Next-Generation Software Development

Jeff Barr

(he/him)
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VP & Chief Evangelist, AWS

Hello, I am Jeff

- **Who I Am**
- VP and Chief Evangelist, AWS
- Husband, parent, grandparent
- Technologist
- Maker (3D printing, LEGO, electronics)
- BS - Computer Science (1985)
- Masters of Communication in Digital Media (2013)
- Professional developer since 1979
- Spoke at first JAWS meeting in 2010

What I Do

- AWS News Blog (2004-2024)
- Social media
- AWS OnAir live stream
- Global events
- Customer meetings

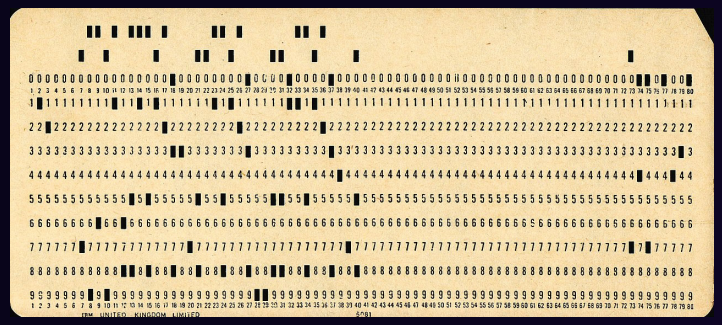
February 23, 2010 First JAWS-UG Meeting

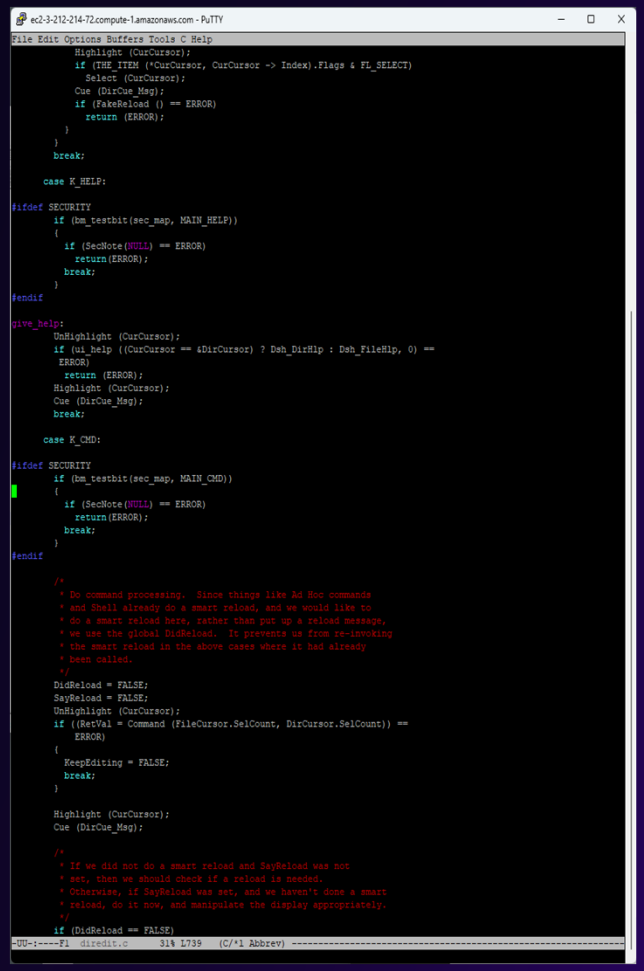
Introducing Angelo Shirahata, President AWSJ

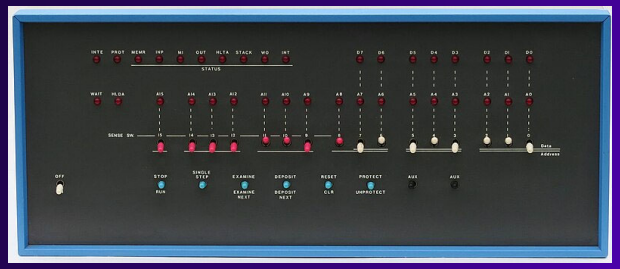
- President of AWSJ since November 2024
- Education:
  - Keio University
  - Bond University (Australia)
- Career:
  - Nissho Iwai Corporation
  - General Electric
  - Schneider Electric

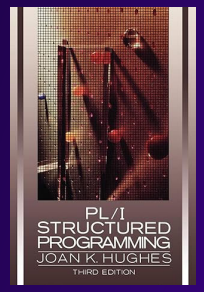
My development background

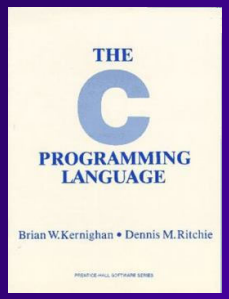
- Mainframe - PL/I
- PDP-8 - BASIC
- PDP-11 – C
- Microcomputers – 8080, 6502, 68000
- C, PHP, Python, Perl

