Effektiv Kode med C og C++

Forelesning 5, vår 2015
Alfred Bratterud

Agenda:

- Litt repetisjon
  - Constructorer og destructorer
- Klasser og headerfiler
- Makefile
- Exceptions

Litt repetisjon

konstruktører i klasser

- Konstruktøren har som jobb å initialisere alle medlemmer - ved å kalle deres konstruktører.
- OBS: Lager du en konstruktør selv, uten argumenter, mister du den «implisitte» default-konstruktøren som lages for deg
- I alle egne konstruktører må alle medlemmer initialiseres manuelt - evt. ved å kalle default-konstruktør.
- Man må da initialisere slik:

```
class student{
  int nr;
  int nr = 0; // OK i C++11
  int birth_year{1979} // OK i C++11
  string name_;
  public:
     student(string n): nr{10},name_(n) { ... }
     int get_nr();
     string name();
};
```

Destruktorer

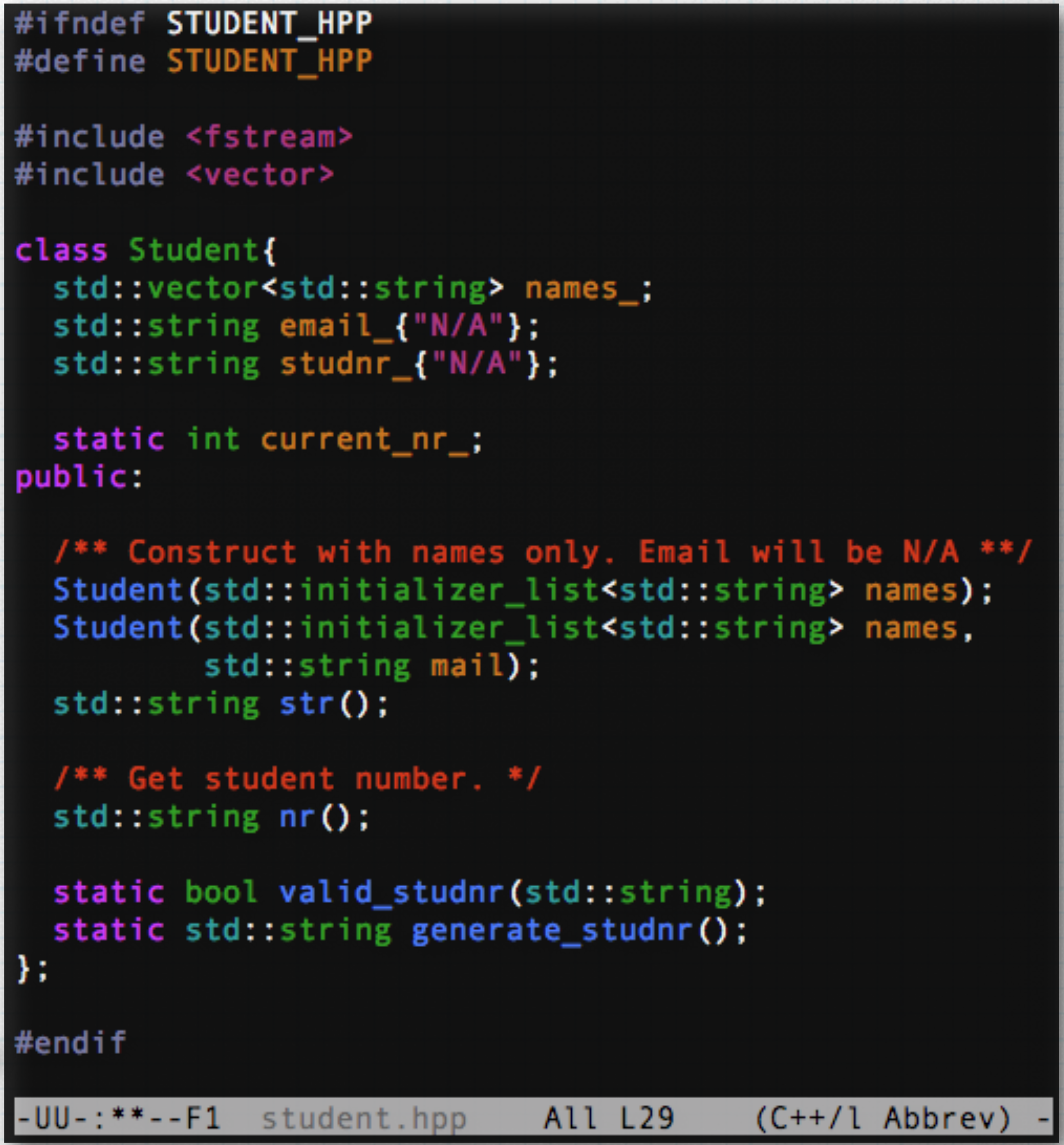
- Destruktor har ansvar for å rydde opp, dvs. frigjøre det minnet / evt. andre ressurser klassen har satt av.
- Destruktoren til en klasse "myClass" heter "   ~myClass()
- Vi kan lage egne, som vanlig, men alle objekter har en "default destructor"
- ....Den kaller destructoren til medlemmene. Default destructor for peker?
- Hva vil vi typisk gjøre i en "destructor"?
    - Frigjøre alt klassen allokerte med new!
    - Evt. lukke filer!
- Fantastisk garanti: Destructor kalles alltid når variabel går ut av skop.
- Hvorfor har vi ikke destructorer i java/php?
    - Alle problemene i C++ skyldes pekere ;-)

Interface v.s. Implementation

- "Interfacet" til en klasse (eller et bibliotek) består av deklarasjoner av alle medlemmene, men kun med "signaturene" til funksjonene
    - Denne ligger gjerne i en egen "header-fil" (class_student.hpp)
- "Implementasjonen" ligger gjerne i en annen fil (class_student.cpp), som "inkluderer" header-fila
- Fordi vi da kan «interface»/«snakke» med ferdig kompilerte klasser, kun ved å kjenne til header fila
- Skjer via «linking» mellom din binærfil og den ferdig kompilerte klassen
    - Gjøres av «linkeren» (GNU ld i Linux-vm'en)
    - Kan gjøres «Statisk» eller «dynamisk» - til og med «run time»
    - I Windows: .dll'er er delte, ferdigkompilerte biblioteker. I Linux: .so
- G++ kompilerer *og* linker. For å kun kompilere - bruk g++ -c myfile.cpp. Det genererer en kompilert objektfil myfile.o som kan linkes med andre filer.

Kursstandard: header

"Include guard":
En macro som hindrer
multippel inkludering



```
#ifndef STUDENT_HPP
#define STUDENT_HPP

#include <fstream>
#include <vector>

class Student{
  std::vector<std::string> names_;
  std::string email_{"N/A"};
  std::string studnr_{"N/A"};

  static int current_nr_;
public:

  /** Construct with names only. Email will be N/A **/
  Student(std::initializer_list<std::string> names);
  Student(std::initializer_list<std::string> names,
          std::string mail);
  std::string str();

  /** Get student number. */
  std::string nr();

  static bool valid_studnr(std::string);
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#endif

-UU-:**--F1  student.hpp    All L29    (C++/l Abbrev) -
```
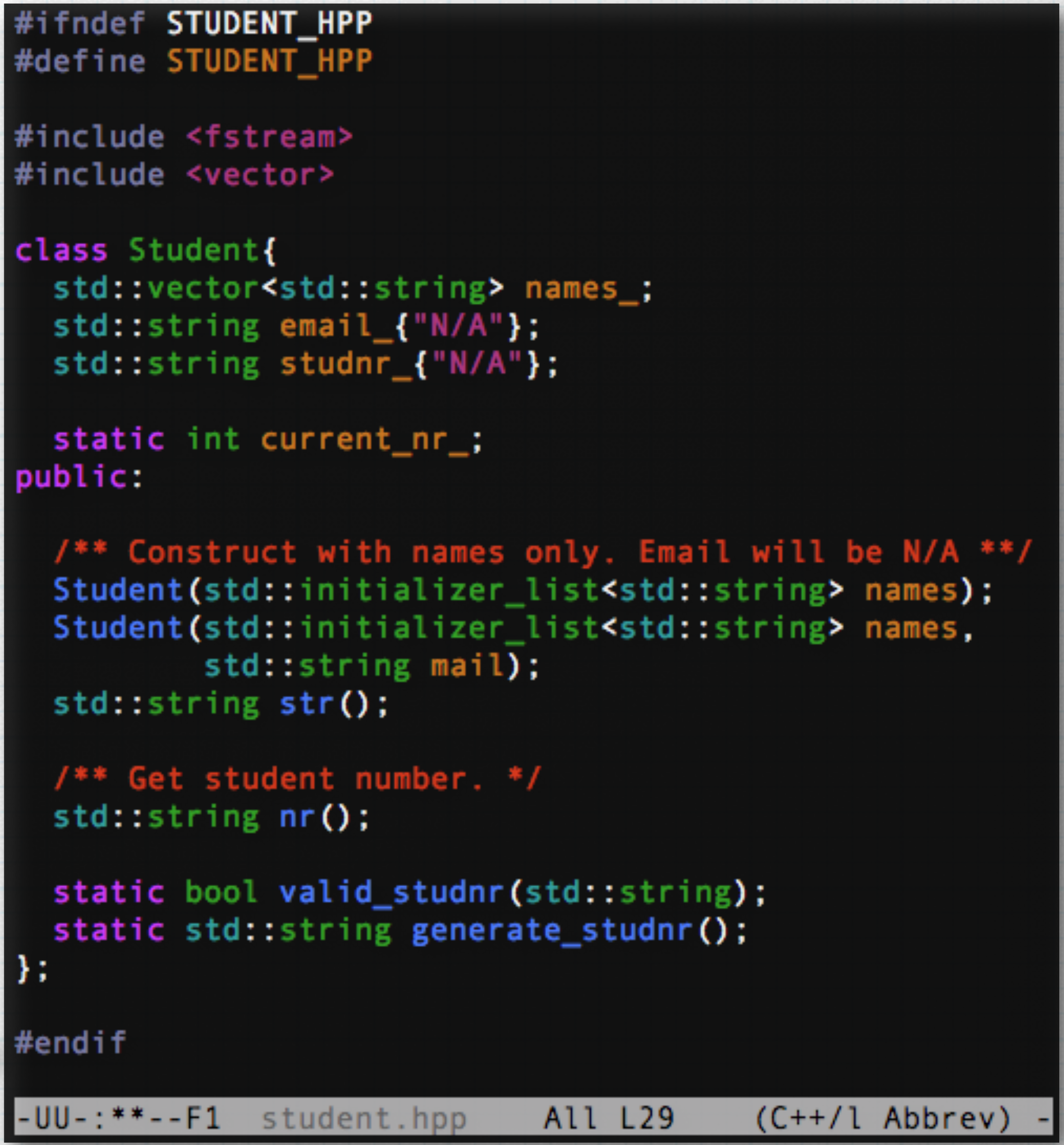

"Include guard"

Kursstandard: header

"Include guard":
En macro som hindrer multippel inkludering

Vi trenger kanskje «PI» eller «Card» flere steder i programmet - men klasser og variabler kan ikke deklareres flere ganger! (Funksjonssignaturer går, men ikke kropper.)



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-UU-:**--F1  student.hpp     All L29     (C++/l Abbrev) -
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"Include guard"

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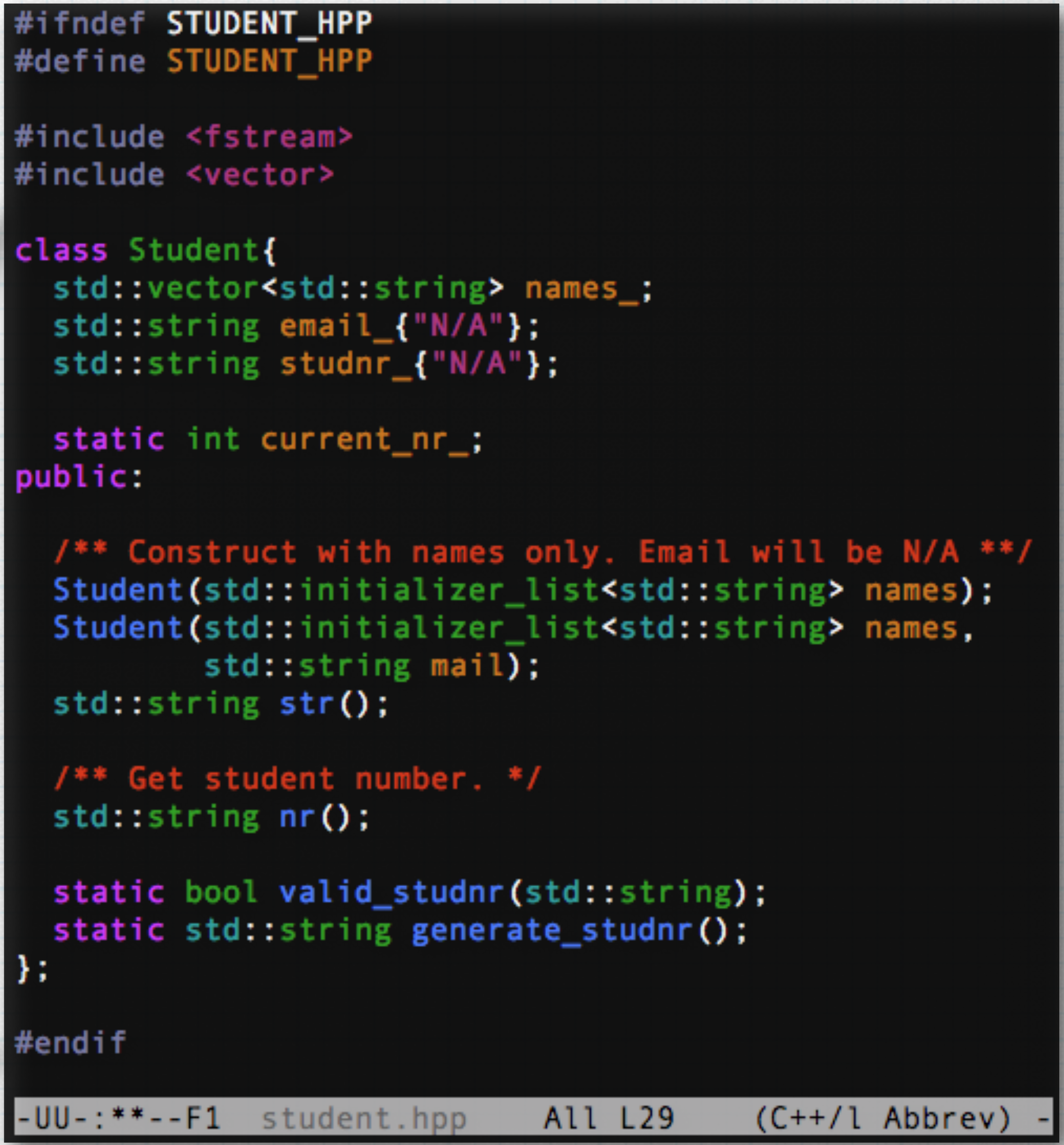
Ingen "using namespace std;"



