NOTE: this is the SOLUTION to Exam 3.

The correct answers are indicated for each question, with explanations as needed.

Dr. Manikas

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1 1 / 1 point

Examples of high-level programming languages that use **Row-Major Mapping** for array storage in memory include (check all that apply):

- [ ] Fortran
- [x] Python
- [x] C++
- [ ] MATLAB

Feedback

General Feedback

- Row-Major Mapping
  - Used in C/C++, Python
- Column-Major Mapping
  - Used in Fortran, MATLAB

2 1 / 1 point

Examples of high-level programming languages that use **Column-Major Mapping** for array storage in memory include (check all that apply):

- [x] Fortran
- [ ] Python
- [x] MATLAB
- [ ] C++

Feedback

General Feedback

- Row-Major Mapping
  - Used in C/C++, Python
- Column-Major Mapping
  - Used in Fortran, MATLAB

3 1 / 1 point

Assume that we have the following matrix that we wish to store in main memory:

$$\begin{bmatrix} A11 & A12 & A13 \\ A21 & A22 & A23 \\ A31 & A32 & A33 \end{bmatrix}$$

The matrix elements are stored in main memory as shown below, with the first matrix element stored in main memory location 0. The matrix elements are stored in _____ order.

0	A11
1	A12

2 A13
3 A21
4 A22
5 A23
6 A31
7 A32
8 A33

- Row Minor
- Column Minor
- ✓ Row Major
- Column Major

4 1 / 1 point

Assume that we have the following matrix that we wish to store in main memory:

$$\begin{bmatrix} A11 & A12 & A13 \\ A21 & A22 & A23 \\ A31 & A32 & A33 \end{bmatrix}$$

The matrix elements are stored in main memory as shown below, with the first matrix element stored in main memory location 0. The matrix elements are stored in _____ order.

0 A11
1 A21
2 A31
3 A12
4 A22
5 A32
6 A13
7 A23
8 A33

- Row Minor
- Row Major
- ✓ Column Major
- Column Minor

5 1 / 1 point

We have a 16 x 16 matrix whose elements are stored as single-precision numbers. Given that the IEEE floating-point standard for single-precision numbers (32 bits) is used for each matrix element, how many **bytes** are required to represent each matrix element?

✓ 4

Feedback

General Feedback

The IEEE floating-point standard for single-precision numbers is 32 bits. There are 8 bits/byte, so each matrix element requires (32 bits) / (8 bits/B) = 4 B.

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6 1 / 1 point

We have a 32 x 32 matrix whose elements are stored as double-precision numbers. Given that the IEEE floating-point standard for double-precision numbers (64 bits) is used for each matrix element, how many **bytes** are required to represent each matrix element?

✓ 8

Feedback

General Feedback

The IEEE floating-point standard for double-precision numbers is 64 bits. There are 8 bits/byte, so each matrix element requires (64 bits) / (8 bits/B) = 8 B.

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7 1 / 1 point

When arithmetic or logical operations are applied to vectors, this is called:

- A vector
- ✓ Vector processing
- A reorder buffer
- A vector processor

Feedback

General Feedback

- Vector processing occurs when arithmetic or logical operations are applied to vectors

8 1 / 1 point

A set of scalar data items, all of the same type, stored in memory, is called:

- A vector processor
- A reorder buffer
- Vector processing
- ✓ A vector

Feedback

General Feedback

- Vector - a set of scalar data items, all of the same type, stored in memory

9 1 / 1 point

We have VMIPS code with 3 convoys. How many **chimes** will this sequence take?

- ✓ 3

Feedback

General Feedback

Recall that each convoy takes 1 chime.

We have **3** convoys, so this sequence will take **3 chimes**.