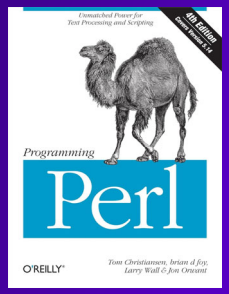




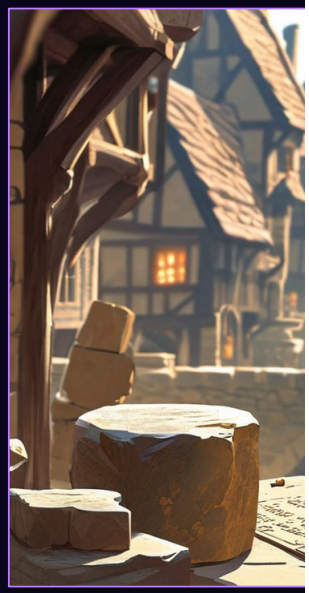








Images produced by Amazon Bedrock & Amazon Nova Canvas



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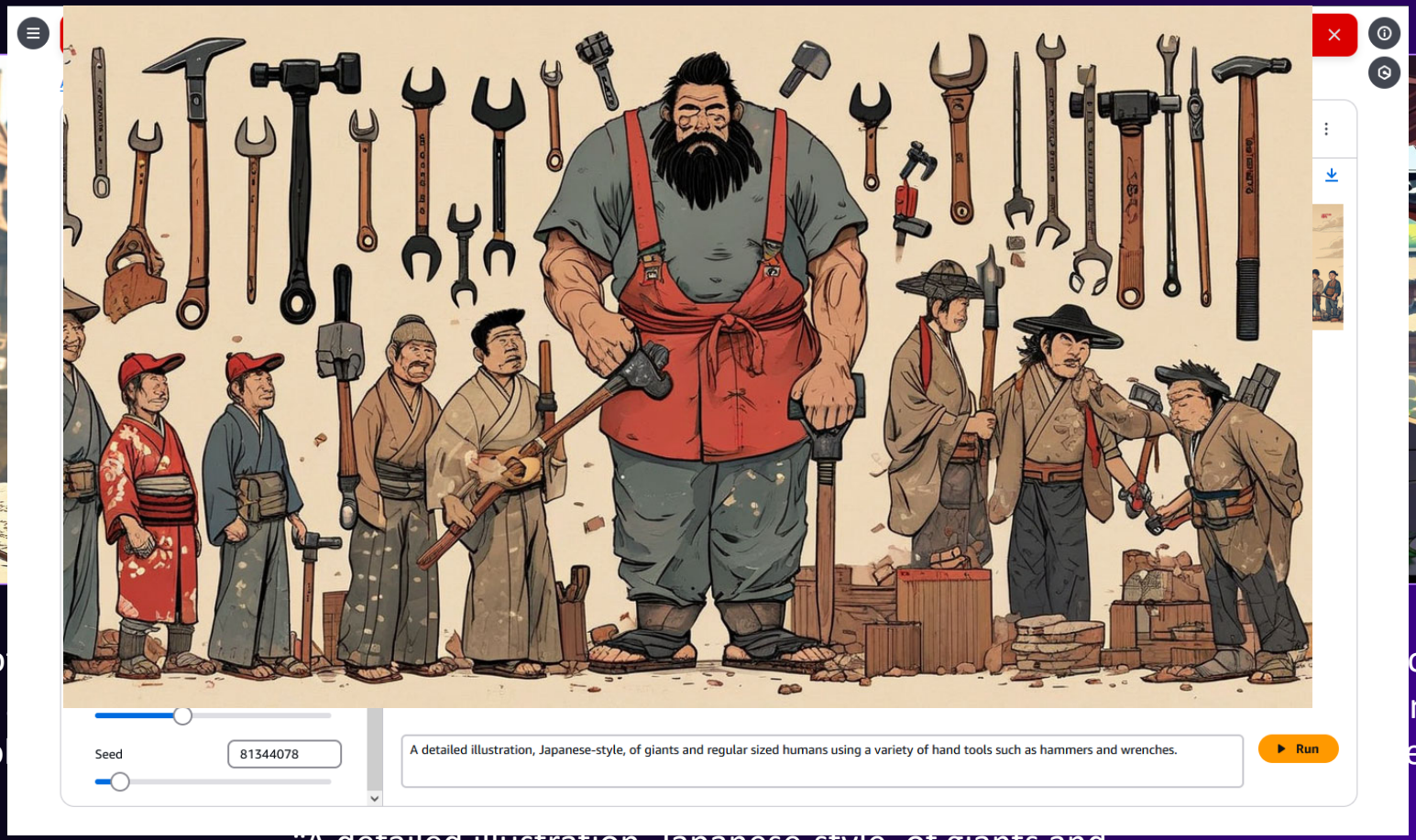

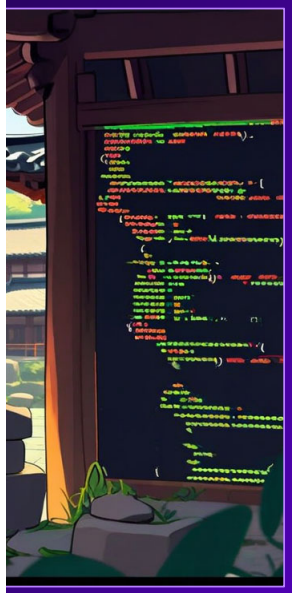

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e 1600s.”

“A detailed illustration, Japanese-style, of giants and regular sized humans using a variety of hand tools such as hammers and wrenches.”

Let’s Dive In!

An exceptionally interesting point in time

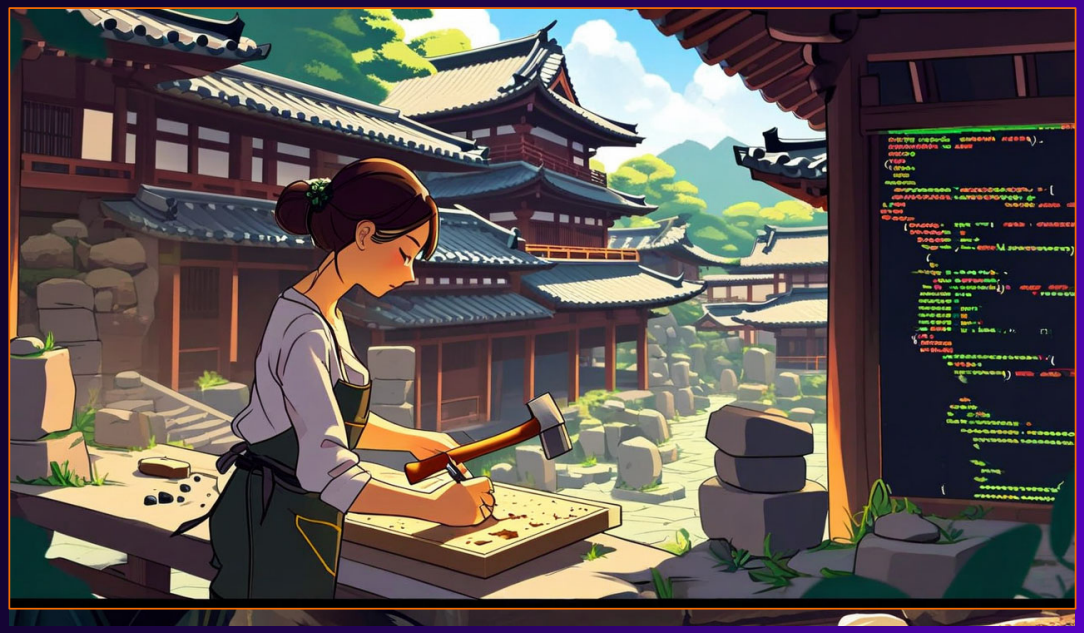
- The practice of software development continues to evolve
- Many developers express a feeling of uncertainty
- How did we get here?
- Where are we going?
- Where do I fit in?
- How do we prepare?

"A software developer surrounded by question marks."

Where are we today?

- [Some/Many] developers are creating space-age programs using outdated tools and processes!