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-UU-:**--F1  student.hpp     All L29     (C++/l Abbrev) -
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"Include guard"

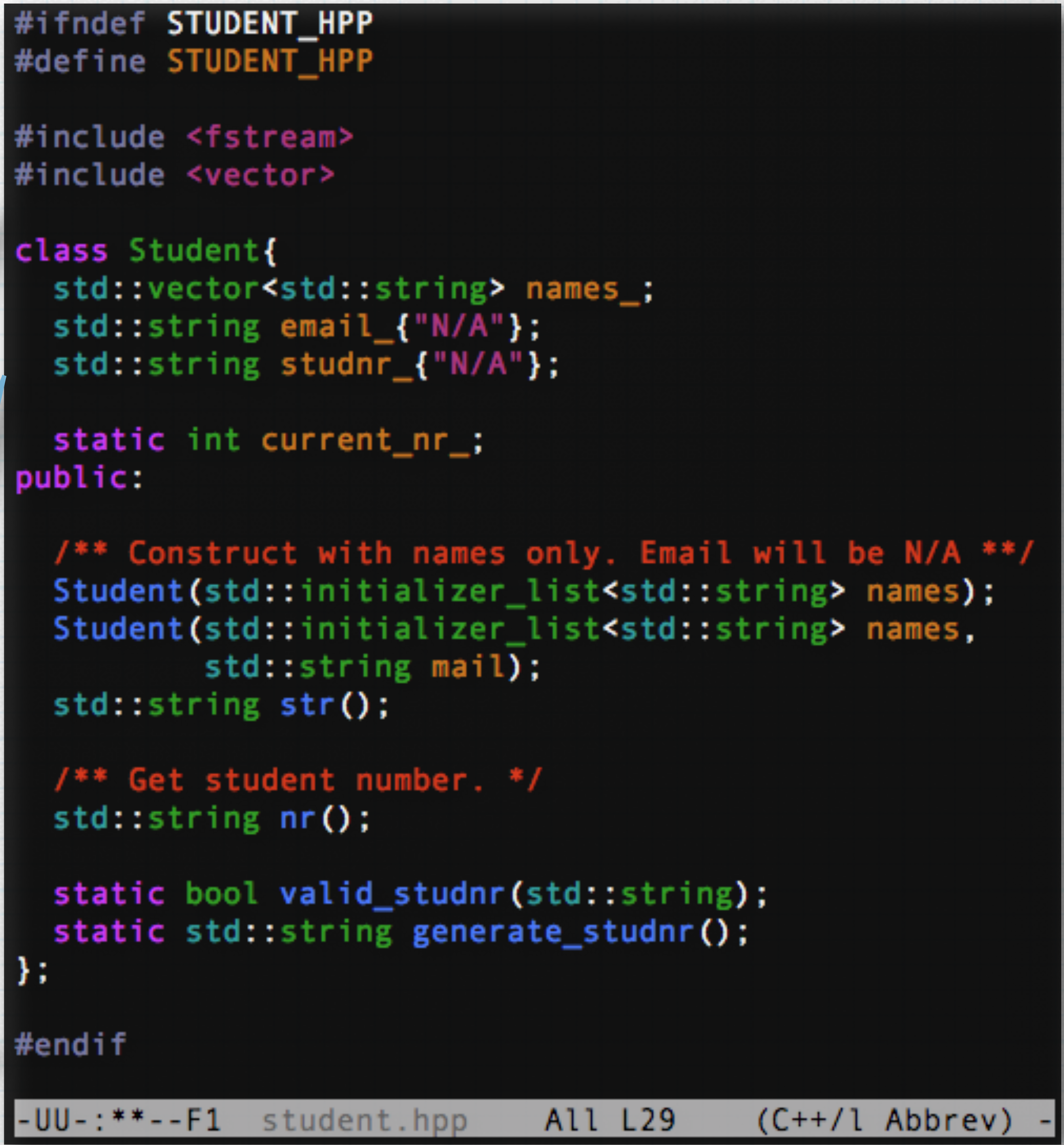
Kursstandard: header

"Include guard": En macro som hindrer multippel inkludering

Ingen "using namespace std;"

En klasse, helt uten kropper. Men- vi har med includes for å kunne bruke typene som medlemmer

"Include guard"



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-UU-:**--F1  student.hpp     All L29     (C++/l Abbrev) -
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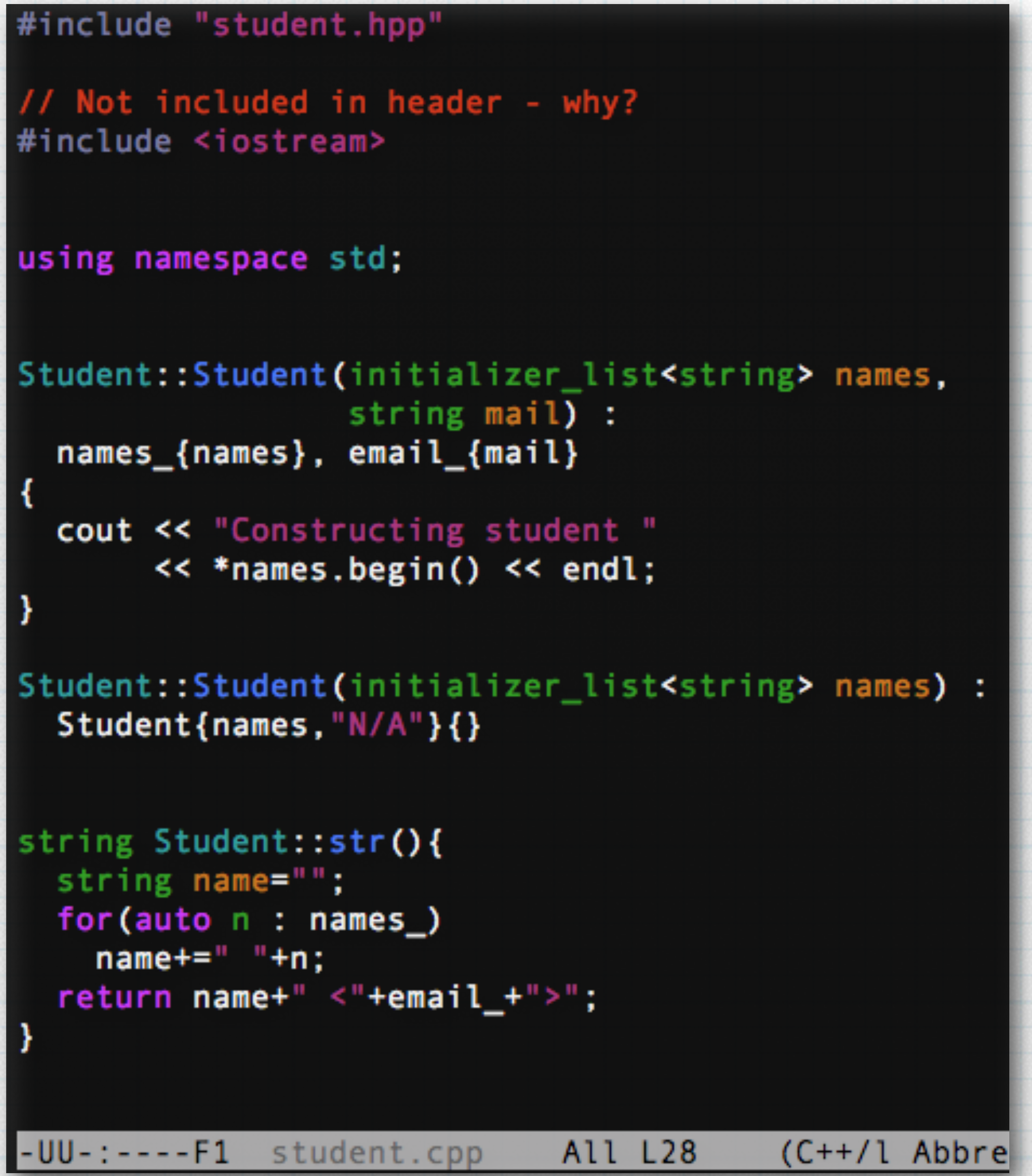
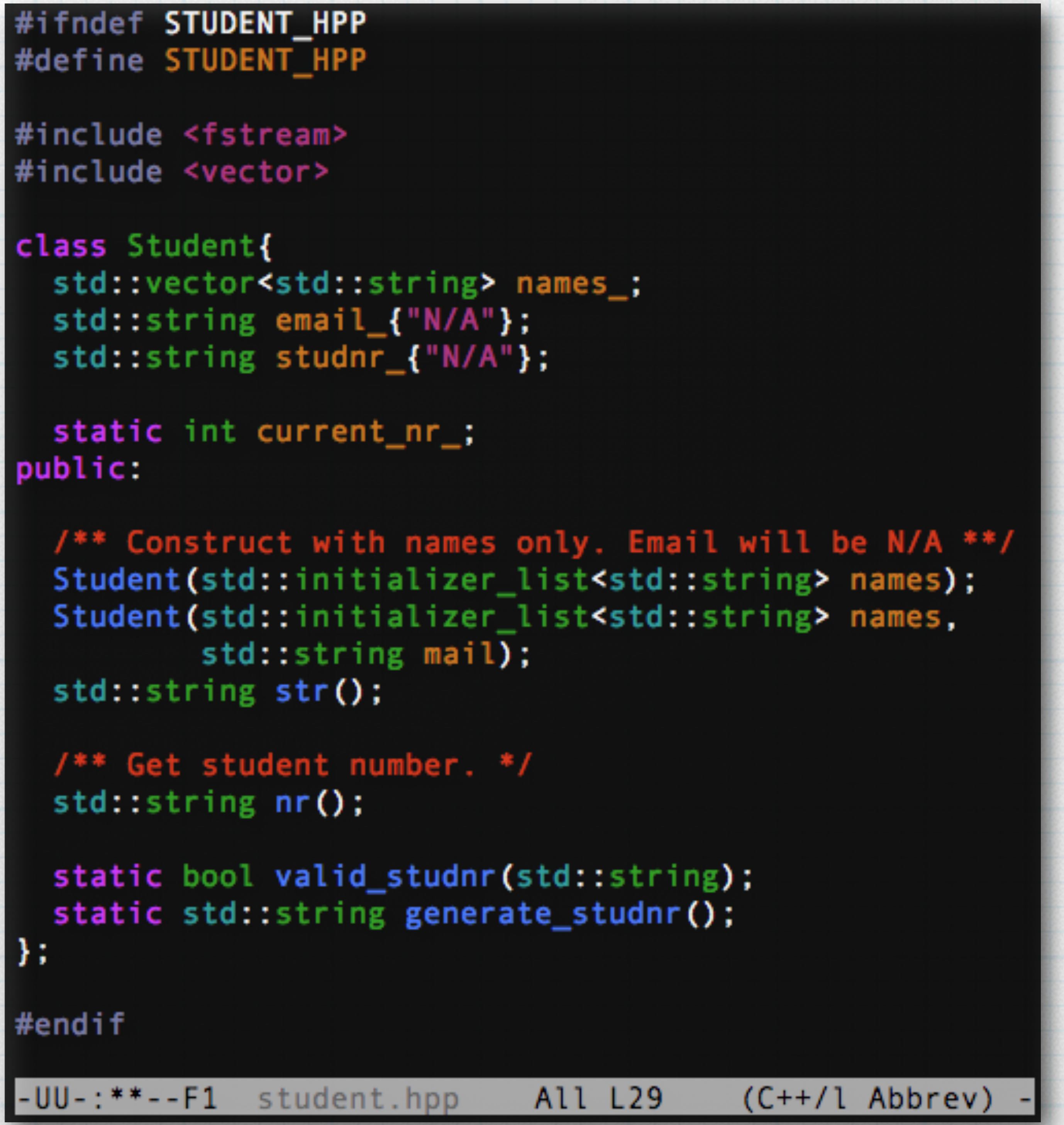
Header + Implementasjon



```
#include "student.hpp"

// Not included in header - why?
#include <iostream>


using namespace std;


Student::Student(initializer_list<string> names,
                 string mail) :
  names_{names}, email_{mail}
{
  cout << "Constructing student "
       << *names.begin() << endl;
}

Student::Student(initializer_list<string> names) :
  Student{names,"N/A"}{}


string Student::str(){
  string name="";
  for(auto n : names_)
    name+=" "+n;
  return name+" <"+email_+">";
}


-UU-:----F1  student.cpp    All L28    (C++/l Abbre
```



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-UU-:**--F1  student.hpp    All L29    (C++/l Abbrev) -
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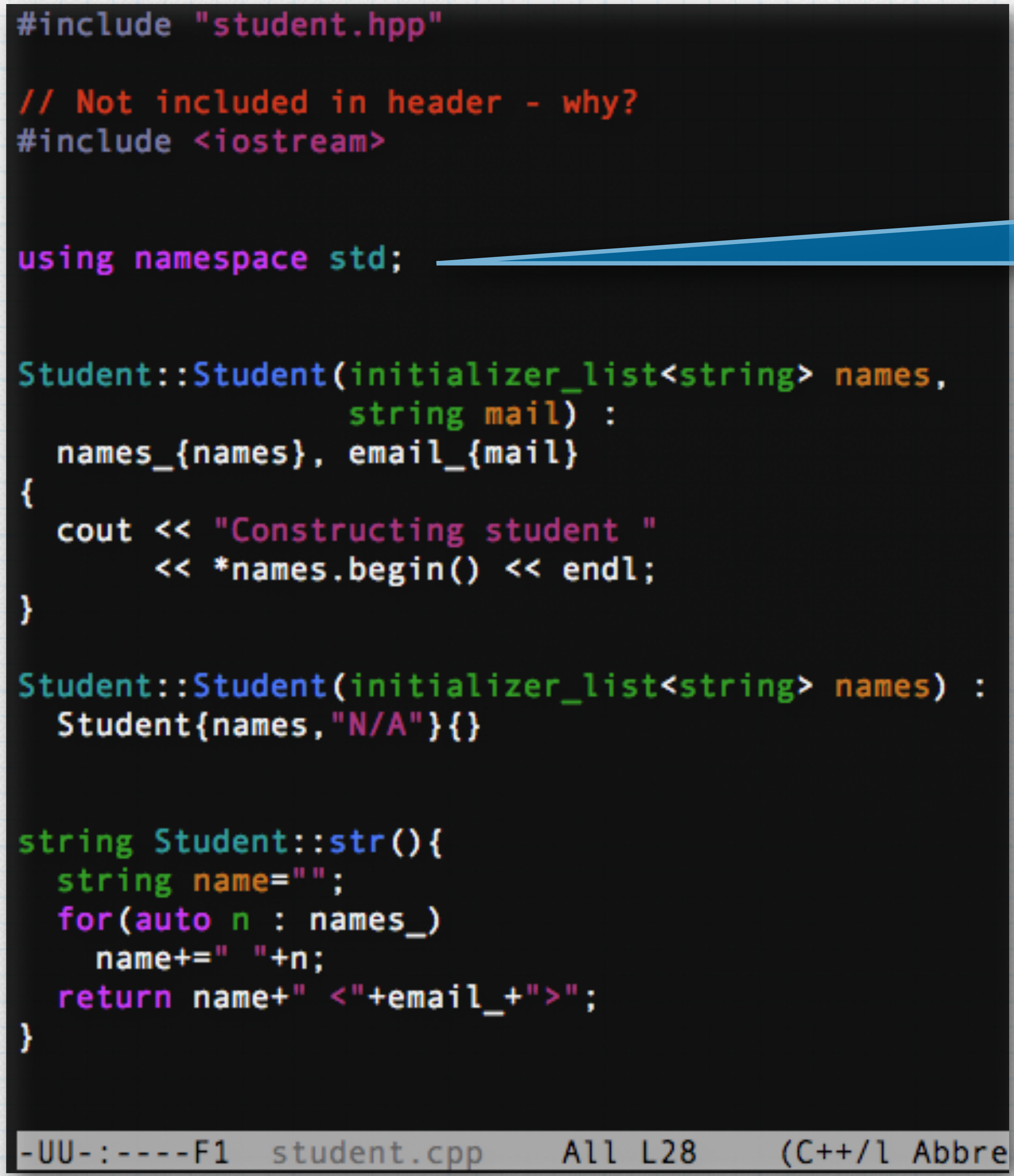