10 1 / 1 point

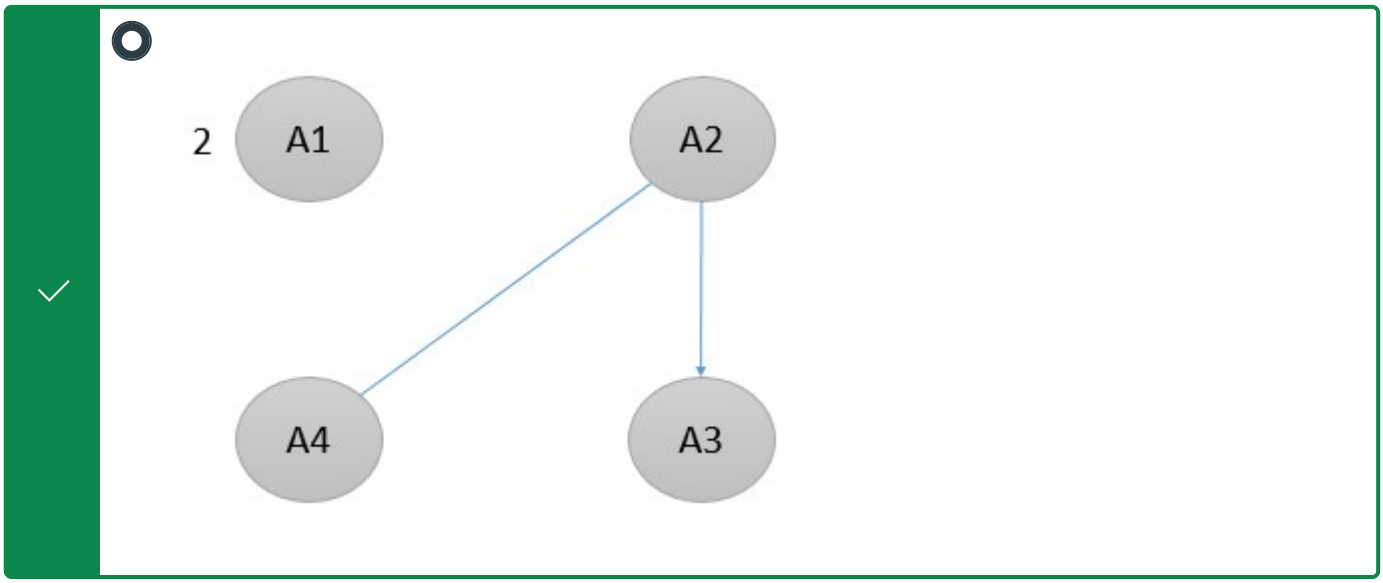
We have a dual-core processor that allows **out-of-order execution:**

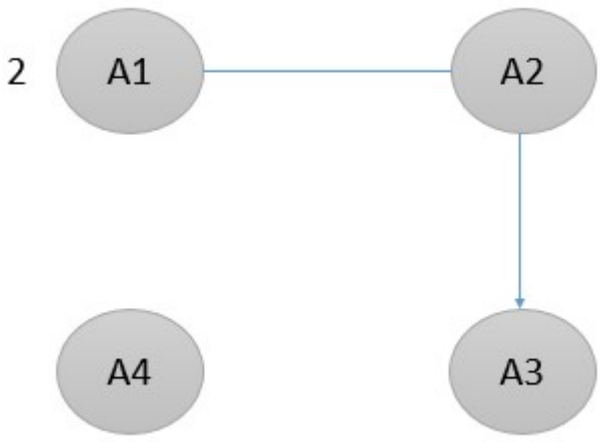
- Operations do not have to be executed in order (e.g. A1, A2, A3, A4), and can be done in *parallel*, as long as dependencies are observed
- Each core has a separate functional unit
- Only one thread can be run on a core at a time

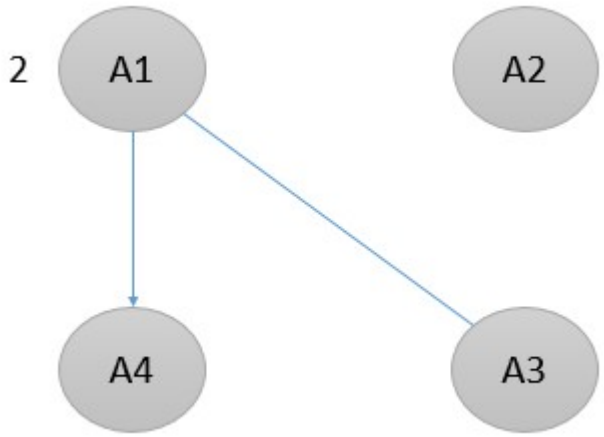
We have a thread running in one of the cores: the thread's operations are specified below:

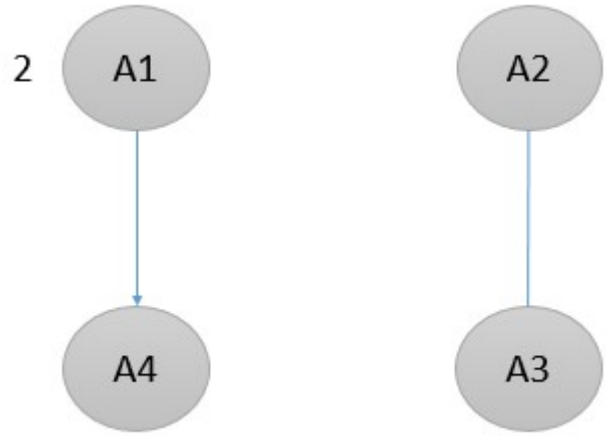
- A1 – takes 2 cycles to execute
- A2 – conflicts for a functional unit with A4
- A3 –depends on the result of A2
- A4 – conflicts for a functional unit with A2