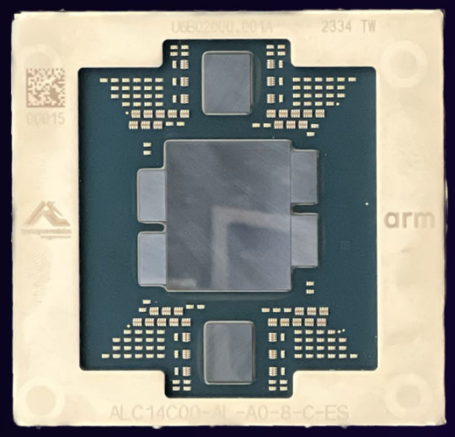
- There's room for everyone:
  - Informal / self-taught
  - CS-educated / professional coder
  - Math-educated / formal approach

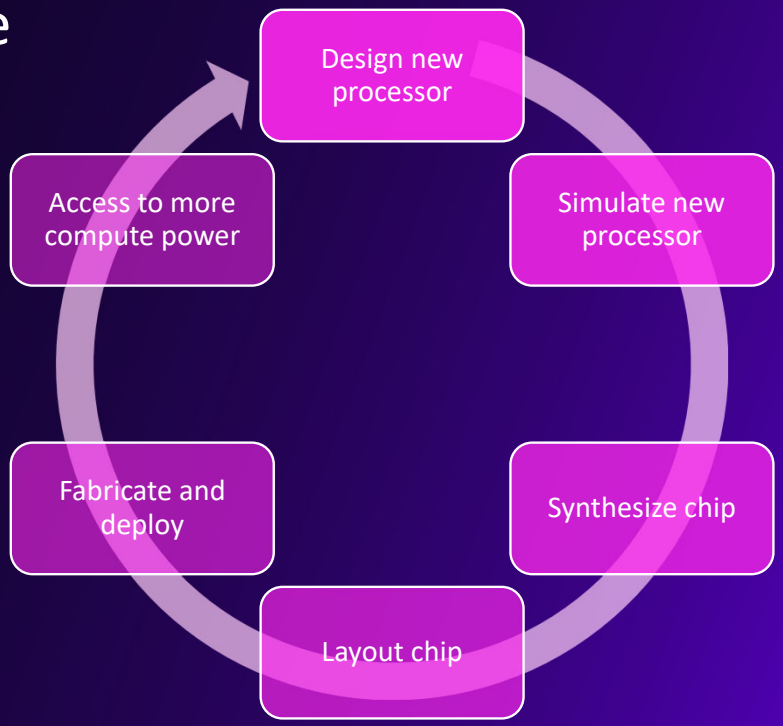


"a female software developer writing code using a hammer and a chisel to carve the code in stone. The scene looks like a Japanese city in the 1600s."

The Amazon virtuous cycle in action for hardware

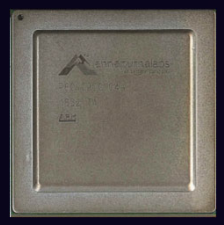
- Each generation of hardware accelerates production of the next one
- Time between generations shrinks
- Each generation more powerful & capable