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Student::Student(initializer_list<string> names) :
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string Student::str(){
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  for(auto n : names_)
    name+=" "+n;
  return name+" <"+email_+">";
}


-UU-:----F1  student.cpp    All L28    (C++/l Abbre
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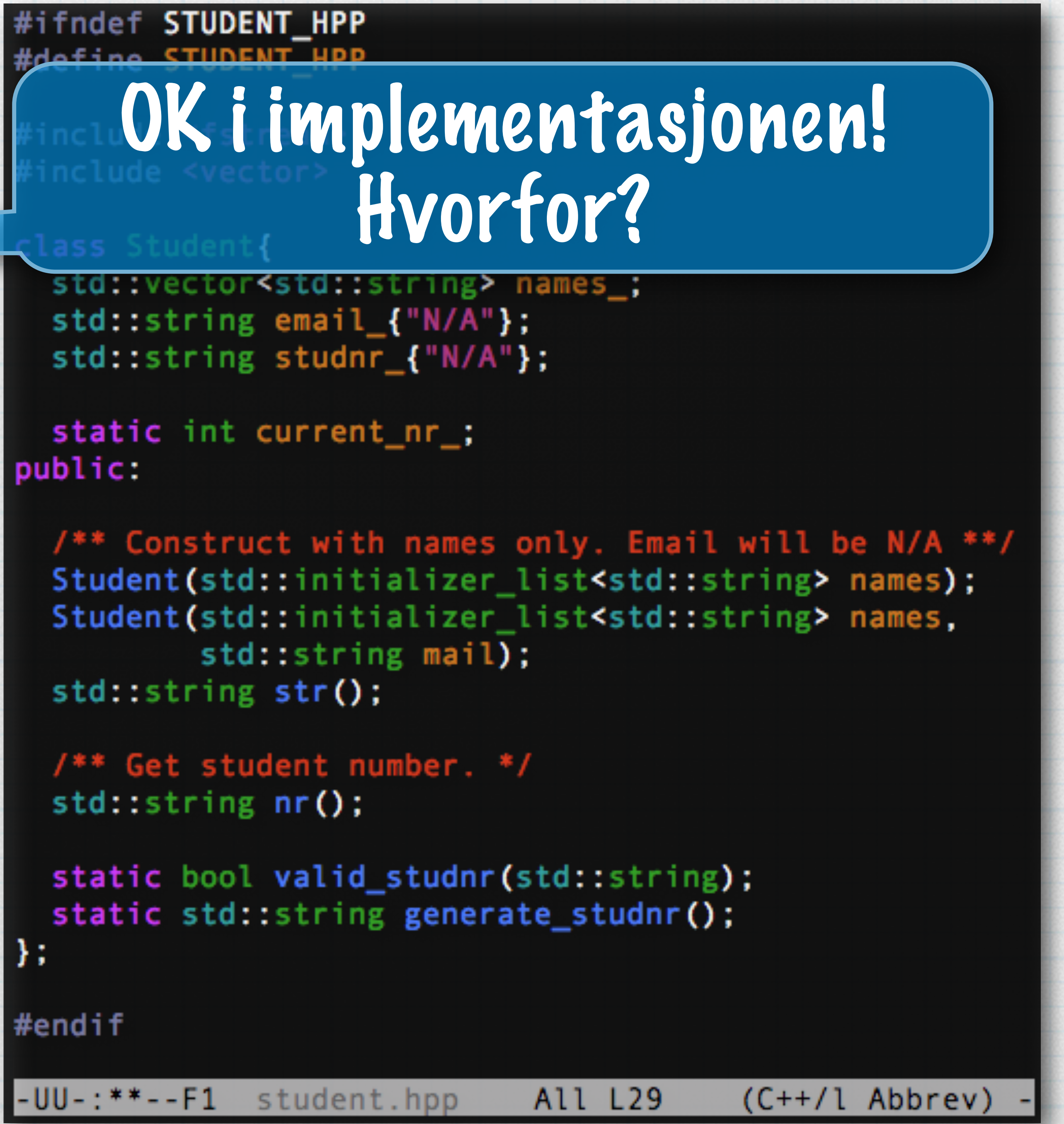

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-UU-:**--F1  student.hpp    All L29    (C++/l Abbrev) -
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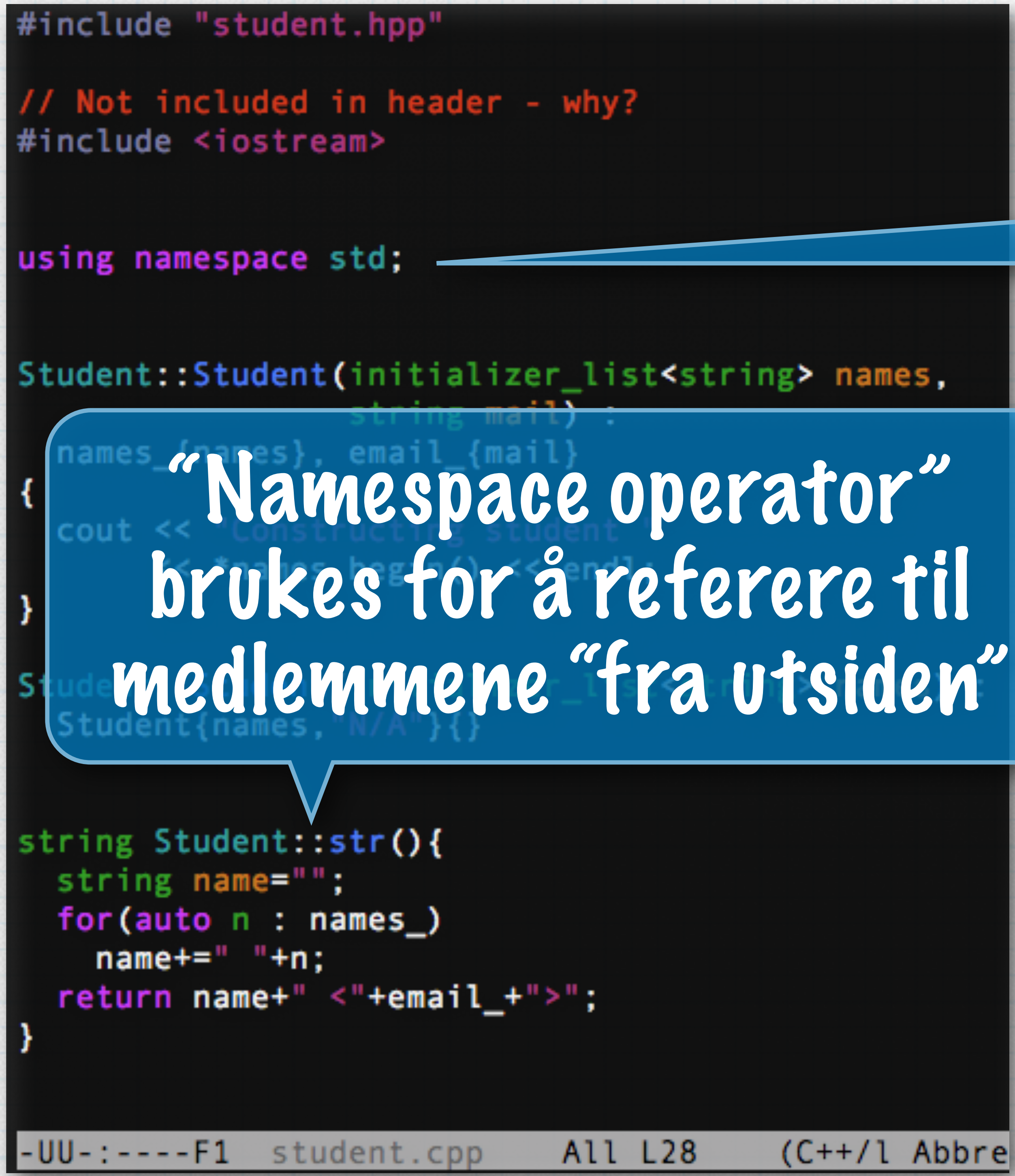
OK i implementasjonen!
Hvorfor?

Header + Implementasjon



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-UU-:----F1  student.cpp    All L28     (C++/l Abbre
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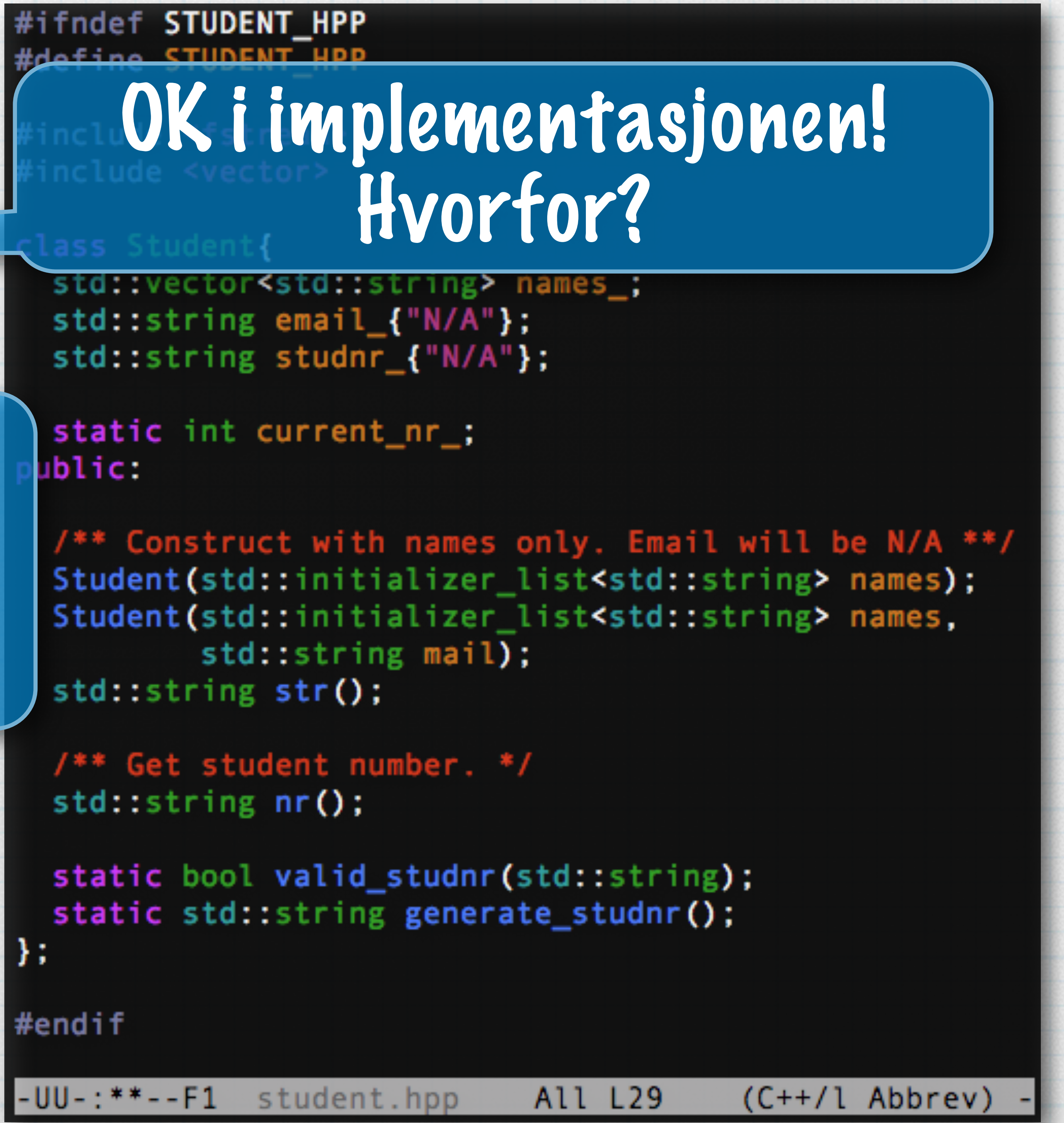

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-UU-:**--F1  student.hpp    All L29     (C++/l Abbrev) -
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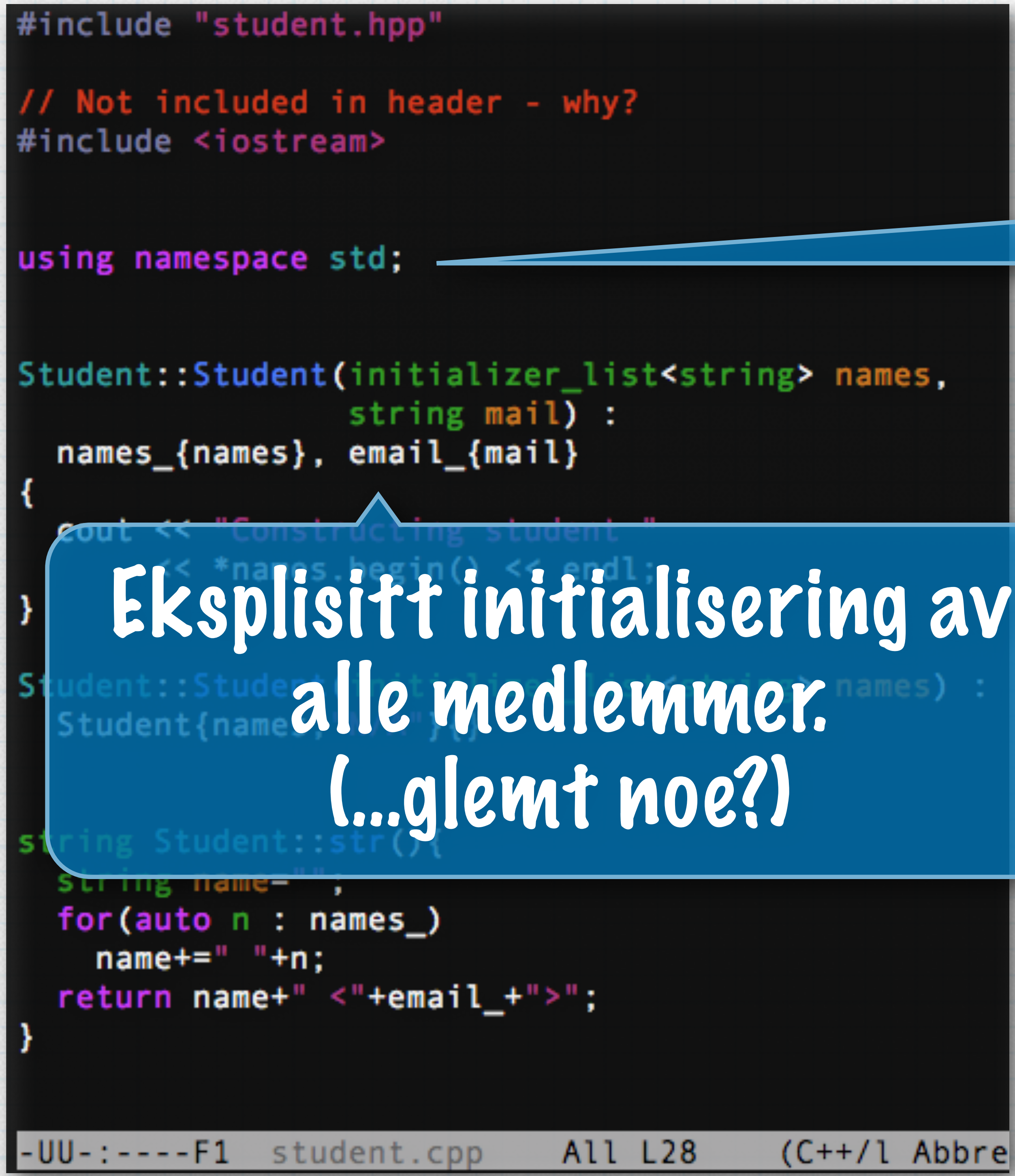
OK i implementasjonen!
Hvorfor?

