Masters Course in Financial Modelling On-Line:

Options, Swaps and Derivatives

http://www.lifelong-learners.com/fin/ua

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Course layout in 2004

Goal: acquire a practical understanding of pricing models

- Historical data $\rightarrow$ (drift, volatility) $\rightarrow$ present value of derivative $\rightarrow$ arbitrage?
- What are the models' limitations, how sure are we about their assumptions?
- Are you ready to take investment decisions using your own money?

Tailor the difficulty to your level: easy, masters, quants

1. Introduction: modern portfolio, financial risk, historical data and modelling
2. Stock-/bond market securities and terminal payoff from derivatives
3. Random nature of market prices and modelling: trees, Black-Scholes, Vasicek
4. European option payoff dynamics: vanilla, binary and barrier options
5. Bonds, swaps and derivatives when the interest rates fluctuate
6. American payoff dynamics

Interactive studies in a problem based learning environment

- Analyze real-time data and perform simulations in regular web browser
- Submit 15-20 assignments with daily feed-back and constructive criticism

A Network of Participants – simultaneously

Students from the Swedish Netuniversity and the Univesity of Adelaide

- Stockholm (21 students), Gdansk (14), Singapore (2), other (5)
- Undergraduates (14), graduates (20), professionals (8)

$\Rightarrow$ merge smaller classes and benefit from the economy of scale

sharing different cultural perspectives and educational backgrounds

- Engineering (19 students), finance (17), business (5)

$\Rightarrow$ open horizons of both the students and the teachers

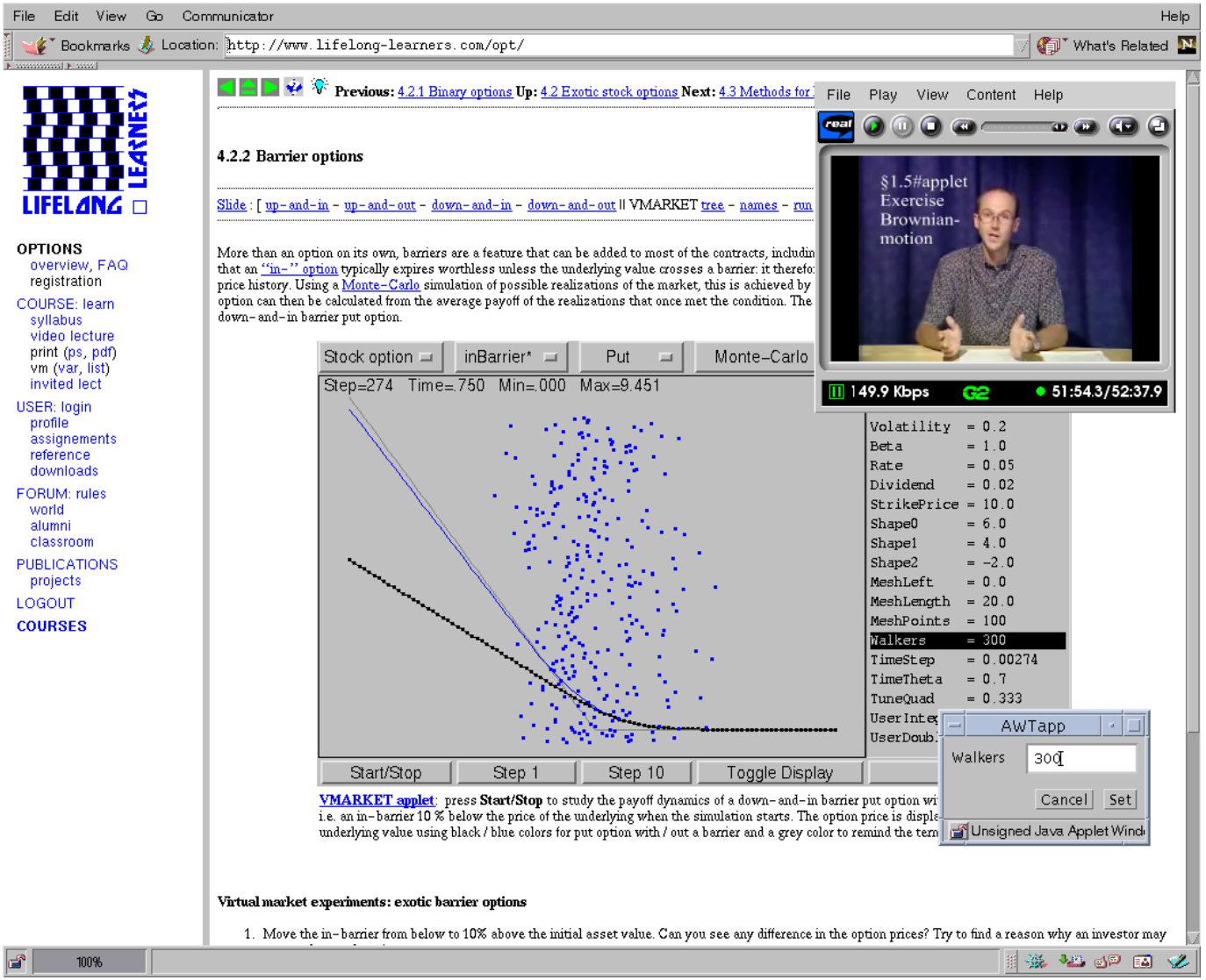
with teachers from different countries and professions

