A note on homework output

Your output should match the spec *exactly*.

- Computers are dumb and don't know what you mean
- We can't anticipate your possible enhancements

Errors and exceptions

EECS 211

Winter 2018

Kinds of errors

- Static (compile-time) errors
  - Syntax errors
  - Semantic (type) errors
  - Linker errors
- Dynamic (run-time) errors
  - Logic errors (bugs)
  - User and environment errors

Static versus dynamic errors

Static happens at build time

Dynamic happens at run time

Static versus dynamic errors

Static	happens at build time
Dynamic	happens at run time

Consequently, programs with static errors can't be run!

Syntax errors

When the program doesn't have the correct form for a program. Examples:

- Unmatches bracket or parenthesis
- Missing or extraneous semicolon
- A reserved word used where an identifier is required

Semantic errors

When something doesn't make sense. Examples:

- Calling a function that hasn't been declared
- Calling a two-argument function with three arguments
- Using an int where a string is required

Linker errors

When some promised definitions are still missing at the end of the build process

(This will make more sense later)

Logic errors

When the programmer gets something wrong. Examples:

- Integer divide-by-zero
- Array out-of-range error
- Crashes when attempting to render two tables side-by-side

User and environment errors

When the user does something wrong, or the environment isn't in the required state. Examples:

- Attempting to open a file that doesn't exist
- The network being down
- Clicking in a modally-inactive window

What should we do in case of error?

It depends:

Programmer errors All is lost! So probably crashing is best

User/env. errors Be user-friendly! Allow the user to recover

What should we do in case of error?

It depends:

Programmer errors All is lost! So probably crashing is best*

User/env. errors Be user-friendly! Allow the user to recover

* unless it's required to be robust (like a flight control system)

What should we do in case of error?

It depends:

Programmer errors All is lost! So probably crashing is best*

User/env. errors Be user-friendly! Allow the user to recover†

* unless it's required to be robust (like a flight control system)
† unless the programmer is the user and the user doesn't care

Example logic error

```
// Computes the mean value of a vector
double mean(vector<double> sample)
{
    double sum = 0;

    for (double element : sample)
        sum += element;

    return sum / sample.size();
}
```

Example logic error

```
// Computes the mean value of a vector
double mean(vector<double> sample)
{
    double sum = 0;

    for (double element : sample)
        sum += element;

    return sum / sample.size();
}
```

Now suppose mean is called with an empty vector…

Whose job is it to prevent this?

Options:

- The author of mean (the *service*)

Whose job is it to prevent this?

Options:

- The author of mean (the *service*)
- The author of the code that calls mean (the *client*)

Whose job is it to prevent this?

Options:

- The author of mean (the *service*)
- The author of the code that calls mean (the *client*)
- Both!

What the client should do

Try not to call mean with an empty vector!

What the client should do

Try not to call mean with an empty vector!

If the empty data set is coming from the user (or a file), the client should present an error message and allow the user to recover

What the service should do

Several options:

- Just return nonsense
- Crash the program
- Throw an exception
- Declare a precondition (and one of the above)

Just return nonsense!

```
// Computes the mean value of a vector
double mean(vector<double> sample)
{
    double sum = 0;

    for (double element : sample)
        sum += element;

    return sum / sample.size();
}
```

Just return nonsense!

```
// Computes the mean value of a vector
double mean(vector<double> sample)
{
    double sum = 0;

    for (double element : sample)
        sum += element;

    return sum / sample.size();
}
```

Pros:

- It's fast
- It's simple

Cons:

- Hard to debug

Document the precondition and return nonsense

```
// Computes the mean value of a vector
// PRECONDITION: !sample.empty()
double mean(vector<double> sample)
{
    double sum = 0;
    for (double element : sample) sum += element;
    return sum / sample.size();
}
```

Document the precondition and return nonsense

```
// Computes the mean value of a vector
// PRECONDITION: !sample.empty()
double mean(vector<double> sample)
{
    double sum = 0;
    for (double element : sample) sum += element;
    return sum / sample.size();
}
```

Pros:

- It's fast
- It's simple
- It's clearer

Cons:

- Still hard to debug

Crash the program

```
#include <cstdlib>

double mean(vector<double> sample)
{
    if (sample.empty()) {
        std::cerr << "Empty sample has no mean\n";
        exit(1);
    }
    ⋮
}
```

Crash the program

```
#include <cstdlib>

double mean(vector<double> sample)
{
    if (sample.empty()) {
        std::cerr << "Empty sample has no mean\n";
        exit(1);
    }
    ⋮
}
```

Pros:

- Easier to debug
- Still pretty simple

Cons:

- What if client wants to recover?
- Takes time to check (maybe)

Throw an exception

```
#include <stdexcept>

double mean(vector<double> sample)
{
    if (sample.empty())
        throw std::runtime_error(
            "empty sample has no mean");
    ⋮
}
```

Throw an exception

```
#include <stdexcept>

double mean(vector<double> sample)
{
    if (sample.empty())
        throw std::runtime_error(
            "empty sample has no mean");
    ⋮
}
```

Throw an exception

```
#include <stdexcept>

double mean(vector<double> sample)
{
    if (sample.empty())
        throw std::runtime_error(
            "empty sample has no mean");
    ⋮
}
```

Pros:

- Easiest to debug
- Allows client to recover

Cons:

- Takes time to check (maybe)
- More complicated

To the terminal!