Based on the thread's operations, select the correct **dependency graph** for this thread:









11 1 / 1 point

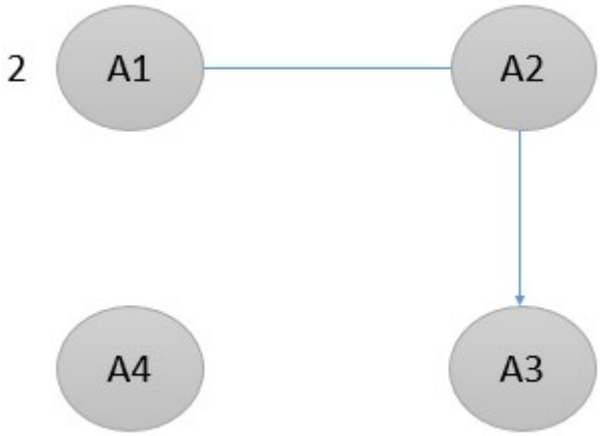
We have a dual-core processor that allows **out-of-order execution:**

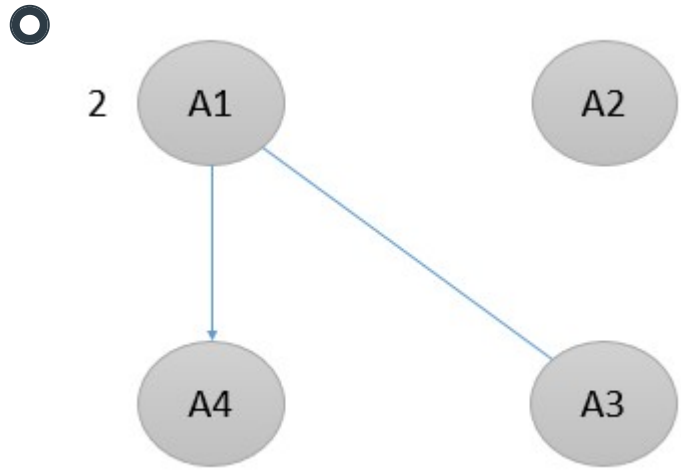
- Operations do not have to be executed in order (e.g. A1, A2, A3, A4), and can be done in *parallel*, as long as dependencies are observed
- Each core has a separate functional unit
- Only one thread can be run on a core at a time

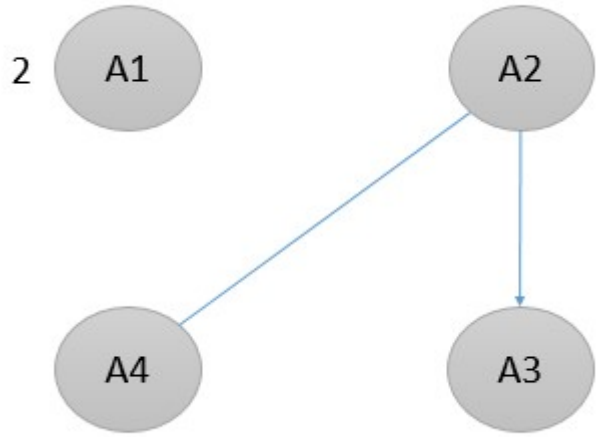
We have a thread running in one of the cores: the thread's operations are specified below:

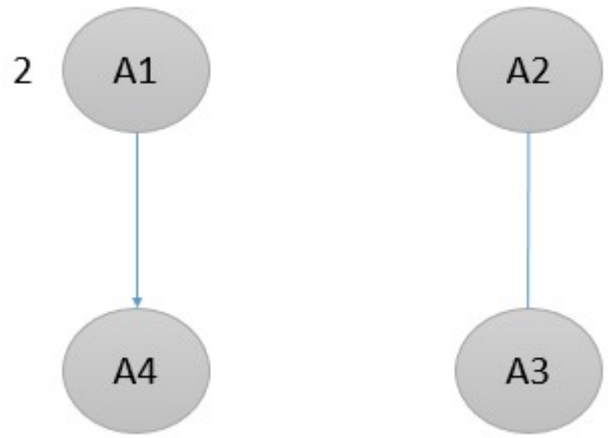
- A1 – takes 2 cycles to execute; conflicts for a functional unit with A3
- A2 – no conflicts or dependencies
- A3 – conflicts for a functional unit with A1
- A4 –depends on the result of A1

Based on the thread's operations, select the correct **dependency graph** for this thread:


2
A1
A2
A4
A3


2
A1
A2
A4
A3


2
A1
A2
A4
A3



12 1 / 1 point

We have a matrix multiplication program running on a single-core system. To speed up program execution, we want to run this program on a multi-core system. Given the parameters below, what is the **execution time** for this program on the multi-core system?