"Namespace operator" brukes for å referere til medlemmene "fra utsiden"

Header + Implementasjon



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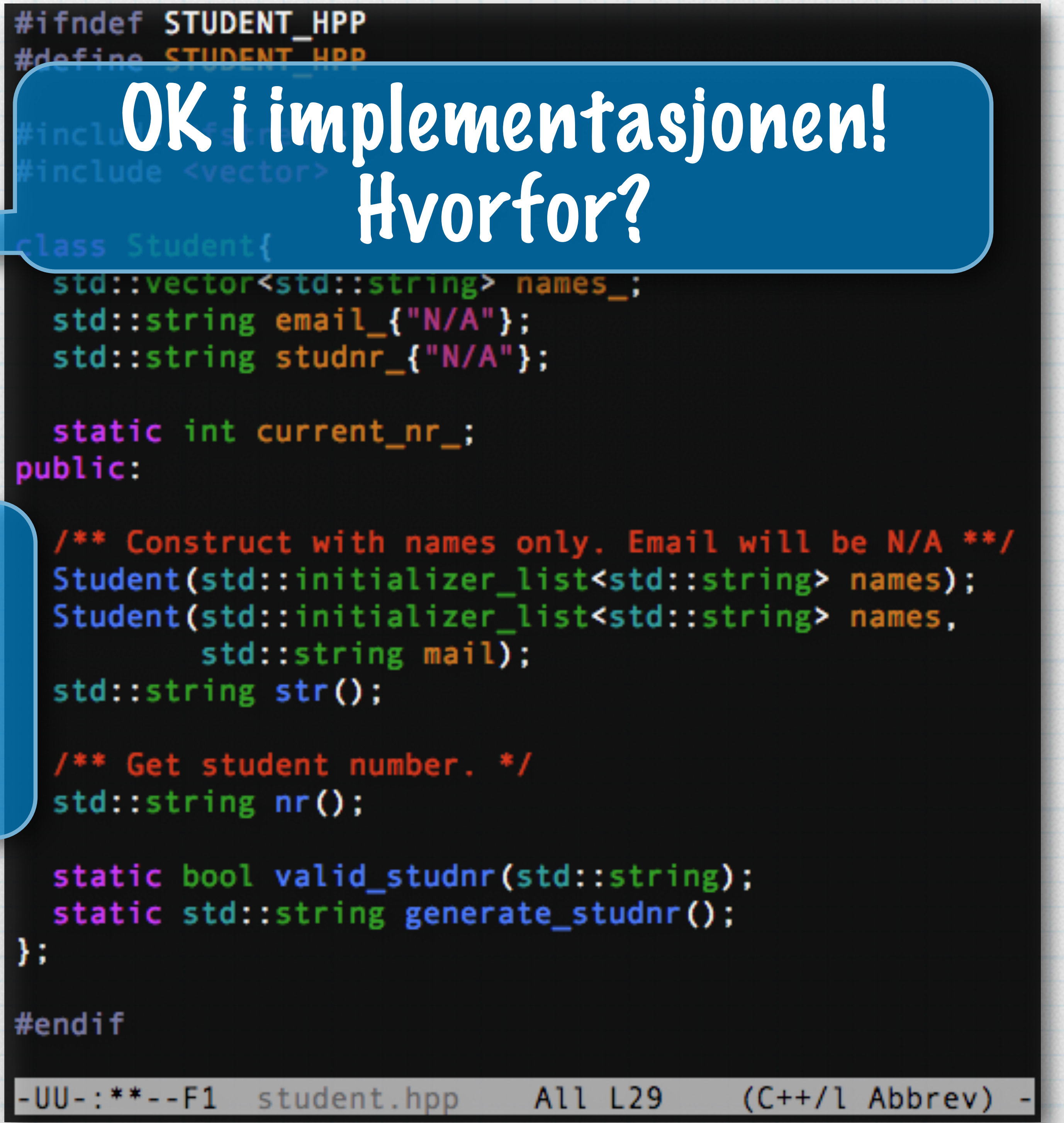
    name+=" "+n;
  return name+" <"+email_+">";
}
```

```
-UU-:----F1  student.cpp    All L28    (C++/l Abbre
```

Eksplisitt initialisering av alle medlemmer.
(...glemt noe?)



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```
-UU-:**--F1  student.hpp    All L29    (C++/l Abbrev) -
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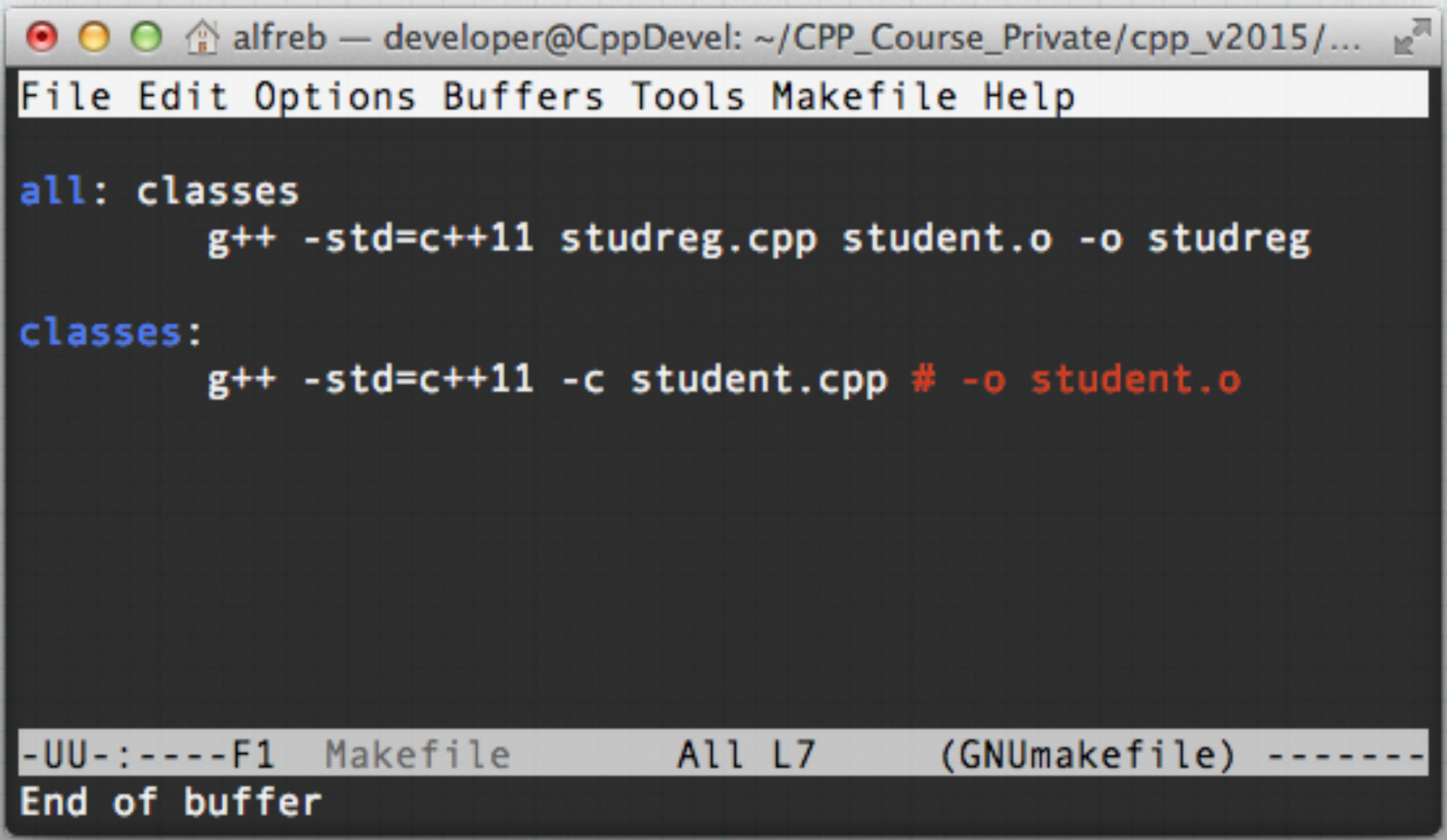
OK i implementasjonen!
Hvorfor?

Makefile

* Programmet "Make" fra GNU er et nyttig kompilerings- og installasjonsverktøy
* I prinsippet et "script", med shell-kommandoer++
* Hvis en mappe inneholder en fil "Makefile" vil denne kjøres med kommandoen "make"
* Makefila består av "merkelapper", en for hver kompileringsjobb
* Typiske merkelapper: "all", "clean", "configure", "install"
* Finnes alternativer; cmake, nmake etc. GNU Make skal brukes i kurset - oblig2 vil kreve make-fil.

Makefile: Minimal og bedre enn ingenting

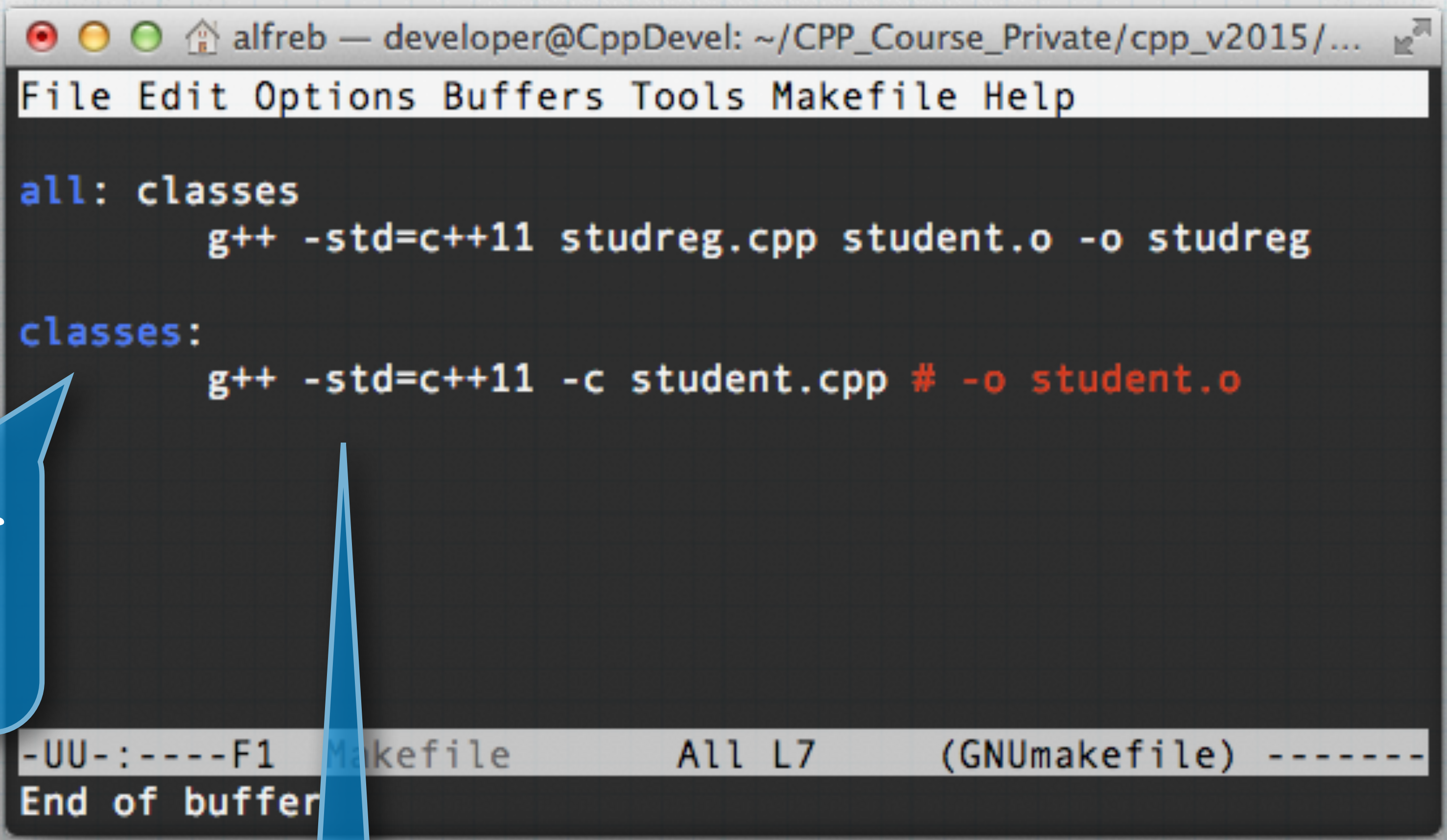

alfreb — developer@CppDevel: ~/CPP_Course_Private/cpp_v2015/...
File Edit Options Buffers Tools Makefile Help