- Sweden, Poland, Australia, USA
- professors, researchers, professionals

$\Rightarrow$ reduce reply time, broaden the collective expertise

More than 30 learners freely access an average of 10 open webpages every day

Passive and Active Learning – anytime, anywhere



A student centered approach

Passive: read course notes, watch RealVideo recordings

- re-play arguments, pause... or skip the recordings on the Web
- conventional reading, listening and analyzing preset animations

Active: experiments test the individual understanding

- edit the parameters in a Java-powered document, answer computer quiz questions
- predict and verify the properties and the limitations of a theory
- explore new possibilities and develop a real intuition for the subject

Interactive: discussions that are tailored to the classroom

- discussion forums provide quick answers and share the experience 24h/day
- different opinions trigger new questions that enhance the learning
- we now reward original discussions in the same way as we do for assignments

Learning objects are perceived and used in a different manner by individuals

Students submit Assignments with Formulas and Programs

File Edit View Go Communicator Help

1.4 Random walk (work sheet)

Edit the templates and submit your solution in the textfields below. Be careful: modify only one of t
time and correct all the Java compiler errors before you switch to a new assignment!

Determine the diffusion constant for a random–walk process with steps of a typical duration τ and
calculate first the RMS displacement $\langle z^2 \rangle(t)$ of the position after a large number $M = t/\tau$ of *statist*
Take the second moment of the diffusion equation and integrate by parts to calculate the average [
other using the *ergodicity theorem*).

Edit the TeX template below and explain with your own words and formulas how you derive the n

```
Consider a walk with a large number $M$ of statistically independent
steps $\xi_i$ randomly distributed, so that the statistical average of
the random variable yields $<\xi>=0$.
The final position $z=\sum_{i=1}^M \xi_i$ in average coincides with the
initial position $<z>=\sum_{i=1}^M <\xi_i>=0$. The root mean square
```

Submit TeX

Modify the Java code below to insert your own scheme in the JBONE applet and execute it in you

```
      for(int j = 0; j < numberOfParticles; j++){
        particlePosition[j] += velocity * timeStep +
          random.nextGaussian() *
          Math.sqrt(2 * diffusCo * timeStep);
      } // for
```

Submit java

Modify the Tag parameters below to to run your scheme in a regime that is physically meaningful:

```
      <param name=Velocity          value=0.>
      <param name=Diffusion         value=0.5>
      <param name=TimeStep          value=0.5>
      <param name=MeshPoints        value=64>
      <param name=Particles         value=1>
```

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1.4 Random walk

Consider a walk with a large number M of statistically independent steps ξ_i randomly distributed, so that the statistical average of the random variable yields $\langle \xi \rangle = 0$. The final position $z = \sum_{i=1}^{M} \xi_i$ in average coincides with the initial position $\langle z \rangle = \sum_{i=1}^{M} \langle \xi_i \rangle = 0$. The root mean square (RMS) displacement, however, is finite

$$\langle z^2 \rangle = \left\langle \left(\sum_{i=1}^{M} \xi_i \right) \left(\sum_{j=1}^{M} \xi_j \right) \right\rangle = \sum_{i=1}^{M} \langle \xi_i^2 \rangle + \sum_{i \neq j} \langle \xi_i \xi_j \rangle = M \langle \xi^2 \rangle = \frac{t}{\tau} \lambda_{mfp}^2$$

where τ defines the average time elapsed between consecutive steps, $M = t/\tau$ is the number of steps taken during a time interval of duration t and λ_{mfp} is the so–called mean free path.