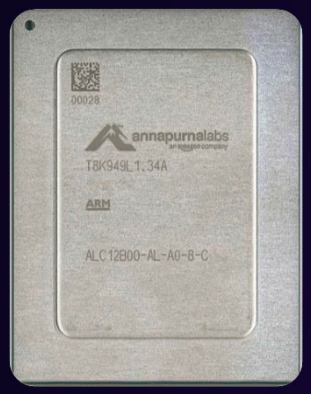


Four generations of AWS Graviton chips

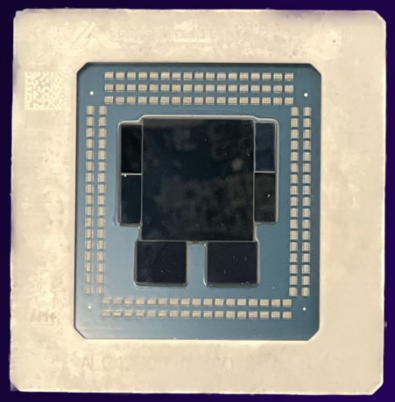
Graviton
2018



Graviton2
2019



Graviton3
2021



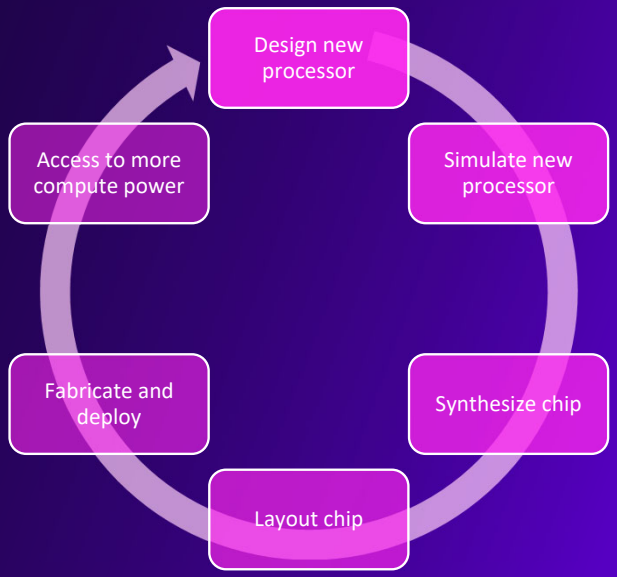
Graviton4
2023

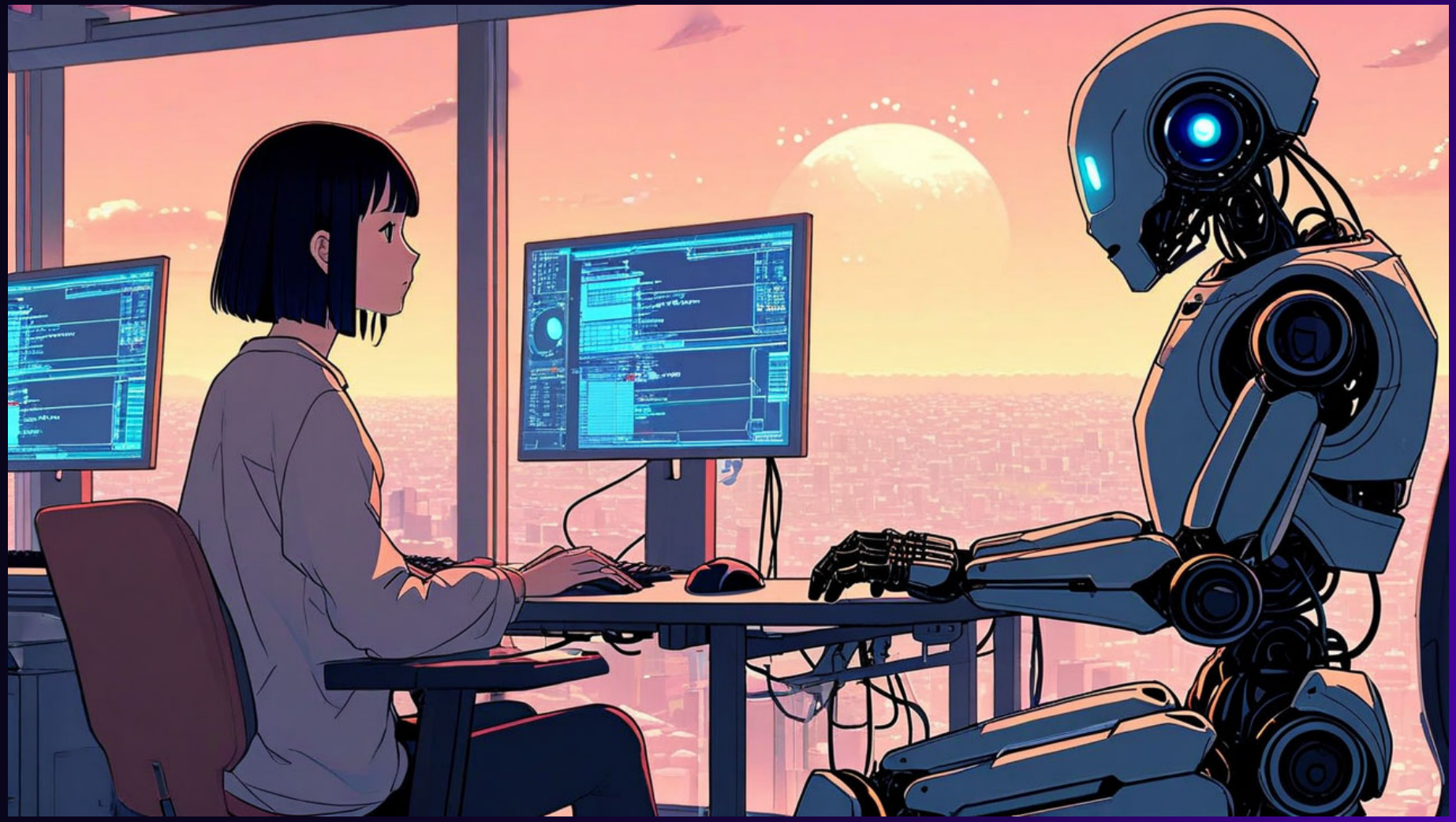
Graviton Improves EDA Workloads

100s of Millions of CPU Hours
to simulate and test designs

Over $100 Million
to design and build a modern CPU

Arm Validates IP 1,000X+ Faster with Solido on AWS Graviton2

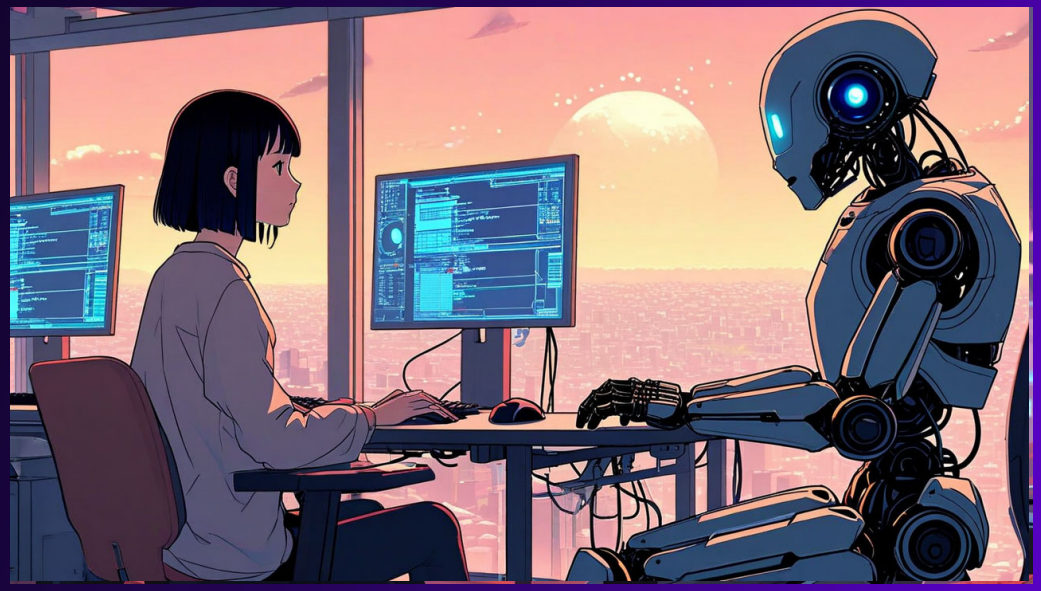




A similar virtuous cycle for software

- Better computers support better and richer software
- We have been using software to build software since the beginning
- AI-powered coding assistants are just the next step
- Make you more powerful
- An assistant, not a replacement

"A female Japanese software developer sitting next to a robot, **wiht** both of them at their own computers, all in a japanese manga sci-fi landscape"



The future is here but not yet evenly distributed

- Where are you today?

Hand-writing instructions using 0's and 1's	Coding in assembly language	Coding in a higher-level language	Using an AI-powered coding assistant	Using formal methods to validate your code	Using a Quantum Computer

Developers and code

- Developer's responsibility:
  - Produce code that meets self-imposed or customer-driven requirements

- Desirable code attributes:
  - Correct – Behaves as expected
  - Fast – Makes efficient use of resources
  - Maintainable – Easy to update
  - "Good" (a qualitative measure)

"developer and source code at a white board, in a futuristic Japanese setting"

It’s all about the tools!