```
all: classes
	g++ -std=c++11 studreg.cpp student.o -o studreg

classes:
	g++ -std=c++11 -c student.cpp # -o student.o
```

```
-UU-:----F1  Makefile          All L7      (GNUmakefile) -------
End of buffer
```

Makefile: Minimal og bedre enn ingenting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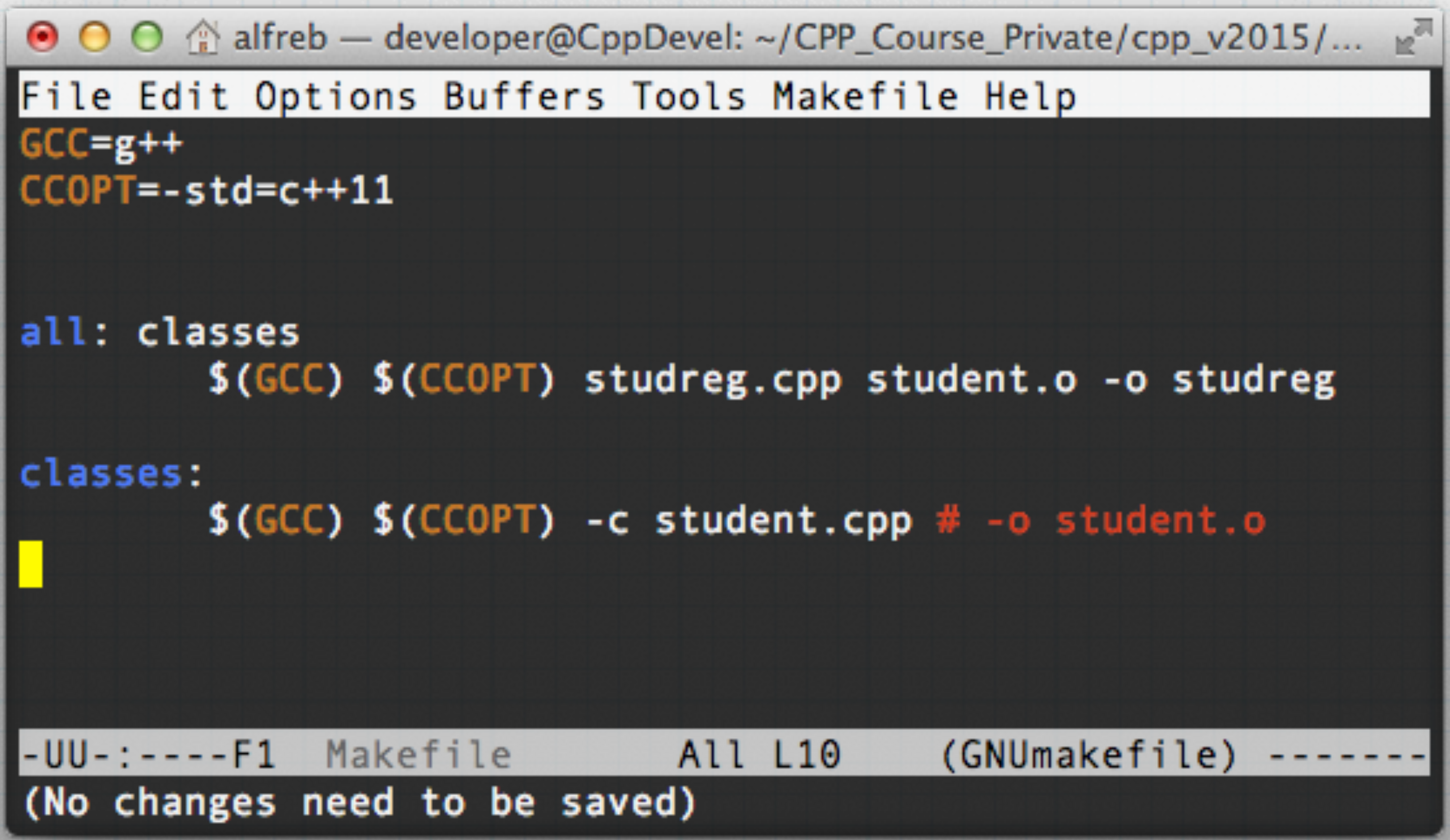
-UU-:----F1  Makefile          All L7      (GNUmakefile) -------
End of buffer
```

Merkelapper, for ulike "deljobber"

Innhold kan være en vanlig shell-kommando

Makefile: Variabler gjør fila «DRY»



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File Edit Options Buffers Tools Makefile Help

```
GCC=g++
CCOPT=-std=c++11

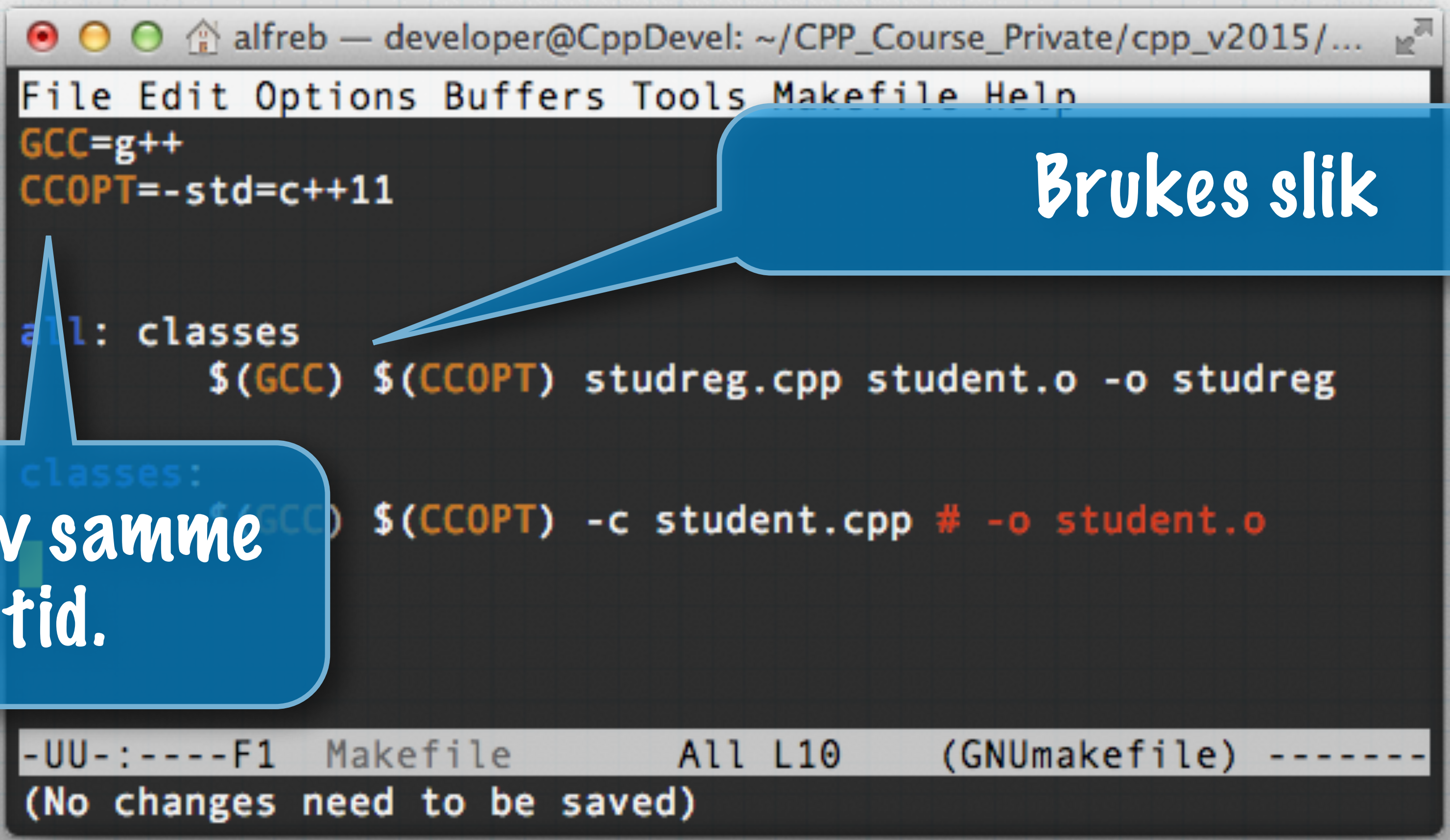

all: classes
	$(GCC) $(CCOPT) studreg.cpp student.o -o studreg

classes:
	$(GCC) $(CCOPT) -c student.cpp # -o student.o

```

```
-UU-:----F1  Makefile         All L10     (GNUmakefile) -------
(No changes need to be saved)
```

Makefile: Variabler gjør fila «DRY»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-UU-:----F1  Makefile        All L10    (GNUmakefile) -------
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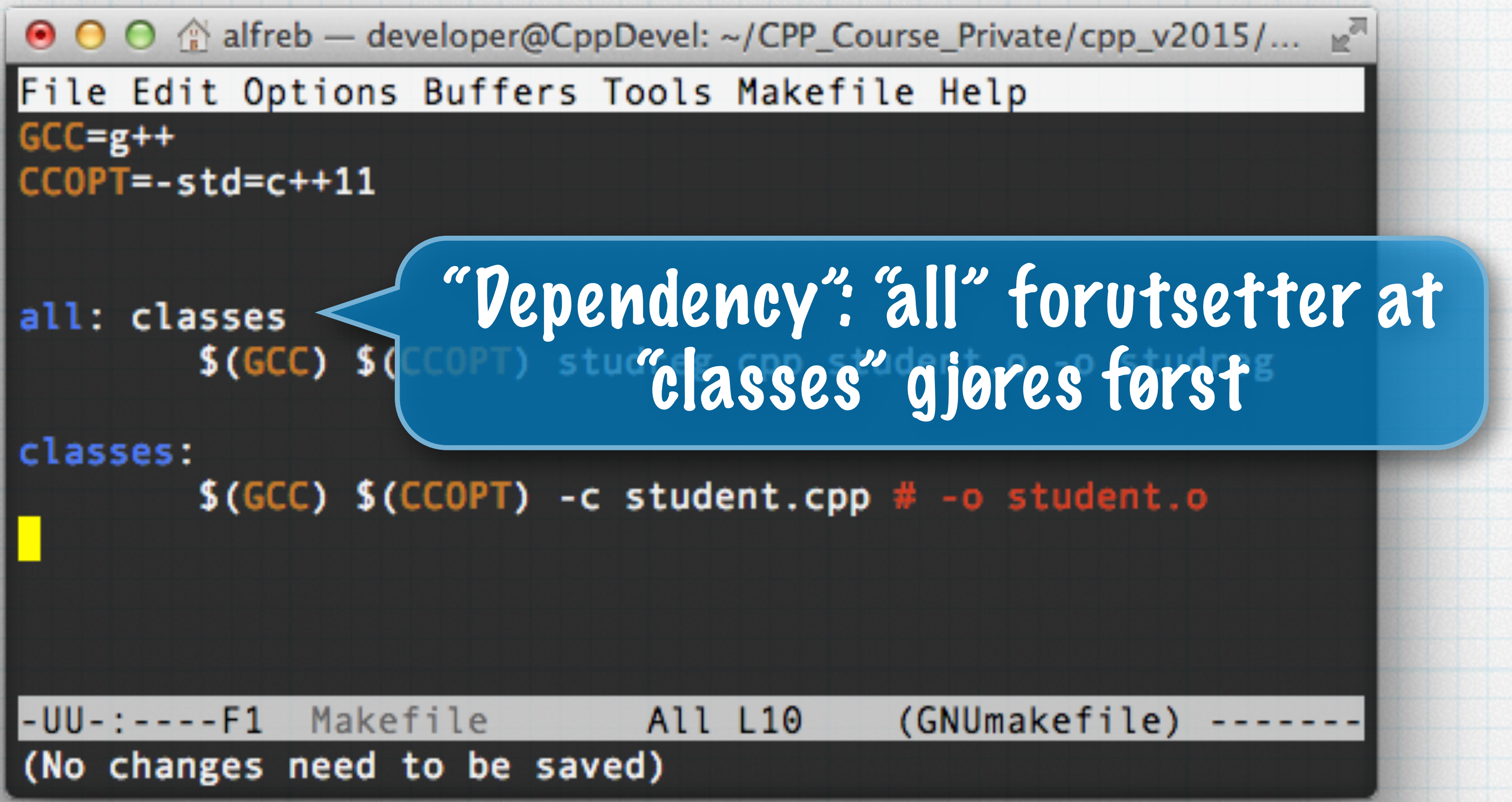
Brukes slik

Variabler, nyttig av samme grunn som alltid.

Makefile: Variabler gjør fila «DRY»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File Edit Options Buffers Tools Makefile Help