- Matrix multiplication on single-core system = 20 seconds
- Thread start time for each core on multi-core system = 200 ms
- Number of cores in multi-core system = 4

✓ 5.8 sec

Feedback

General Feedback

Execution time = (#cores)(thread start time) + (matrix multiplication time)/(#cores)

For our system,

$$Execution\ Time = (4)\left(200 \times 10^{-3}\ \text{sec}\right) + \left(\frac{20\ \text{sec}}{4}\right) = 5.8\ \text{sec}$$

13 1 / 1 point

We have a matrix multiplication program running on a single-core system. To speed up program execution, we want to run this program on a multi-core system. Given the parameters below, what is the **execution time** for this program on the multi-core system?

- Matrix multiplication on single-core system = 10 seconds
- Thread start time for each core on multi-core system = 100 ms
- Number of cores in multi-core system = 2

✓ 5.2 sec

Feedback

General Feedback

Execution time = (#cores)(thread start time) + (matrix multiplication time)/(#cores)

For our system,

$$Execution\ Time\ =\ (2)\left(100\times10^{-3}\ \text{sec}\right)+\left(\frac{10\ \text{sec}}{2}\right)=5.2\ \text{sec}$$

14 1 / 1 point

We have a quad-core shared-memory processor, where each core has its own cache. The system uses the MESI protocol to ensure cache coherence.
If a cache line has the following condition(s) , what is the MESI protocol state for this cache line?

Cache line is the same as main memory but copies may exist in other caches

- M
- ✓ S
- E
- I

Feedback

General Feedback

- **(M) Modified** - cache line has been modified, is different from main memory
- **(E) Exclusive** - cache line is the same as main memory and is the only cached copy
- **(S) Shared** - Same as main memory but copies may exist in other caches.
- **(I) Invalid** - Line data is not valid (as in simple cache)

15 1 / 1 point

We have a quad-core shared-memory processor, where each core has its own cache. The system uses the MESI protocol to ensure cache coherence.
If a cache line has the following condition(s) , what is the MESI protocol state for this cache line?

Cache line data is not valid

- ✓ ● I
- ○ M
- ○ E
- ○ S

Feedback

General Feedback

- **(M) Modified** - cache line has been modified, is different from main memory
- **(E) Exclusive** - cache line is the same as main memory and is the only cached copy
- **(S) Shared** - Same as main memory but copies may exist in other caches.
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16 1 / 1 point

We have a quad-core shared-memory processor, where each core has its own cache. The system uses the MESI protocol to ensure cache coherence.
If a cache line has the following condition(s) , what is the MESI protocol state for this cache line?

Cache line has been modified and is different from main memory

- ✓ ● M

- I
- S
- E

Feedback

General Feedback

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17 1 / 1 point

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Cache line is the same as main memory and is the only cached copy

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- S
- I
- ✓ E

Feedback

General Feedback

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- **(I) Invalid** - Line data is not valid (as in simple cache)

18 1 / 1 point

The cloud computing characteristic where services or data are available from anywhere is called _____

- Commodified
- ✓ Ubiquitous
- Local
- Remotely hosted

Feedback

General Feedback

- **Remotely hosted**: Services or data are hosted on remote infrastructure.
- **Ubiquitous**: Services or data are available from anywhere.
- **Commodified**: The result is a utility computing model

19 1 / 1 point

The cloud computing characteristic where the result is a utility computing model is called _____

- Ubiquitous
- Local
- ✓ Commodified
- Remotely hosted

Feedback

General Feedback

- **Remotely hosted**: Services or data are hosted on remote infrastructure.
- **Ubiquitous**: Services or data are available from anywhere.
- **Commodified**: The result is a utility computing model

20 1 / 1 point

The cloud computing characteristic where services or data are hosted on remote infrastructure is called _____

- Local
- ✓ Remotely hosted
- Commodified
- Ubiquitous

Feedback

General Feedback

- **Remotely hosted**: Services or data are hosted on remote infrastructure.
- **Ubiquitous**: Services or data are available from anywhere.

- **Commodified**: The result is a utility computing model

21 1 / 1 point

Amazon S3 is part of what cloud computing layer?