#define DeveloperTools "…"

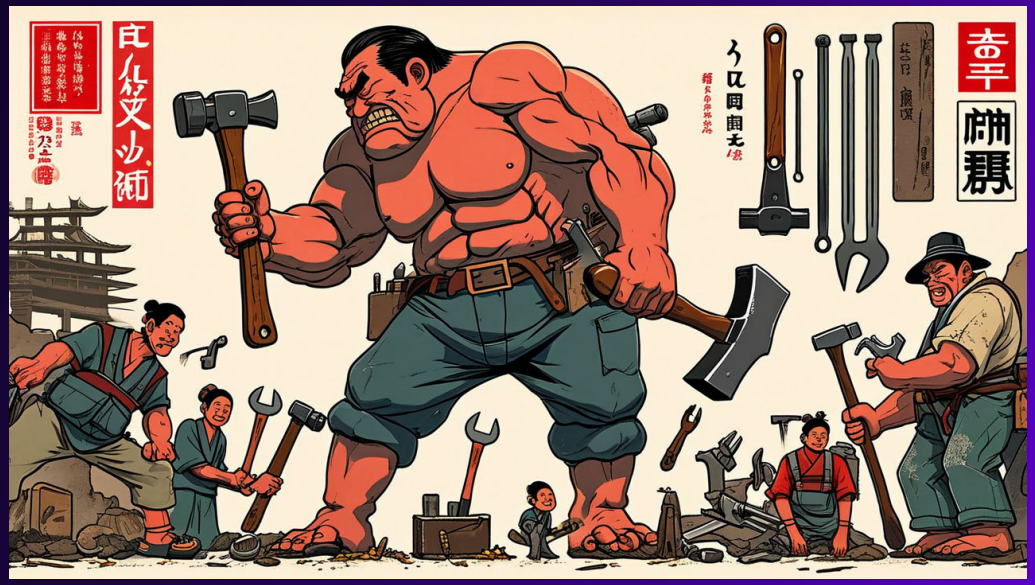
A developer tool is anything made from bits that helps you to do your job:

- Language feature
- Executable (editor, compiler)
- Function or class library
- Training & reference material
- …

"A futuristic Japanese-style library with books, racks of computers, keyboards, some hand tools, and more. There are three people sitting at a table in the middle."

Why developer tools matter

- Tools let us “stand on the shoulder of giants” (Isaac Newton)
- Tools build on and compose with other tools
- Tools improve with (and take advantage of) available compute power, and grow more powerful themselves as a result



“A detailed illustration, Japanese-style, of giants and regular sized humans using a variety of hand tools such as hammers and wrenches.“

Tools Over Time

Assembler

Editor

Compiler

Linter

Debugger

CASE tools

IDE

Source code control

Profiler

Indenting

Colorization

Syntax-directed editing

Auto-complete

IntelliSense

Programmability

Single step

Disassemble

Breakpoints

Call stack

Symbols

Base compiler

Optimizing compiler

Checkout compiler

Instructional compiler

Diagramming

Modeling languages

Flow charts

Visual programming

Tools Over Time

Assembler

Editor

Compiler

Linter

Debugger

CASE tools

IDE

Source code control

Profiler

Single-pass compiler

Optimizing compiler

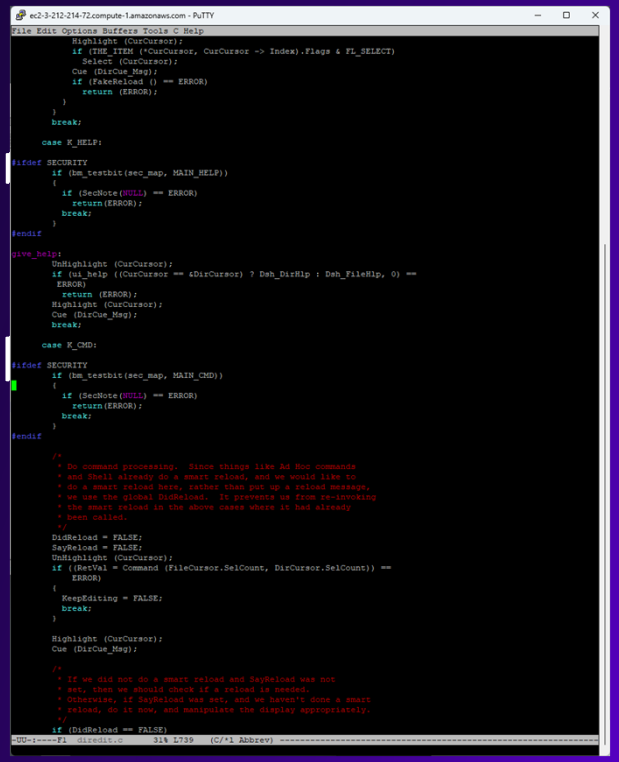
Syntax-directed editing

Interpretive compiler

Incremental compiler

Symbols

Programmability



Language features

Compile time

- Structured programming
- Data types
- Objects
- Exceptions
- Memory safety

Run time

- Array bounds checking
- Exception handling
- Memory management / GC
- Overflow detection
- Assertion

Each one helps us to do a better job and to write better code

Packaging and reusable code

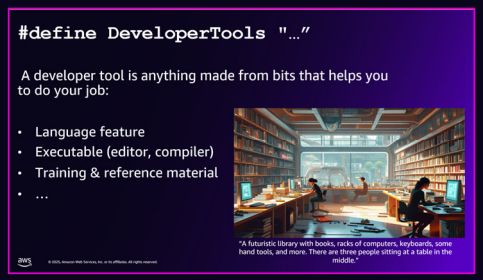
- Macro libraries
- Standard libraries
- Classes
- Open source

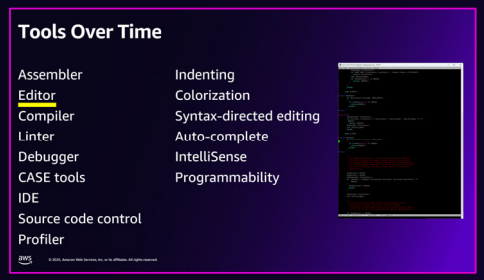
“happy software developers on the beach, looking out at a glorious rainbow made up of source code fragments.”

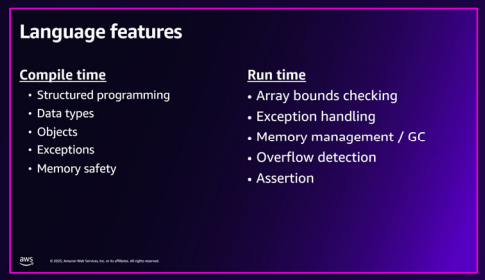
And my point is….

- As humans, we conceptualize, build, and use tools
- Then we use them to build even more tools
- As developers we do the same
- Tools are good
- Respect (don’t fear) progress

Mix it all together







Model Training and Fine Tuning

LLM with deep understanding of development processes, tools, documentation, APIs, coding styles, and code

What’s Next / What’s New / What’s Now?