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classes:
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-UU-:----F1  Makefile        All L10    (GNUmakefile) -------
(No changes need to be saved)
```
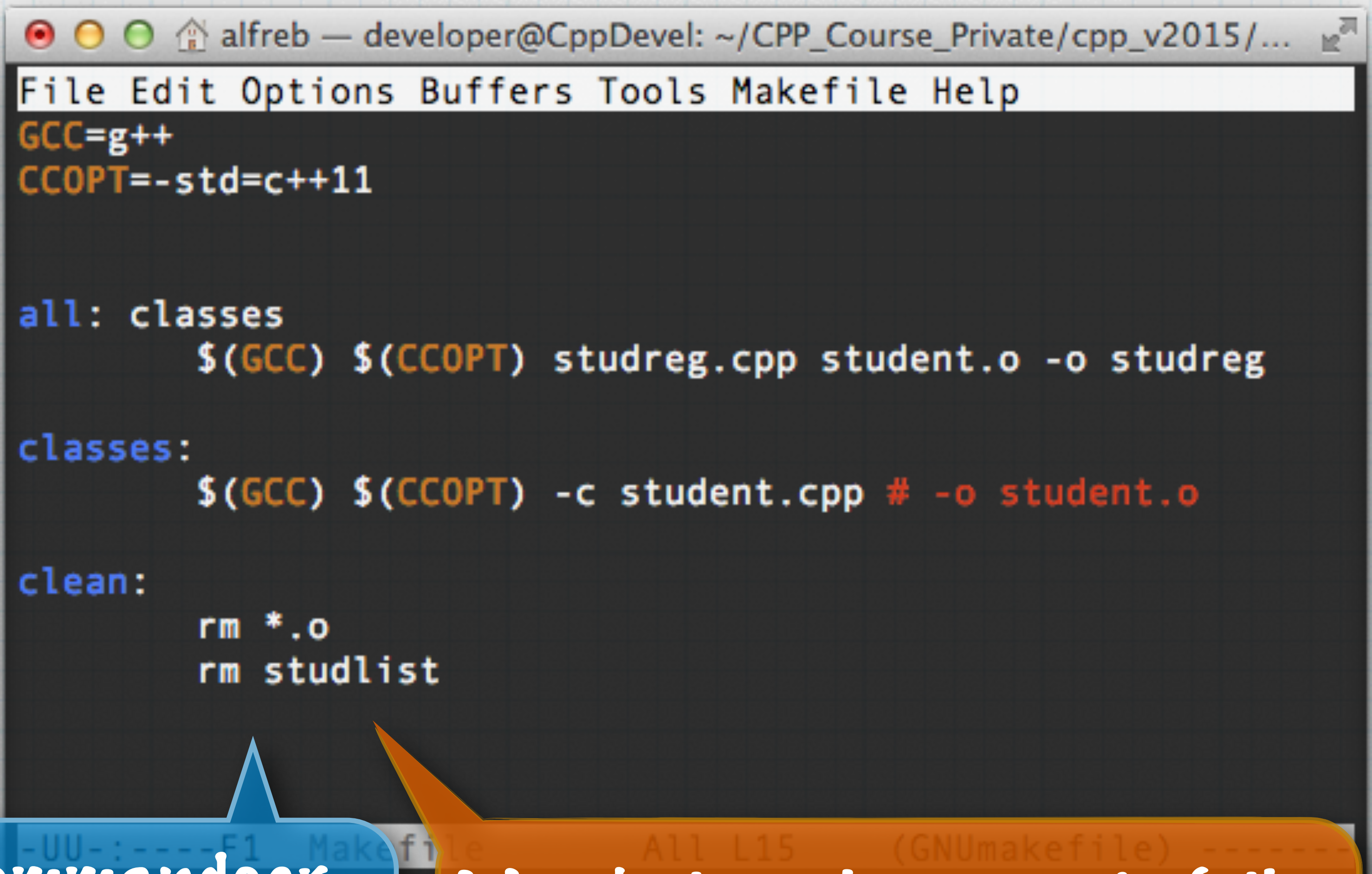

"Dependency": "all" forutsetter at "classes" gjøres først

Makefile: Eksempel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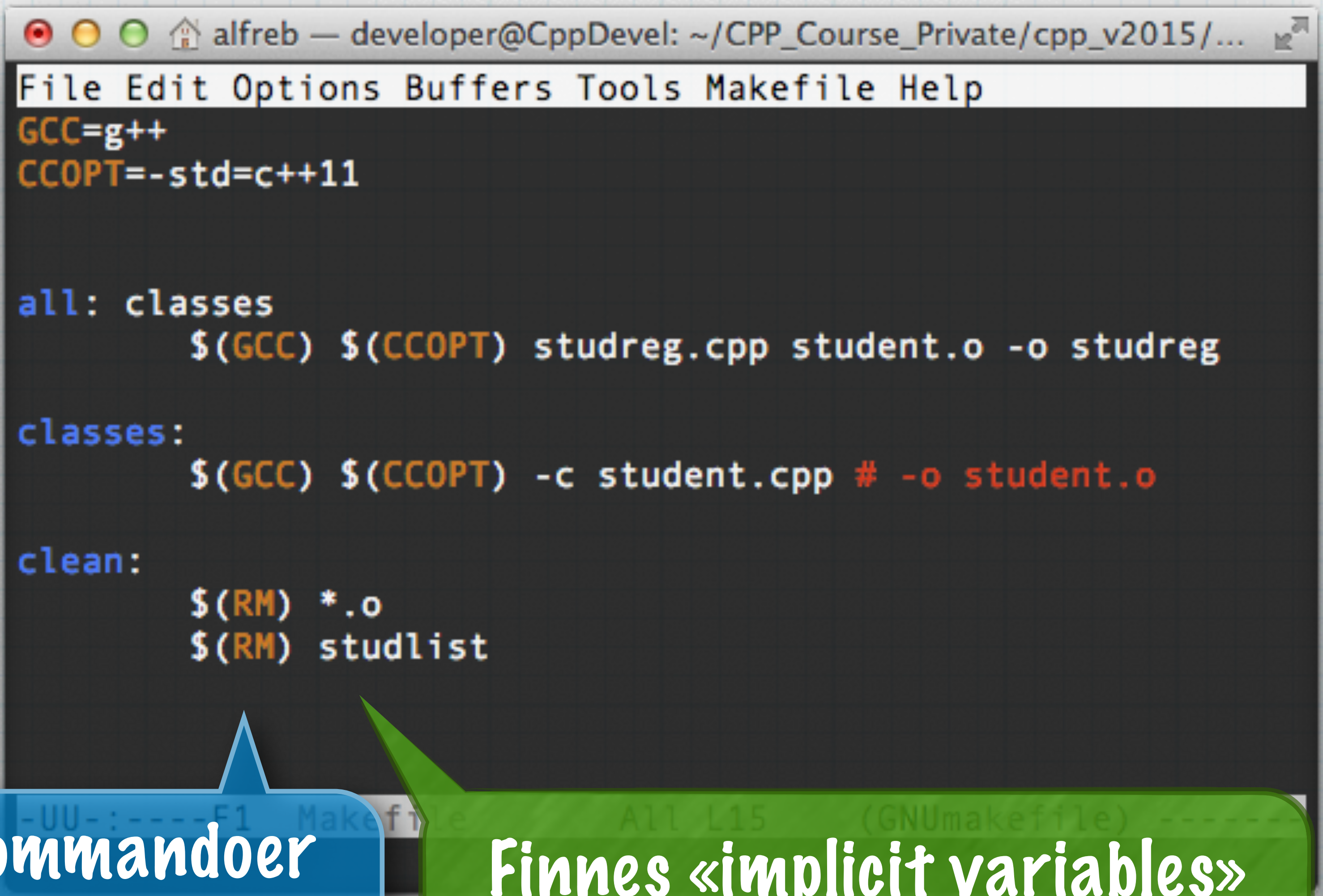
File Edit Options Buffers Tools Makefile Help
-UU-:----F1 Makefile   All L15   (GNUmakefile) -------

```
GCC=g++
CCOPT=-std=c++11


all: classes
	$(GCC) $(CCOPT) studreg.cpp student.o -o studreg

classes:
	$(GCC) $(CCOPT) -c student.cpp # -o student.o

clean:
	rm *.o
	rm studlist
```

Vanlige shell-kommandoer kan brukes fritt - med wildcards

Men hvis en kommando feiler, stopper Make...

Makefile: Eksempel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File Edit Options Buffers Tools Makefile Help

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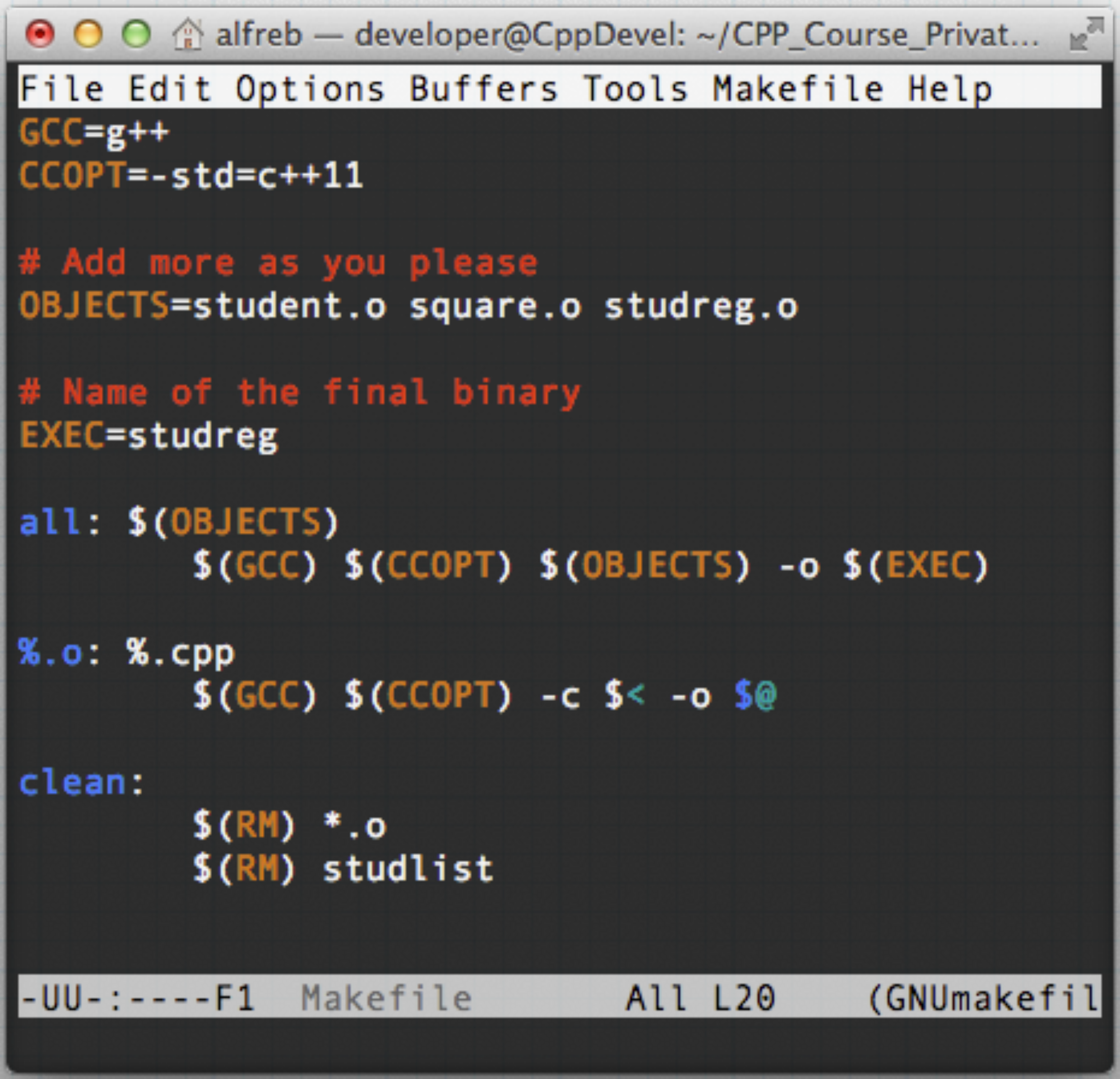
-UU-:----F1  Makefile      All L15     (GNUmakefile) ------
```

Vanlige shell-kommandoer kan brukes fritt - med wildcards

Finnes «implicit variables» for flere av dem*

* https://www.gnu.org/software/make/manual/html_node/Implicit-Variables.html

Makefile: Fullstendig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File Edit Options Buffers Tools Makefile Help

```
GCC=g++
CCOPT=-std=c++11

# Add more as you please
OBJECTS=student.o square.o studreg.o

# Name of the final binary
EXEC=studreg

all: $(OBJECTS)
	$(GCC) $(CCOPT) $(OBJECTS) -o $(EXEC)

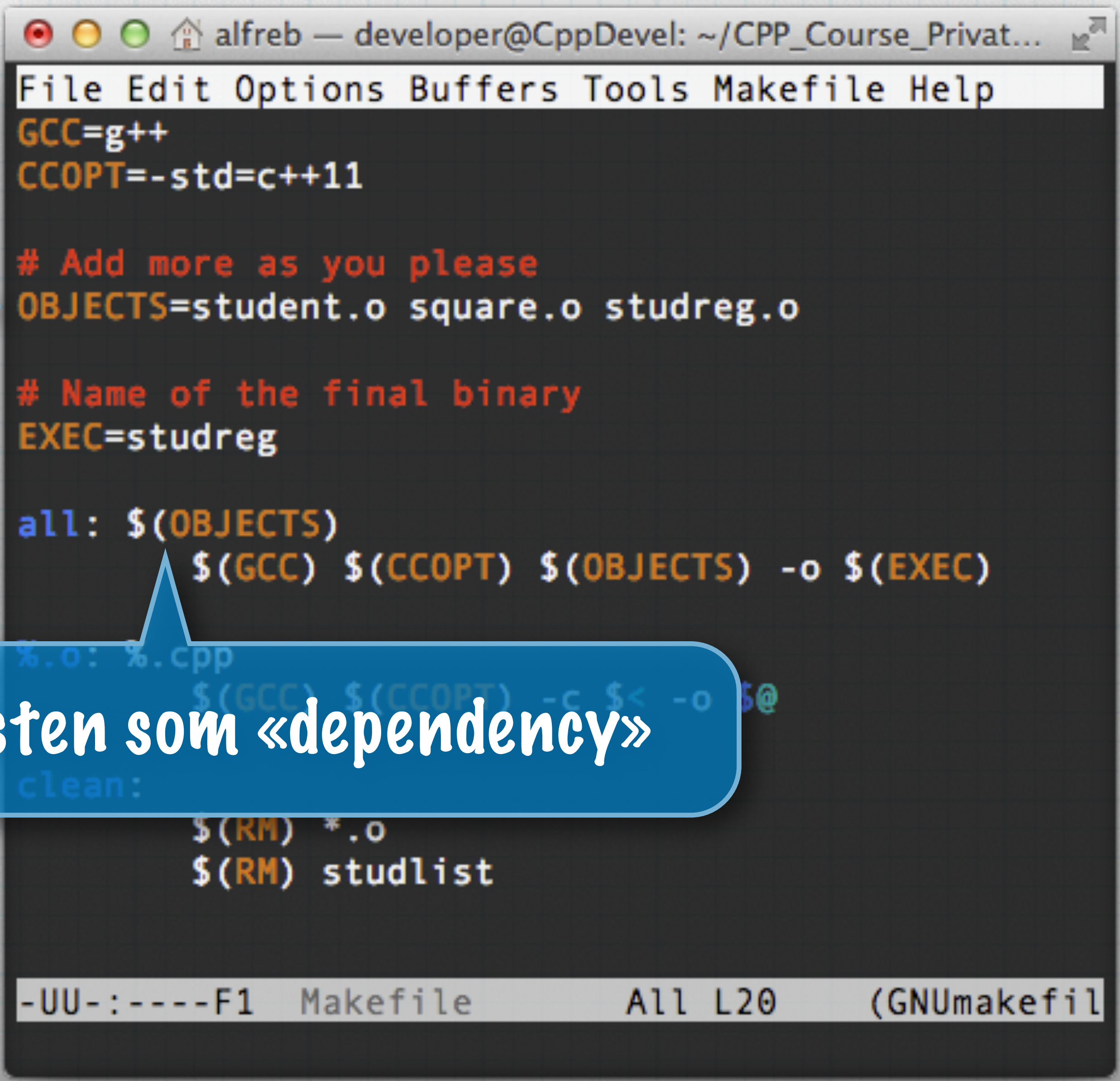
%.o: %.cpp
	$(GCC) $(CCOPT) -c $< -o $@

clean:
	$(RM) *.o
	$(RM) studlist
```