- Application Service
- ✓ Storage Platform
- Server Platform
- Application Platform

Feedback

General Feedback

Application Service (SaaS)	MS Live/ExchangeLabs, IBM, Google Apps; Salesforce.com Quicken Online, Zoho, Cisco
Application Platform	Google App Engine, Mosso, Force.com, Engine Yard, Facebook, Heroku, AWS
Server Platform	3Tera, EC2, SliceHost, GoGrid, RightScale, Linode
Storage Platform	Amazon S3, Dell, Apple, ...

22 1 / 1 point

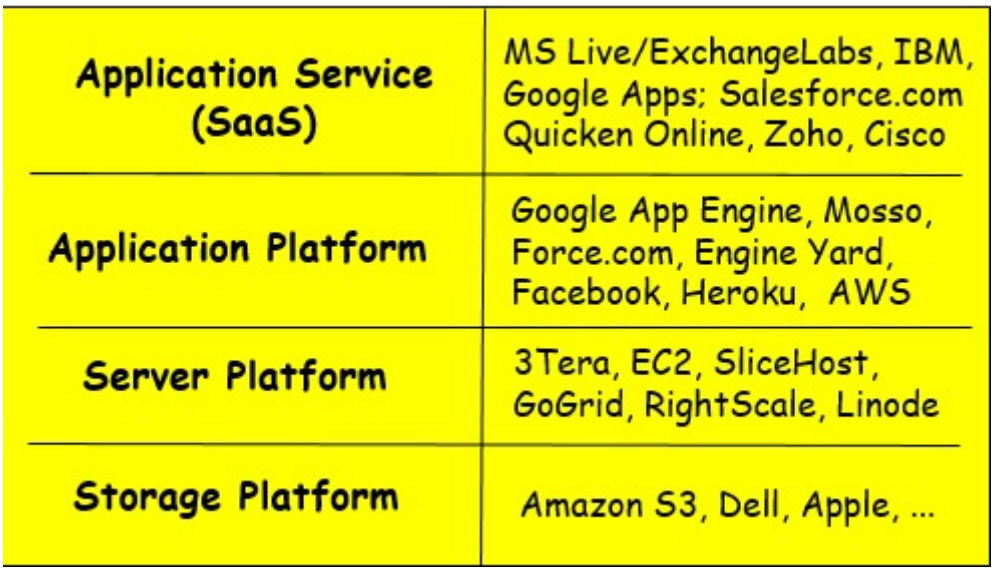
Google Apps and Quicken Online are part of what cloud computing layer?

- Storage Platform
- Server Platform
- ✓ Application Service

Application Platform

Feedback

General Feedback



23 1 / 1 point

GoGrid and EC2 are part of what cloud computing layer?

Storage Platform

✓ Server Platform

Application Platform

Application Service

Feedback

General Feedback

Application Service (SaaS)	MS Live/ExchangeLabs, IBM, Google Apps; Salesforce.com Quicken Online, Zoho, Cisco
Application Platform	Google App Engine, Mosso, Force.com, Engine Yard, Facebook, Heroku, AWS
Server Platform	3Tera, EC2, SliceHost, GoGrid, RightScale, Linode
Storage Platform	Amazon S3, Dell, Apple, ...

24 1 / 1 point

AWS and Facebook are part of what cloud computing layer?

- Application Service
- Server Platform
- Storage Platform
- ✓ Application Platform

Feedback

General Feedback

Application Service (SaaS)	MS Live/ExchangeLabs, IBM, Google Apps; Salesforce.com Quicken Online, Zoho, Cisco
Application Platform	Google App Engine, Mosso, Force.com, Engine Yard, Facebook, Heroku, AWS
Server Platform	3Tera, EC2, SliceHost, GoGrid, RightScale, Linode
Storage Platform	Amazon S3, Dell, Apple, ...

25 1 / 1 point

For machine learning strategies, examples of **supervised** learning include:

- [x] Regression Algorithms
- [ ] Clustering Algorithms
- [x] Classification Algorithms
- [ ] Dimensionality Reduction Algorithms

Feedback

General Feedback

1. **Supervised Learning:** the training set contains data and the correct output of a given task with that data. Examples include:
    a. **Classification Algorithms:** training set is dataset and class of each piece of data. Computer learns how to classify new data.
    b. **Regression Algorithms:** predict a value of an entity's attribute.
2. **Unsupervised Learning:** the training set contains data, but no solutions. Examples include:
    a. **Clustering Algorithms:** training set is dataset covering various dimensions. The data are partitioned into clusters based on specified criteria.
    b. **Dimensionality Reduction Algorithms:** training set is also dataset covering various dimensions. The algorithm project the data to fewer dimensions, with the goal of attempting to better capture the fundamental aspects of the original data.