineering for new computational models, with a focus on quantum-enabled software systems

Enactment recommendations focus on institutional obstacles, including economic, human, and policy barriers.

6. Investment priorities should reflect the benefits of software engineering as a critical national capability.
7. Institutionalize ongoing advancement of software engineering research.
8. Develop a strategy for ensuring an effective workforce for the future of software engineering.

Emerging Technology Study Is Underway

- The SEI is using a scenario-based approach to link emerging technology to core customer values and needs
 - The All-Domain Military Internet of Everything (ADMloE) is intended to envision how the DoD will operate in a realistic and probable future
- The study incorporates an Emerging Technology Knowledge Base (ETKB) as a structured framework designed for openness, scalability, and analyzability. Primary goals:
 - Create a platform that is formalized and scalable in content and can provide the means for analysis
 - Establish known information that does not need to be rewritten (e.g., smart reuse, no overlap)
 - Provide the means to explore emerging tech in a fun and engaging way (i.e., link-surfing)
 - Crowdfsource a “Wikipedia” for emerging tech across the SEI



Additional SSD Highlights

- SEI is advancing software architecture and machine learning R&D through customer engagements and in the development of an upcoming Dagstuhl seminar.
- Our research-to-practice mission in machine learning mismatch was recently recognized with a best paper award at ICSE.

N. Nahar, S. Zhou, G. Lewis and C. Kästner, "Collaboration Challenges in Building ML-Enabled Systems: Communication, Documentation, Engineering, and Process," 2022 IEEE/ACM 44th International Conference on Software Engineering (ICSE), 2022, pp. 413-425, <https://ieeexplore.ieee.org/document/9793960>



- Our technical debt work is having enduring impact:
 - A core paper was awarded a 10-year most influential paper award at ICSCA.

R. L. Nord, I. Ozkaya, P. Kruchten and M. Gonzalez-Rojas, "In Search of a Metric for Managing Architectural Technical Debt," 2012 Joint Working IEEE/IFIP Conference on Software Architecture and European Conference on Software Architecture, 2012, pp. 91-100, <https://resources.sei.cmu.edu/library/asset-view.cfm?assetid=58830>



- The National Defense Authorization Act (NDAA) Section 835 calls for a study to influence technical debt practice and policy, which the SEI has been asked to conduct.

AI Division Highlights

AI Workforce Development

Training teams to meet mission challenges

AI Labs

Accelerating collaboration to solve mission challenges

- The SEI AI Division is working to mature the discipline of AI Engineering by surfacing leading practices in a community-wide movement, using defense and national security problems as a context for definition.
- Recently launched the [AI Workforce Development Initiative](#), with the goal of providing training in a variety of AI engineering topics to accelerate DoD organizations' ability to gain the leap-ahead advantages AI promises.
- Launched two virtual laboratories: Advanced Computing Laboratory and Adversarial Machine Learning Laboratory.
- Work in the Advanced Computing Lab spans the entire stack, from algorithms to assembler, across the full computing spectrum, from big iron to the edge.
- The Adversarial Machine Learning Lab is working to make machine learning as secure as possible for the DoD and Intelligence Community.

CERT Division Highlights

- **New CERT director:** In April 2021, SEI added retired Air Force brigadier general Greg Touhill to our team as the director of our CERT division. Greg came to us from Appgate, a cybersecurity and software company specializing in secure remote access, where he served as president of its federal division. Prior to that, Greg served as the United States government's first Federal Chief Information Security Officer.
- **New CERT Strategy:** The CERT strategy focuses on advancing cyber by design; enhancing cyber resilience; moving the market; and shaping the future of cybersecurity.
- **Increasing CERT's aperture:** CERT broadened its activities to provide more timely and relevant support to activities designed to better secure the cyber ecosystem. Examples include orchestrating research into Zero Trust best practices with key industry partners; hosting the National Insider Risk/Threat Conference; building international cyber partnership capacity in support of national security goals; researching new techniques to secure data in a quantum-enabled ecosystem; and developing novel approaches to train and educate the workforce on cybersecurity.