-UU-:----F1 Makefile   All L20   (GNUmakefil

Makefile: Fullstendig

Liste av objektfiler vi skal bygge (hver for seg)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clean:
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-UU-:----F1  Makefile        All L20     (GNUmakefil
```
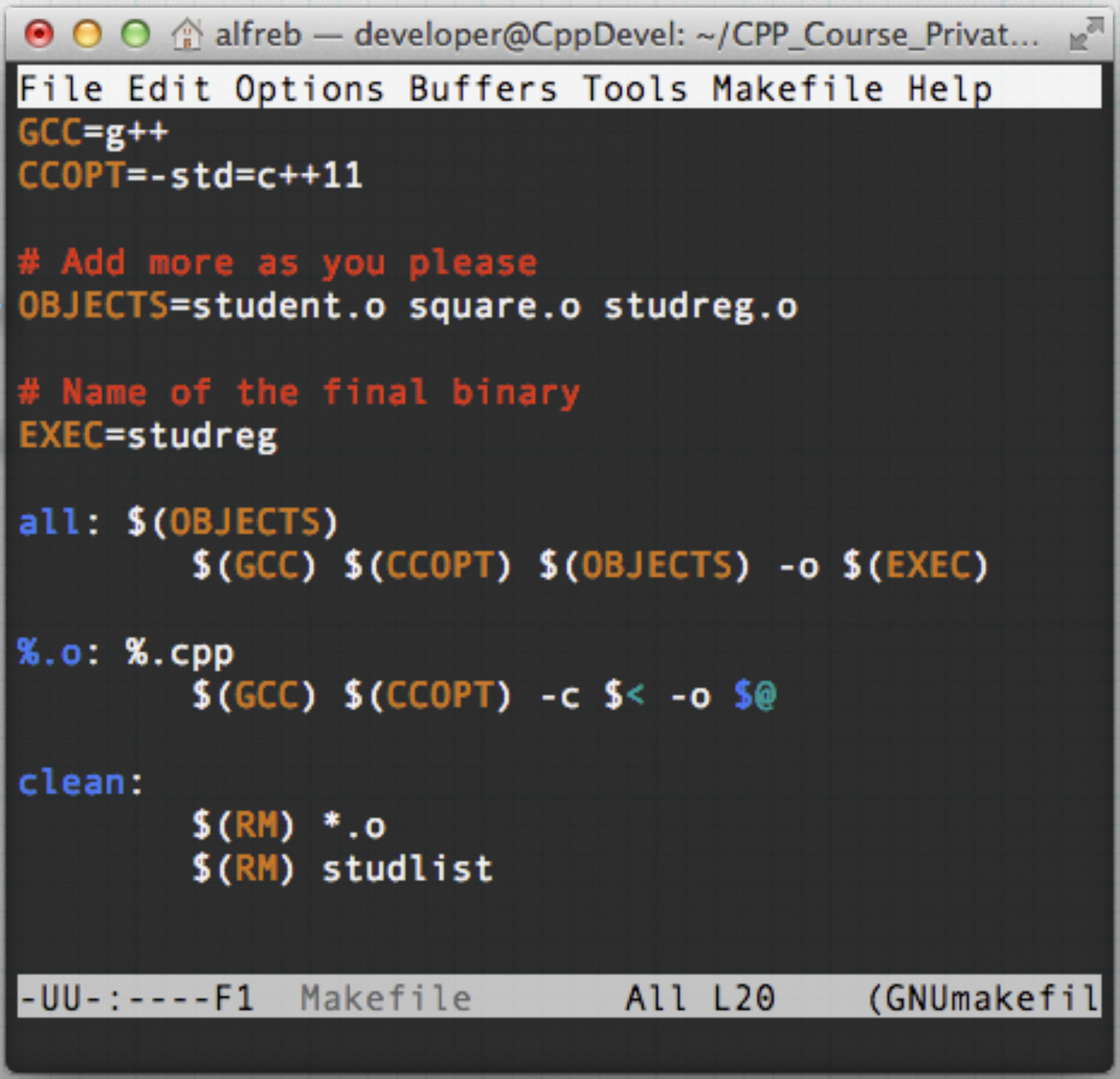

Hele listen som «dependency»

Makefile: Fullstendig

Liste av objektfiler vi skal bygge (hver for seg)

Vanlig variabel (her, binærfila)


alfreb — developer@CppDevel: ~/CPP_Course_Privat...
File Edit Options Buffers Tools Makefile Help
-UU-:----F1 Makefile   All L20   (GNUmakefil

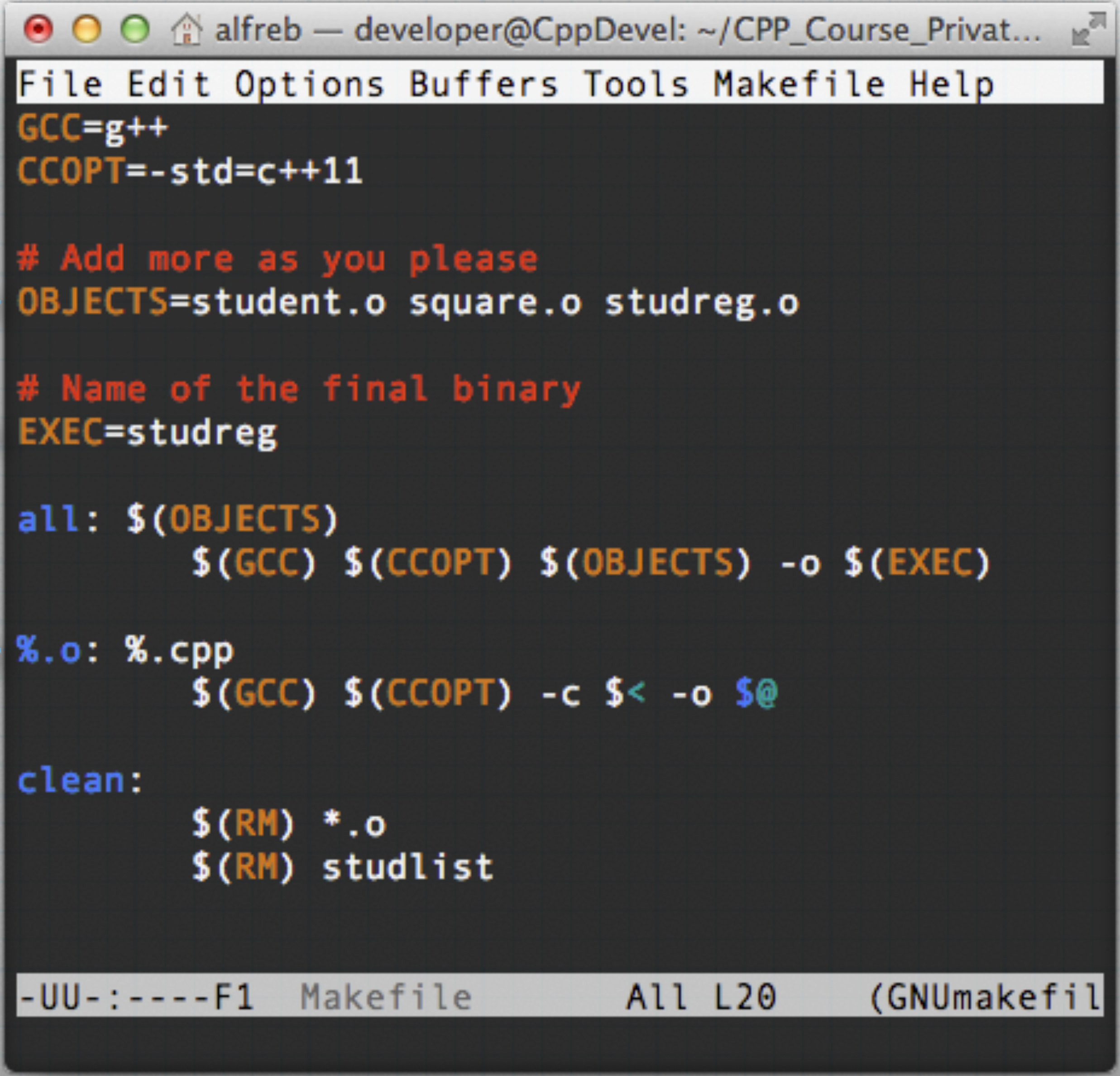
```
GCC=g++
CCOPT=-std=c++11

# Add more as you please
OBJECTS=student.o square.o studreg.o

# Name of the final binary
EXEC=studreg

all: $(OBJECTS)
	$(GCC) $(CCOPT) $(OBJECTS) -o $(EXEC)

%.o: %.cpp
	$(GCC) $(CCOPT) -c $< -o $@

clean:
	$(RM) *.o
	$(RM) studlist
```

Makefile: Fullstendig

Liste av objektfiler vi skal bygge (hver for seg)

Vanlig variabel (her, binærfila)

«Pattern rule» for samtlige .cpp-filer som skal bli .o-filer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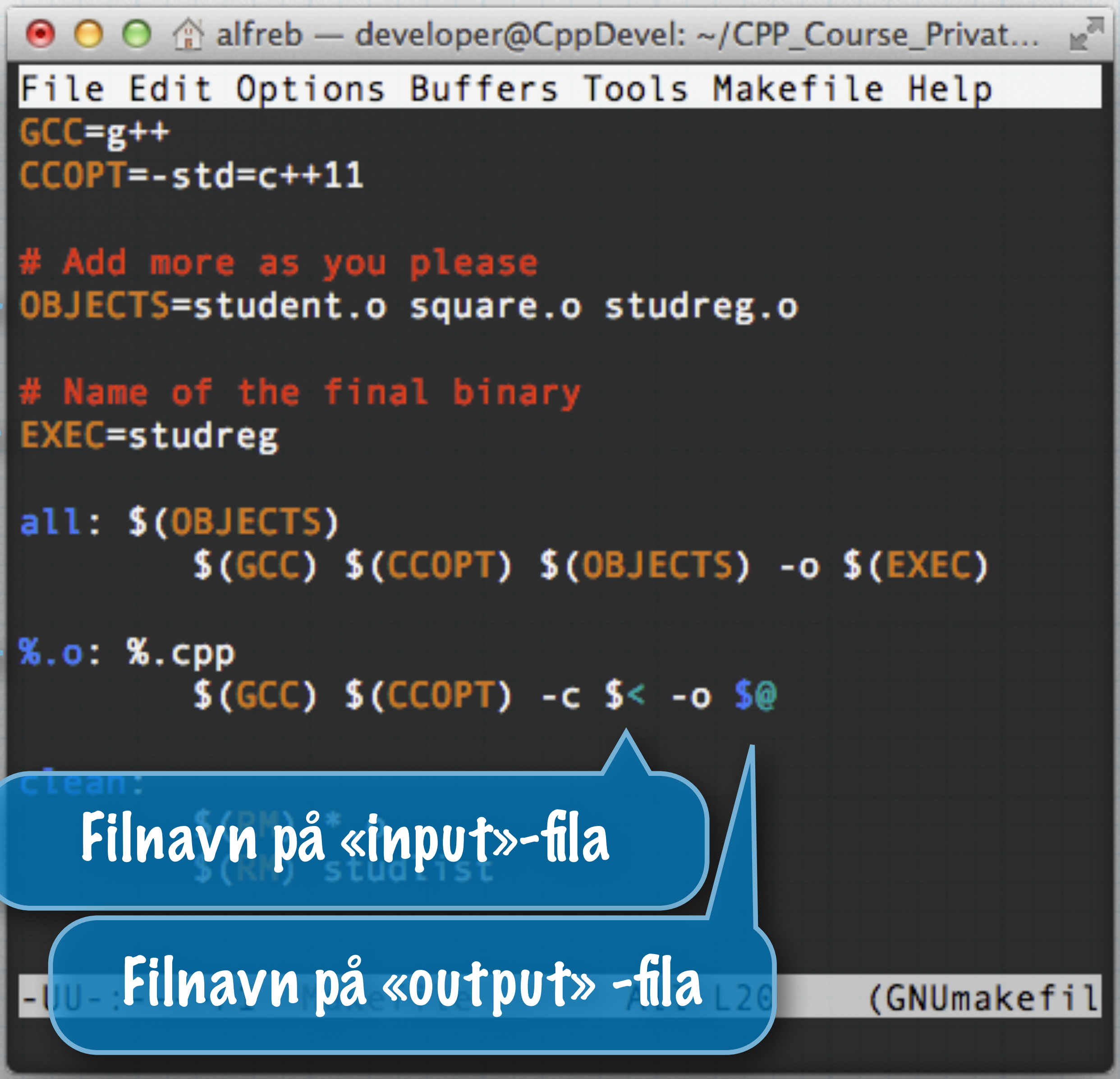
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```

Filnavn på «input»-fila

Filnavn på «output» -fila

Makefile: Fullstendig

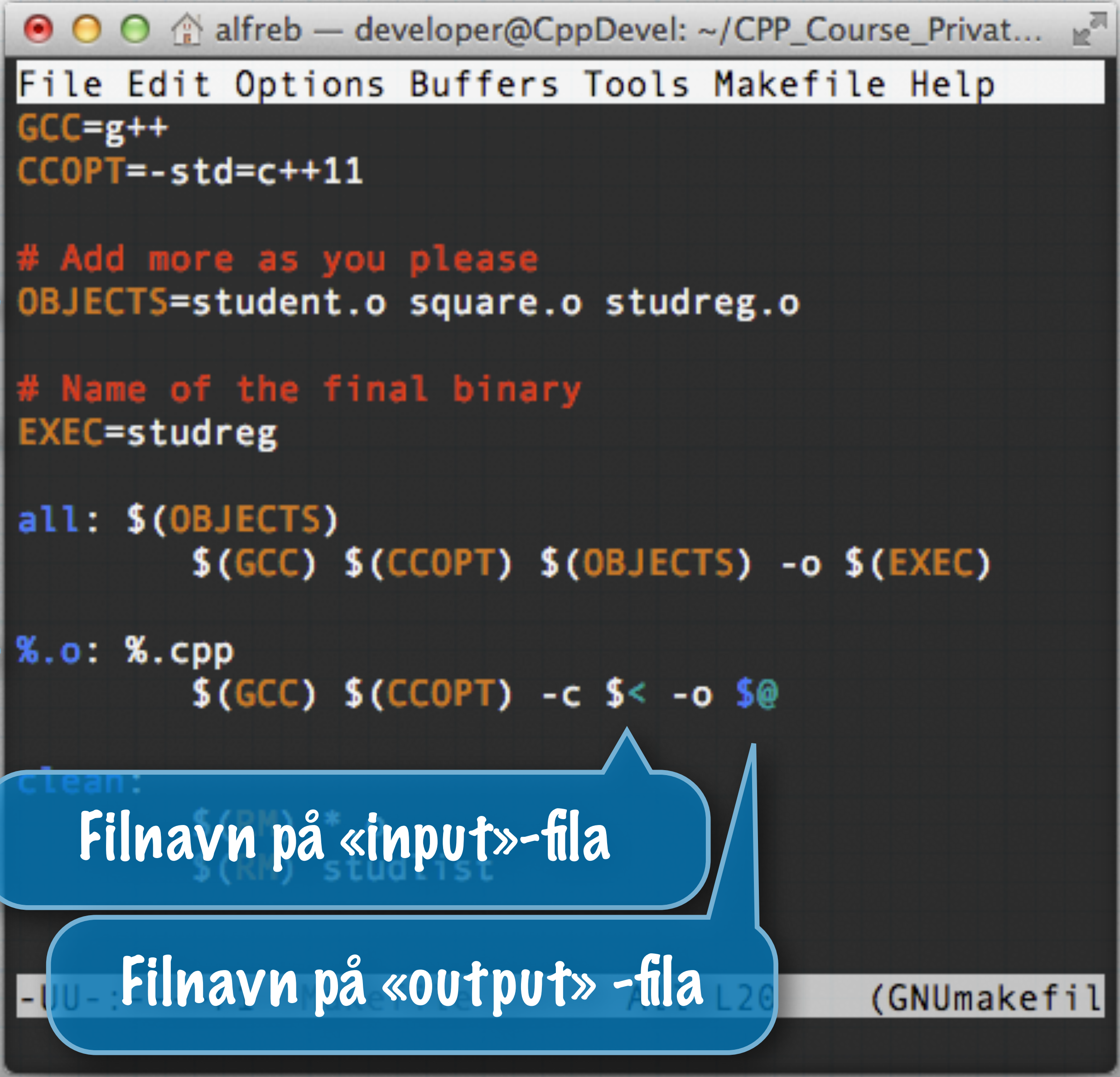
Liste av objektfiler vi skal bygge (hver for seg)

Vanlig variabel (her, binærfila)

«Pattern rule» for samtlige .cpp-filer som skal bli .o-filer

Alt du trenger nå er å legge til flere filer under «OBJECTS».

Ny klasse «teacher.cpp»? Legg til «teacher.o»


alfreb — developer@CppDevel: ~/CPP_Course_Privat...
File Edit Options Buffers Tools Makefile Help

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-UU-:---F1  Makefile     All L20     (GNUmakefil
```