Now, repeat the calculation with the second moment of the diffusion equation and define the total density N as

$$\overline{z^2}\,(t) = \frac{1}{N} \int_{-\infty}^{+\infty} z^2\, n(z,t)\, dz$$

$$N(t) = \int_{-\infty}^{+\infty} n(z,t)\, dz$$

The first term yields

$$\int_{-\infty}^{+\infty} z^2\, \partial_t n\, dz = \partial_t \int_{-\infty}^{+\infty} z^2\, n\, dz = N\, \partial_t\, \overline{z^2}$$

and the second after two integration by parts gives

Problem Based Learning, Corrections and Support

The Students perform and submit all the assignments electronically:

- text, equations (TEX) and programs (Java) are compiled into webpages
- a regular browser displays and test-runs each individual applet
- the technology is rapidly acquired using examples or templates

Feed-back and help from peers to derive the solutions:

- applets provide for an immediate, severe, but automatic and fair correction
- questions are discussed informally (with TEX formulas) in the forum
- answers from peers are usually useful and competent; they develop the feeling of belonging to a virtual classroom, foster human contacts
- limited supervision is provided by the pool of teachers

Automatic corrections... create a new rewarding role for the teacher:

- applets correct the details $\Rightarrow$ the teacher can focus on the larger picture
- select reference solution among students $\Rightarrow$ competition to appear on exclusive list
- teacher's role is less to judge rather than to inspire, show the way, open horizons

Corrections (from a pool of teachers)... anywhere

File Edit View Go Communicator Help

Bookmarks Go To: http://www.lifelong-learners.com/opt/ What's Related

Teacher: 4.02 correction

Check	Name	Subject	Points	Pass
☑	Junichiro Shiomi	Use options	/10	☐

```
<!----- 03/11/02 17:13:08 from Jaun: insert new corrections above this line -----><hr>
There is no self evident way to solve this assignement, i.e. there are many possible solution
To explore them you need to see what you can do by buying options whith the stock that you wa
protect as an underlying. At least this will give you a hint at what the insurence should cos
You could for example consider buying a put option that enables you to sell your stock if the
goes below 0.9S0. What kind of put option is most appropriate? If you do this you will also s
the price you arrive at below is way to high.
<!----- 30/10/02 10:08:13 from Hurtig: insert new corrections above this line -----><hr>
```

OK Reset

4.02 Limit the potential losses from a share

Because of the 3 percent spot rate, in one year, the value of the share will drop down to

$$S_1 = S_0 \exp(-0.03 \times 1) = 0.97 S_0,$$

where S_0 is the share value of today.

Now we think of a log-normally distributed probability density function with mean value S_1 and 30 percent volatility, and define it as insurance can be computed as

$$S_{\text{insurance}} = \int_0^{0.9S_0} P(S)\, dS \times S_0$$

Computing this using Matlab, we obtain,

$$S_{\text{insurance}} = 0.36 S_0$$

Therefore, in order to obtain an actual profit, the price of the share needs to go up at least more than 36 percent of the current price.

Exercise | Exercise 4.06 | Put | Monte-Carlo | Double-click below:

Step=0 Time=.000 Min=.000 Max=10.000 RunTime = 0.1

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Bookmarks Go To: http://www.lifelong-learners.com/opt/ What's Related