“a highway that leads to a space-age city. There are several styles of signs that say "New" along the highway, and some floating in the air. Make it look really, really amazing!”

"The image in the post humorously references the historical impact of compilers on software development jobs, reflecting on how automation and technological advancements have historically displaced certain roles, similar to concerns today about AI and automation."

"The post plays on the current anxiety about AI taking jobs, drawing a parallel with the 1960s when compilers began to automate tasks previously done manually, suggesting a cycle of technological displacement in the tech industry."

What's next / What's new / What's now?

AI-Powered Coding Assistant

- Logical next step
- Make you a better developer
- From intent to code
- Increase efficiency
- Another tool for your toolbox
- Builds on what you know
- Amazon Q Developer

Formal Verfication

- Mathematical basis
- Spec vs implementation
- Prove programs correct
- Automated reasoning and other leading edge techniques
- Heavily used at Amazon
- Will become mainstream

Amazon Q Developer

AI-Powered Coding Assistant

Create an app with Amazon Q Developer

*Untitled - Notepad

File Edit Format View Help

```
I want to create a full-stack web application for Sports Event Management with the following features:

Frontend (React.js):

1. Authentication system
   - React bootstrap index.html and index.js files
   - Login page
   - Registration page
   - Protected routes
   - JWT token management

2. User Interface
   - Modern, responsive design using Material-UI
   - Navigation bar with login/logout functionality
   - Add a logo
   - Dashboard layout

3. Sports Event Management
   - Display list of sports events (Football, Cricket, Tennis, Table Tennis, Badminton, Basketball, Handball,
Hockey)
   - CRUD operations for events (Create, Read, Update, Delete)
   - Event details including:
     * Event name
         * Event Date
         * Teams (Team 1 vs Team 2)
         * Scores
         * Venue
         * Sport type
         * Winner
   - Filtering and sorting capabilities
   - Form validation
   - Confirmation dialogs for delete operations

4. Role-based Access Control
   - Admin users: Full CRUD access
   - Regular users: Read-only access
   - User profile management
```

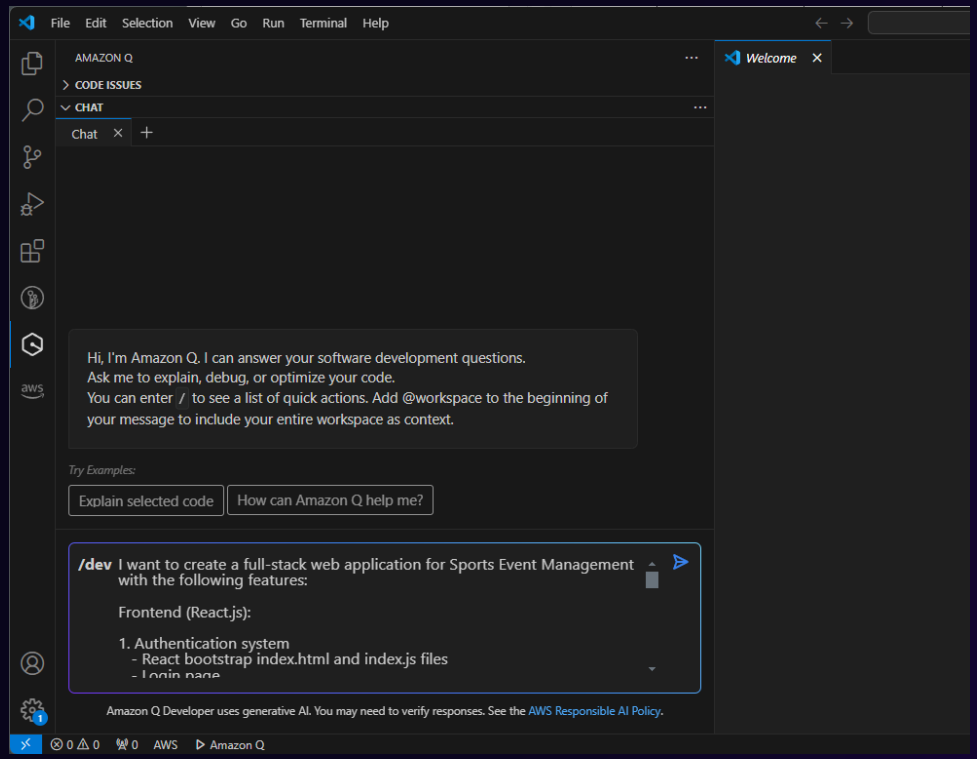
```
Backend (Node.js/Express):

1. API Architecture
   - RESTful API design
   - MVC pattern
   - Error handling middleware
   - Input validation
   - CORS configuration

2. Authentication
   - JWT-based authentication
   - Password hashing
   - Role-based autorization middleware

3. Database (In Memory DB)
   - User schema
   - Add an admin user in advance in db in config file
   - Sports events schema

4. Features
   - CRUD operations for events
   - User management
   - Error logging
   - Input sanitization
   - Rate limiting

Please provide guidance on how to implement this application with best practices and secure coding standards
```