Filnavn på «input»-fila

Filnavn på «output» -fila

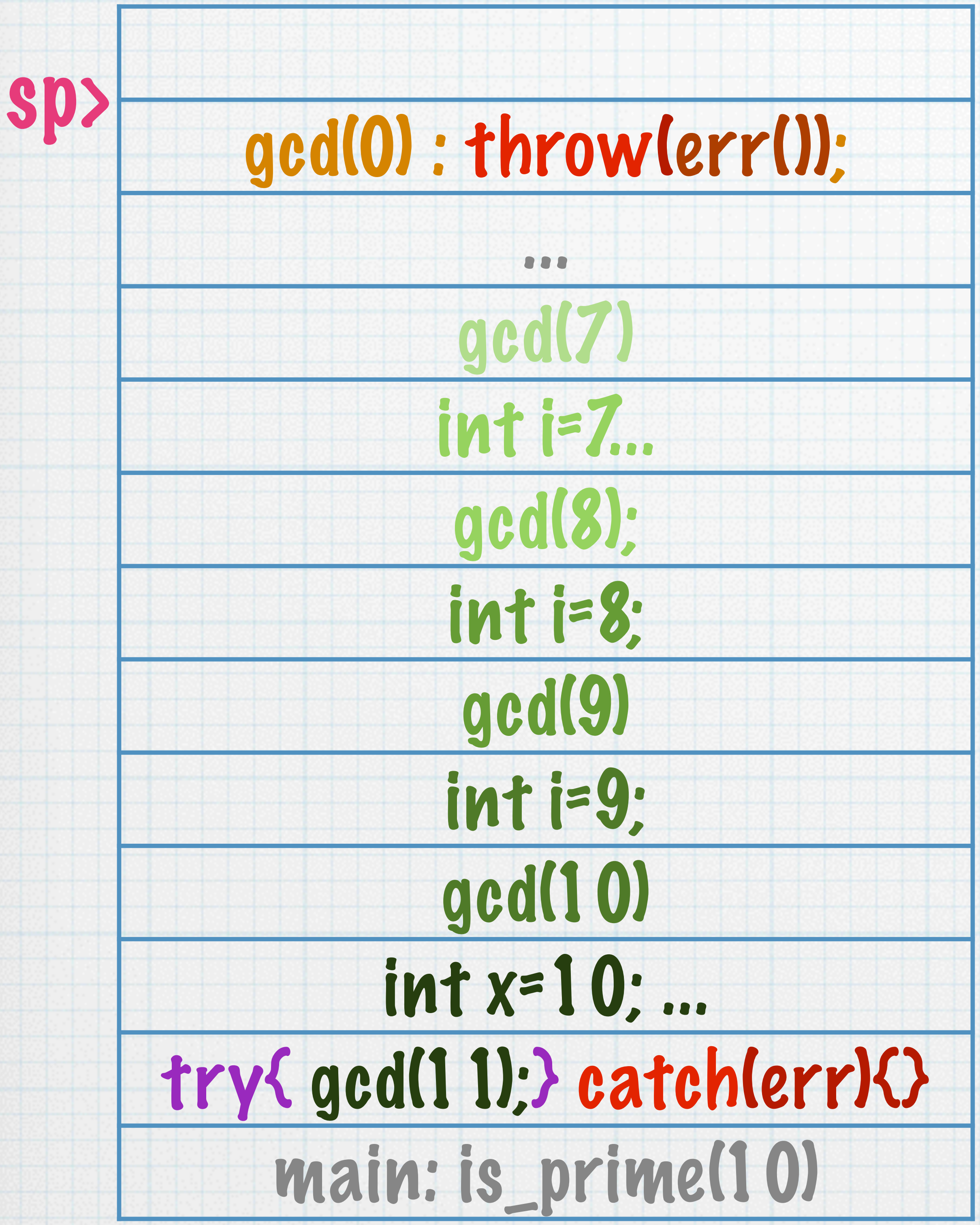
Demo!

student.cpp, studlist.cpp, Makefile

Exceptions

* Exceptions er objekter vi kan kaste tilbake til de som kalte oss, hvis noe galt oppstår.
* I C har vi "errno.h" som definerer nummer på ulike typer vanlige feil. Disse returneres gjerne som "int'er".
* Hva skal vi da med exceptions?
* Slippe utrolig mange "if-statements!"
(mange if == mange feilkilder)
* Exceptions hopper nemlig nedover på stack, helt til de finner en "catch".
* Alle steder på stack som hoppes over, måtte ellers hatt "if-setninger".

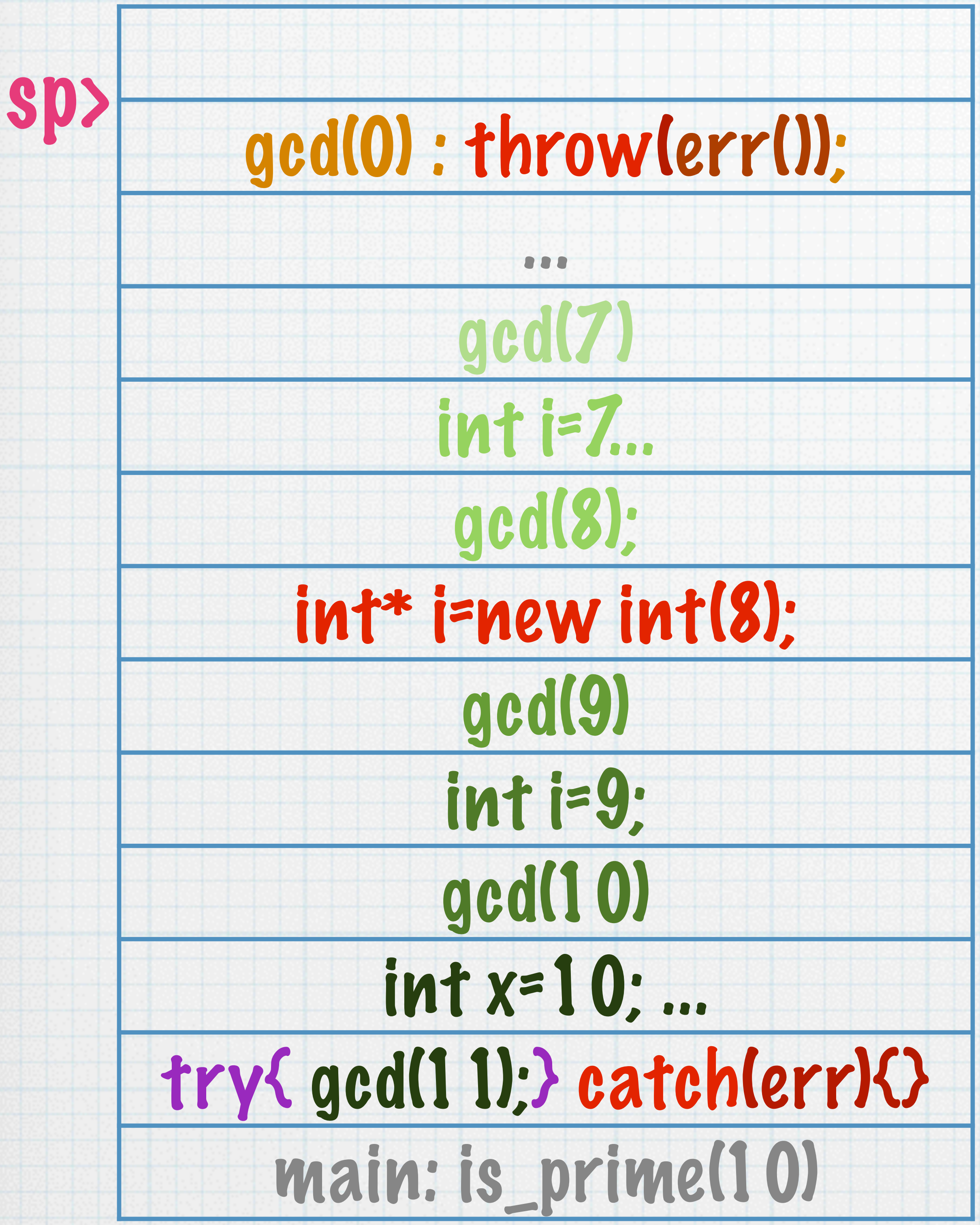
Exceptions



```
sp>
gcd(0) : throw(err());
...
gcd(7)
int i=7...
gcd(8);
int i=8;
gcd(9)
int i=9;
gcd(10)
int x=10; ...
try{ gcd(11);} catch(err){}
main: is_prime(10)
```

- En exception kastes ved å si "throw ..." der ... er et objekt.
- Stacken "hoppes over"
- Helt ned til "catch"
- Og ingen kall imellom trenger å sjekke om det ble returnert riktig
- ...ser dere noen problemer?

Exceptions



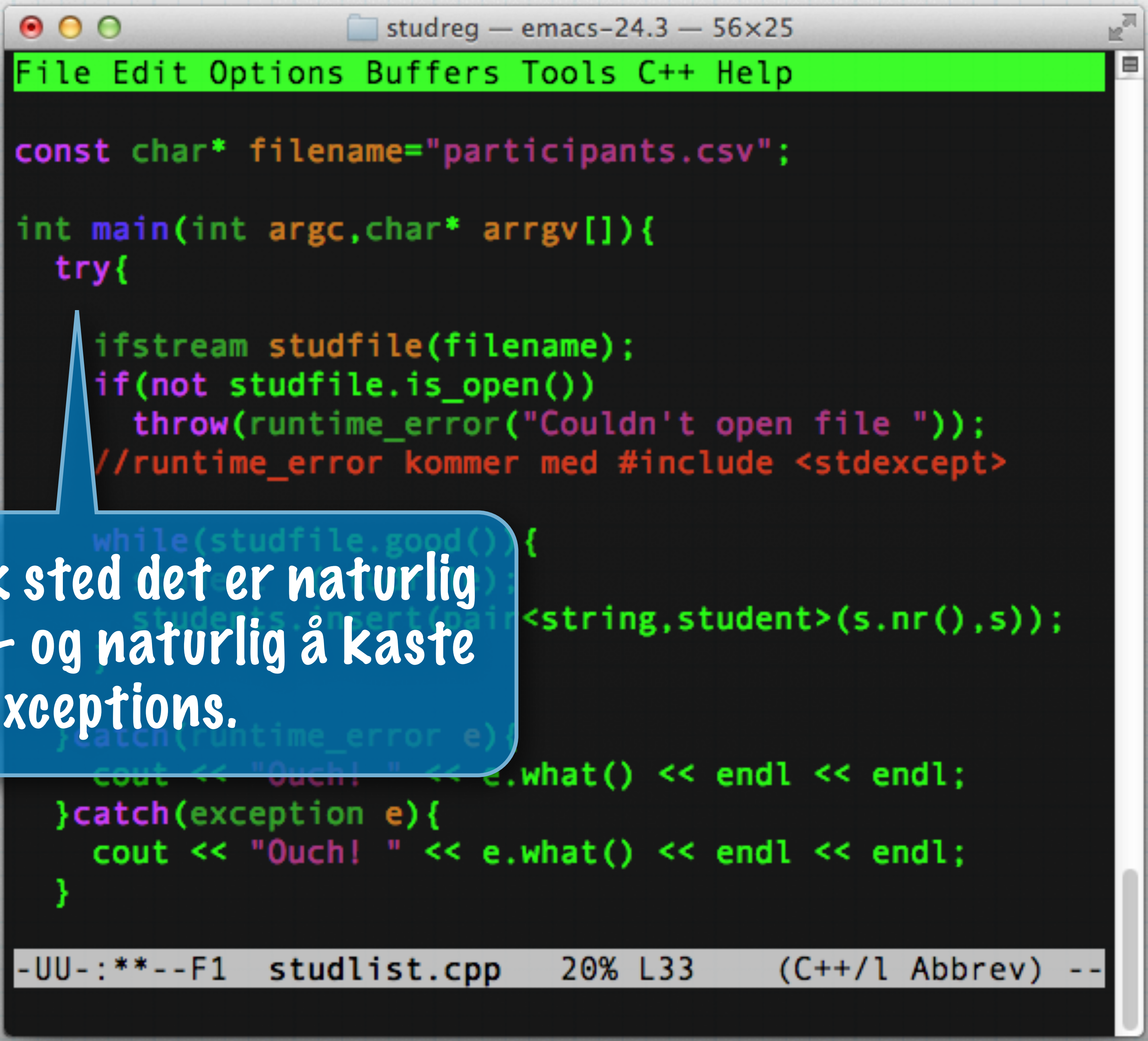
```

gcd(0) : throw(err());
...
gcd(7)
int i=7...
gcd(8);
int* i=new int(8);
gcd(9)
int i=9;
gcd(10)
int x=10; ...
try{ gcd(11);} catch(err){}
main: is_prime(10)
```

* Hva hvis noe ble allokert på veien?
* Det finnes lure løsninger, men inntil videre: Bruk exceptions! (men pass på!)
* ...Fungerer dette bedre i java?
* ...Vel - garbage-collector vil rydde opp - men den må jo rydde opp da.
* Er det verdt det?
* JA! Heller få noen feil fra exceptions, enn å få feil fordi feilhåndteringen er så innviklet.

Exceptions forts.

* Vi kan i prinsippet kaste og fange alle typer objekter. Men, vi har noen standarder. (Og - kompilatoren kan ikke vite hva du kommer til å "catche", så den kan ikke sjekke typen)
* Bruk gjerne <stdexcept>: exceptions som tar string som argument til konstruktør.
* Eller lag egne subklasser av <exception> (stdexcept arver exception). Vent til vi har lært om arv.
* Alle exceptions har en "string what()" som gir en feilmelding.
* For alle funksjoner som kan kaste exceptions - bruk try/catch. STL oppgir alltid hva som kan kastes.

Exceptions: Eksempel


studreg — emacs-24.3 — 56×25
File Edit Options Buffers Tools C++ Help

```
const char* filename="participants.csv";

int main(int argc,char* arrgv[]){
  try{

    ifstream studfile(filename);
    if(not studfile.is_open())
      throw(runtime_error("Couldn't open file "));
    //runtime_error kommer med #include <stdexcept>

    while(studfile.good()){
      student s(studfile);
      students.insert(pair<string,student>(s.nr(),s));
    }

  }catch(runtime_error e){
    cout << "Ouch! " << e.what() << endl << endl;
  }catch(exception e){
    cout << "Ouch! " << e.what() << endl << endl;
  }
-UU-:**--F1  studlist.cpp    20% L33     (C++/l Abbrev) --
```

I/O - Typisk sted det er naturlig med «try» - og naturlig å kaste exceptions.

Demo på github:

exception_leak.cpp