ADA

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A Brief History of Ada

- Ada is a programming language designed for large, long-lived applications, and embedded systems; making them reliable and efficient.
- Its name isn't a acronym, but a homage to Augusta Ada Lovelace (1815 - 1852), who is regarded as the world's first programmer.
- This programming language was also the very first internationally standardized (ISO) Object-Oriented Language.
- Overall, Ada is a multi-faceted; this is because of its simple syntax, strong type checking, and various other aspects within its language.

Sources: https://www.adacore.com/about-ada, http://www2.adacore.com/adaanswers/about/ada

The Evolution of Ada

Programming Structure, Modularity	Ada 83	Ada 95	Ada 2005	Ada 2012
Packages	✔	✔	✔	✔
Child units		✔	✔	✔
Limited with clauses and mutually dependent specs			✔	✔
Generic units	✔	✔	✔	✔
Formal packages		✔	✔	✔
Partial parametrization			✔	✔
Conditional expressions, Case expressions				✔
Quantified expressions				✔
In-out parameters for functions				✔
Iterators				✔
Expression functions				✔
Object-Oriented Programming	**Ada 83**	**Ada 95**	**Ada 2005**	**Ada 2012**
Derived types	✔	✔	✔	✔
Tagged types		✔	✔	✔
Multiple inheritance of interfaces			✔	✔
Named access types	✔	✔	✔	✔
Access parameters, Access to subprograms		✔	✔	✔
Enhanced anonymous access types			✔	✔
Aggregates	✔	✔	✔	✔
Extension aggregates		✔	✔	✔
Aggregates of limited type			✔	✔
Unchecked deallocation	✔	✔	✔	✔
Controlled types, Accessibility rules		✔	✔	✔
Accessibility rules for anonymous types			✔	✔
Preconditions and postconditions				✔
Type invariants				✔
Subtype predicates				✔

Concurrency	Ada 83	Ada 95	Ada 2005	Ada 2012
Tasks	✔	✔	✔	✔
Protected types, Distributed Systems Annex		✔	✔	✔
Synchronized interfaces			✔	✔
Delays, Timed calls	✔	✔	✔	✔
Real-Time Systems Annex		✔	✔	✔
Ravenscar profile, Scheduling policies			✔	✔
Multiprocessor affinity, barriers				✔
Requeue on synchronized interfaces				✔
Ravenscar for multiprocessor systems				✔
Scientific Computing	**Ada 83**	**Ada 95**	**Ada 2005**	**Ada 2012**
Numeric types	✔	✔	✔	✔
Complex types		✔	✔	✔
Vector/matrix libraries			✔	✔
Standard Libraries	**Ada 83**	**Ada 95**	**Ada 2005**	**Ada 2012**
Input/output	✔	✔	✔	✔
Elementary functions		✔	✔	✔
Containers			✔	✔
Bounded Containers, holder containers, multiway trees				✔
Task-safe queues				✔
Character Support	**Ada 83**	**Ada 95**	**Ada 2005**	**Ada 2012**
7-bit ASCII	✔	✔	✔	✔
8/16 bit		✔	✔	✔
8/16/32 bit (full unicode)			✔	✔
String Encoding package				✔

Ada on the TIOBE Index and Google Trends

- On the TIOBE index, ADA is ranked #35 with a rating of 0.346% out of 50 programming languages.
- According to Google Trends, the ADA Language has been most popular in the states of Florida, Massachusetts, New York, California, and Texas in the U.S. (ADA followed by either Language, Programming, and Programming Language in Google Trends).
- Comparing the results to the world shows that the ADA Language is most popular in the countries of France, Indonesia, Nigeria, United States, and India.
- Searches for the ADA Language reached its peak during April of 2004 with searches ranging up to 100 but then steadily declined until December of 2012 where it remained consistently between 10-25 searches to present day(There were some spikes in popularity in searches ranging in the high 30s).

Sources: https://www.tiobe.com/, https://trends.google.com/.

Use of Ada in Industry

"The language has continued to live on especially in the aviation/space software community and a few others where reliability (and now security) is important. For instance, nearly 90% of the code for the F-22 Raptor is in Ada."

- Robert Charette, IEEE member

Initially, Ada was mainly used for military applications. Due to its design leading to high levels of safety and reliability, it is now also used in commercial products and other critical systems where a software bug can have severe consequences.

➔ This means **avionics** and **air traffic control**, commercial **rockets**, **satellites** and other space systems, **railway** transport, **health** systems, and **banking**.

Sources: https://people1.cs.kuleuven.be/~dirk.craeynest/ada-belgium/ada.html, https://www.adaic.org/advantages/projects/ https://www.adaic.org/advantages/case-studies/, https://spectrum.ieee.org/riskfactor/computing/it/ada_still_lives_on

➔ Ada in Industry

- Payroll systems, commercial banking systems, stock quotation transaction systems, language translation system and RDMSs.
- Geophysical exploration and data processing systems, and chemical analysis systems.
- Commercial cellular phone switching and commercial telecommunications applications like PABXs.
- FAA Ada in commercial jets, air traffic control systems, in-flight detection and guidance systems, flight training simulators, and flight control/flight display systems.
- NASAs Space Shuttle and Space Station Environments.
- Automated manufacturing systems, automated materials handling systems, robotics welding systems, and inventory management systems.
- Real-time continuous medical monitoring systems and real-time embedded control of copier and duplicator products.
- Strategic military embedded systems, the majority of which are used in real-time applications, systems and mission trainers.