Ln 42, Col 17 | 100% | Windows (CRLF) | UTF-8

Sanjeev Kumar

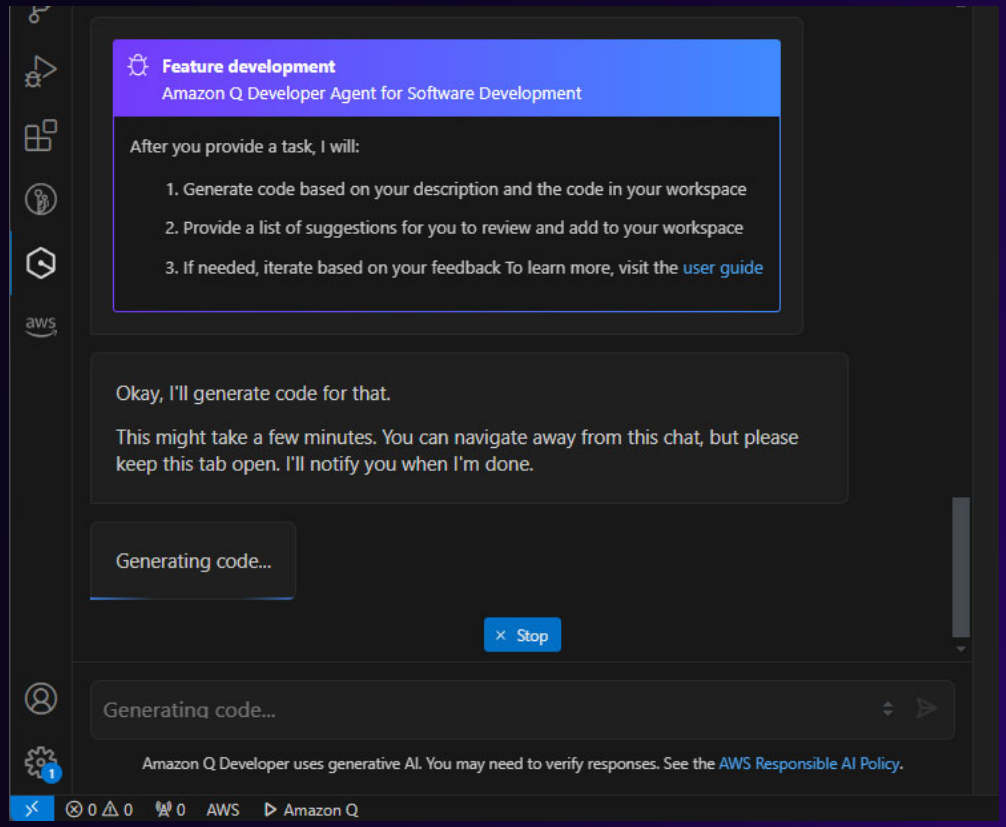
https://www.youtube.com/watch?v=06rB0yNrJT8

Amazon Q Developer in action

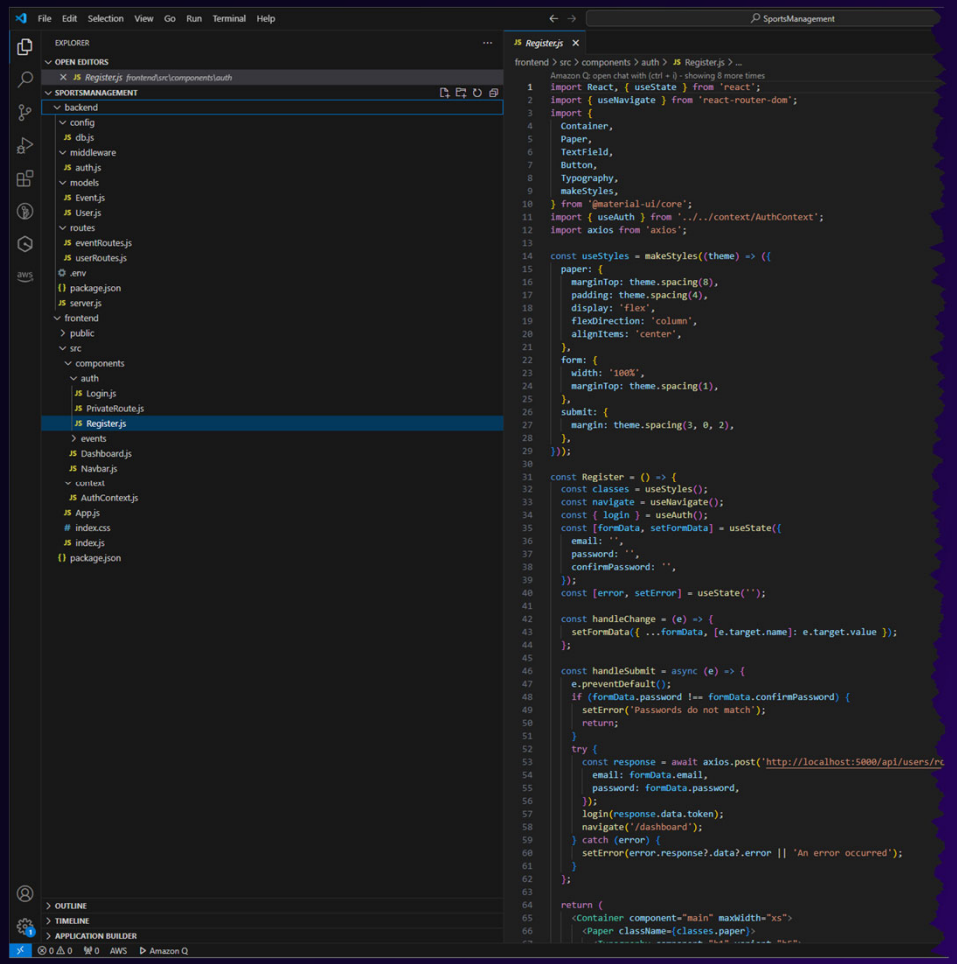


- Create plan
- Look for all features
- Write code
- Create project structure
- Add features and files
- Create summary of changes
- Ask user to accept code

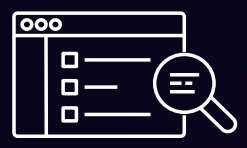
Amazon Q Developer generating code



Amazon Q Developer generated code

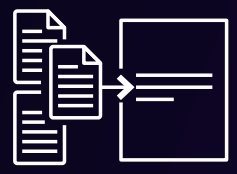


Amazon Q Developer top capabilities



Build faster

Accelerate tasks across the entire SDLC with generative AI-powered capabilities and agents

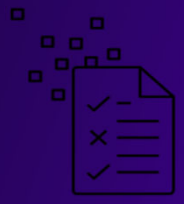


Operate on AWS

Get expert guidance for building on AWS, managing and optimizing AWS cloud resources, and diagnosing and troubleshooting errors.

Transform workloads

Modernize .NET, mainframe, VMware, and Java workloads at enterprise-scale to optimize processes and reduce costs



Leverage Data and AI

Get guidance to quickly and easily build analytics, AI/ML, and generative AI applications.