Air Traffic Control

EuroControl – European air traffic control organization
Over 20 Government ATC Agencies – including: Canada, China, UK and USA
National Air Traffic Services (NATS) – Interim Future Area Control Tools Support (iFACTS)
NATS – New En Route Centre (NERC) system
Lockheed Martin – En Route Automation Modernization (ERAM)

Aviation (Commercial)

Airbus – Aircraft: A320, A330, A340, A350 XWB
Boeing – Aircraft: 787, 777, 767,757, 747-400, 737-200, (and others)
Canadian Air – Aircraft: Regional Jet
United Launch Alliance – Atlas and Delta Expendable Launch Vehicles
Barco – Advanced Jet Avionics Display

Rail Transportation

French High-Speed Rail System (TGV)
Hong Kong Suburban Rail
London Underground
Paris Metro and Suburban Rail

Ada = *Reliability*

(Note that the MTA is not on this list)

Communications, Satellites and Receivers

Inmarsat – Voice/data communications to ships and mobile communications
Hertz – NeverLost GPS receiver
Astrium in the UK – Sentinel-1
EADS CASA – ARGOS 4
CNES – SPOT5/HELIOS2

Aviation (Defense)

BAE Systems – Aircraft: Harrier, Hawk
Boeing – K767 Tanker, C130 AMP
EADS – Aircraft: Tornado, A330 MRTT
Eurocopter – Aircraft: Tiger and NH90 helicopters
Eurofighter GmbH – Aircraft: Eurofighter
Lockheed Martin – Aircraft: F-16, F-22, C-130J
Martin Baker – Aircraft: F14, F18 and T-45

What is Ada used for?

- Ada is intended to be used for applications where the main objective is for your program is reliable and effective
- Ada was made with **readability, maintainability, and portability** in mind.
- Ada is a popular language for embedded systems.
- It is used in systems such as a payroll system, chemical analysis, air traffic control, NASA Space Environments, medical monitoring systems, and many more.
- Ada is also known for its security which why it is used for a lot of government applications.
- Fortran code can be efficiently ported to Ada.

Unique Features of Ada

Scalar ranges

- Ada differentiates itself from other languages like C and Java by allowing programmers to create scalar ranges.
- Scalar ranges explicitly specify the range of values for a variable, increasing portability of the application.
- Creating such constraints for variables makes their desired values very clear and makes it easier to catch bugs and input errors.

Source: http://www2.adacore.com/adaanswers/about/ada

Unique Features of Ada

This is a simple example showing scalar ranges.

Here there is an error in line 8:

```
1  with Ada.Text_IO; use Ada.Text_IO;
2  procedure Grade is
3
4      --declaring an integer variable
5      type Grade is range 0 .. 100;
6
7      --create an instance of the grade
8      g : Grade := 200;
9  begin
10     --print
11     Put_Line ("The grade is " & Grade'Image (g));
12 end Grade;
```

The compiler catches this and insists that the value for g is out of bounds.

```
Error(s):

source.adb:8:18: value not in range of type "Grade" defined at line 5
source.adb:8:18: static expression fails Constraint_Check
gnatmake: "source_file.adb" compilation error
```

Using a number within the bounds, however, is accepted.

```
1  with Ada.Text_IO; use Ada.Text_IO;
2  procedure Grade is
3
4      --declaring an integer variable
5      type Grade is range 0 .. 100;
6
7      --create an instance of the grade
8      g : Grade := 20;
9  begin
10     --print
11     Put_Line ("The grade is " & Grade'Image (g));
12 end Grade;
```

```
The grade is  20
```

Unique Features of Ada

Compile-Time Error Checking

- Ada was specifically designed to address issues that large systems with long lifespans have.
- Rather than having programmers add checks and debug code, Ada has a large amount of compile-time checks that catch these issues and save time for developers.
- Ada compilers can frequently detect errors that with other languages could take testing and debugging to discover. It can even offer suggestions on how to fix these issues.

Source: https://www.ada2012.org/

Unique Features of Ada

This is a simple example showing off the compiler suggestion feature.

Here there is an error in line 7:

```
1 with Ada.Text_IO; use Ada.Text_IO;
2 procedure PrintNum is
3     --declaring an integer variable
4     num1 : Integer := 3;
5 begin
6     --print
7     Put_Line ("The number is " & Integer'Image (num));
8 end PrintNum;
```

The compiler catches this and suggests a fix:

```
Error(s):

source.adb:7:49: "num" is undefined
source.adb:7:49: possible misspelling of "num1"
gnatmake: "source_file.adb" compilation error
```

Here is the fixed code and output:

```
1 with Ada.Text_IO; use Ada.Text_IO;
2 procedure PrintNum is
3     --declaring an integer variable
4     num1 : Integer := 3;
5 begin
6     --print
7     Put_Line ("The number is " & Integer'Image (num1));
8 end PrintNum;
```

```
The number is  3
```

Sources

- https://www.adacore.com/about-ada
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Live Demo: https://rextester.com/XHAL91489