Faster Innovation

Amazon Q Developer for SDLC

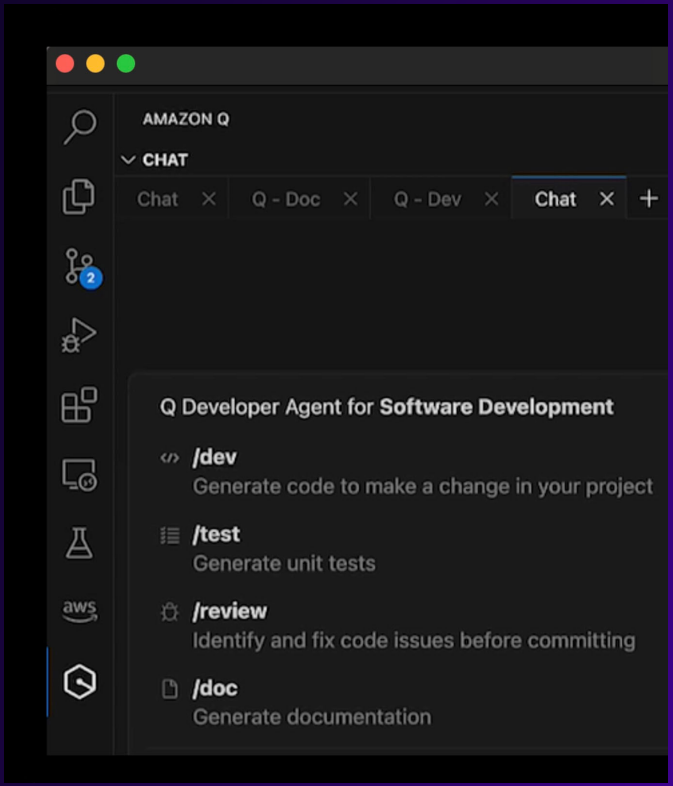
GENERATING CODE REVIEW, TESTS, DOCUMENTATION, GITLAB INTEGRATION, AND OPS HELP

With announcements presented this year,
Amazon Q Developer got 3 new agent capabilities:

1. Enhancing documentation in codebases via `/doc` command.
2. Supporting code reviews to detect and resolve security and code quality issues via `/review`.
3. Generating unit tests automatically and improving test coverage `/test`.

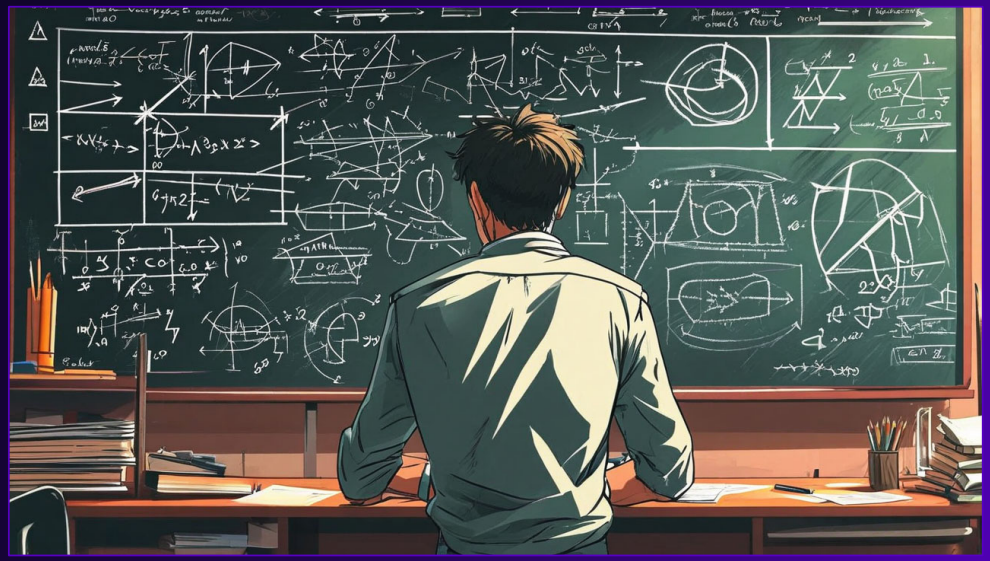
All of the above in your preferred IDE or GitLab Duo with Amazon Q (*preview*), which is one of the most popular enterprise DevOps platforms.

Additionally, there is a new capability in Amazon Q Developer to **investigate and remediate operational issues** (*preview*).



Formal verification

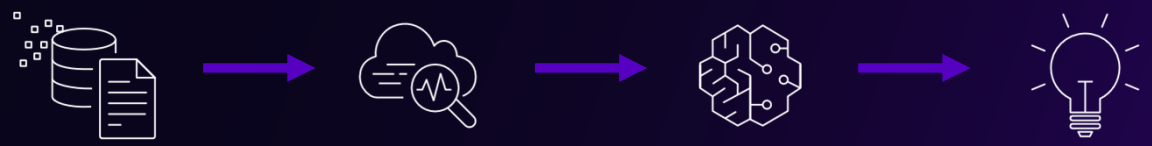
- Mathematically or logically rigorous
- Proof of correctness
- From academia to industry
- Value grows with complexity of system



"A mathematician at a chalk board, working on a complex problem that has a lot of mathematical formulas, diagrams, lines, and arrows, in a manga style."

Machine Learning

Large amount of data (examples of what to predict)



Training

Model

Predictions (inference)

The model can generalize to unseen data but is not 100% correct

Automated Reasoning

Specific information (a company policy, a business process, an operational workflow, a checklist, programming code, …)

Translation (by a human, a computer program, or an LLM)

Formal language (logic)

Ask questions (symbolic reasoning)

Results are accurate, sound, and transparent if assumptions are correct

SAT/SMT solvers

- Propositional satisfiability problem (**SAT**) solvers work with propositional logic formulas to determine if there exists an assignment of true/false values to variables that makes the entire formula true (satisfiable).
- For example, consider the formula:

$$(x \lor y) \land (\neg x \lor z) \land (\neg y \lor \neg z)$$

- A SAT solver would determine if there's any way to assign true/false to x, y, and z to make this true.

SAT/SMT solvers

- Satisfiability modulo theories (**SMT**) solvers extend SAT solving to handle richer logical theories beyond Boolean logic. They can reason about integer and real arithmetic, arrays and data structures, strings, etc.
- For example, an SMT solver can handle formulas like:

  $(x > y) \wedge (y > 0) \wedge (x + y < 10)$ where x and y are integers
- Most modern SMT solvers actually incorporate SAT solvers as their core engine.

Automated reasoning tools

CPROVER – Perform Bounded Model Checking and SatAbs verification on C programs. Detect buffer overflows, pointer safety, and assertions.

Dafny – Verification-aware programming language, blending automated reasoning with familiar programming idioms.

Kani Rust Verifier – Open source verification checking for Rust programs using a SAT solver.

Zelkova – SMT solver used at Amazon for S3 Block Public Access, IAM Access Analyzer, VPC Reachability Analyzer, and more.

Where do you go from here?

- Continue to learn
- Try an AI-powered coding assistant
- Start to learn about automated reasoning and formal verification

Do more with AWS Builder ID

Access 600+ free courses, connect with fellow AWS builders in the community, and build with tools like Amazon Q Developer—all with your single Builder ID

Thank you!

Questions?

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jbarr@amazon.com