Teacher: corrections

sus02 | shiomi@mech.kth.se | all work | select

Exercises

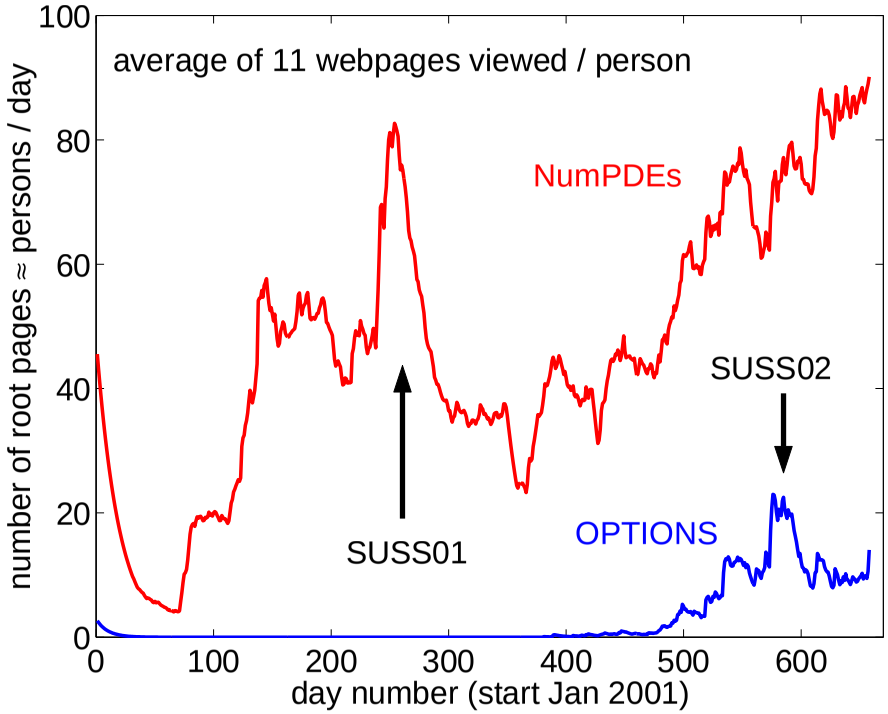
Check	Name	Number	Corrections	Class	Points	Passed
	Junichiro Shiomi	1.00	Reference solution / Jaun	sus02	10 / 10	yes
	Junichiro Shiomi	1.01	Nice! / Hurtig	sus02	10 / 10	yes
	Junichiro Shiomi	1.02	Good, You ve got the point! / Hurtig	sus02	10 / 10	yes
	Junichiro Shiomi	1.03	Good / Hurtig	sus02	10 / 10	yes
	Junichiro Shiomi	2.01	Ok / Hurtig	sus02	10 / 10	yes
	Junichiro Shiomi	2.02	You got the idea. / Hurtig	sus02	10 / 10	yes
	Junichiro Shiomi	2.03	none	sus02	/10	
	Junichiro Shiomi	2.04	Much better now! / Hurtig	sus02	10 / 10	yes
	Junichiro Shiomi	2.05	Good / Hurtig	sus02	10 / 10	yes
	Junichiro Shiomi	3.02	Okay / Hurtig	sus02	10 / 10	yes
	Junichiro Shiomi	3.03	Ok, I think... / Hurtig	sus02	10 / 10	yes
	Junichiro Shiomi	4.01	Ok, / Hurtig	sus02	10 / 10	yes
	Junichiro Shiomi	4.02	Use options / Hurtig	sus02	/10	
	Junichiro Shiomi	4.03	Nice tables! / Hurtig	sus02	5 /10	
	Junichiro Shiomi	4.06	Good / Hurtig	sus02	15 /15	yes
yes	Junichiro Shiomi	4.07	none	sus02	/15	

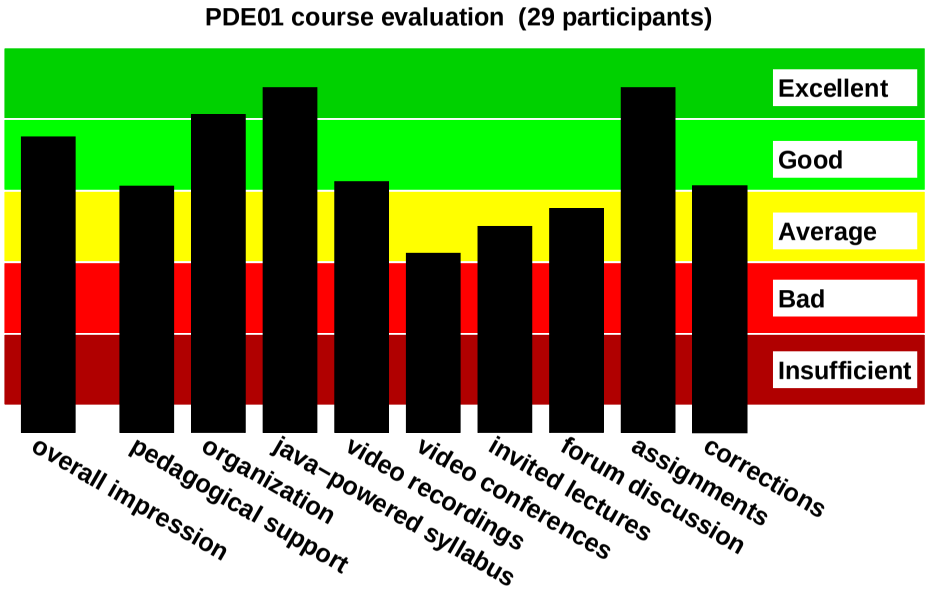
Projects

Check	Name	Pages	Title	Dir	Points	Passed

Facts, Server Statistics and Pedagogical Evaluation

Hardware: 1 PC-server sufficient for 20 simultaneous connections & class of up to 100
Software: open source (→`www.lifelong-learners.com`) can be tailored by the teacher
Portability: works on any browser / system, usually without extra download





Conclusions

Sharing a classroom joining 3 universities in 2 continents

- **cost:** merge small classes to benefit from the economy of scale
- **quality:** increase the overall availability and expertise of the teachers
- **extra:** flexibility (in space, time, speed) is an advantage for everyone
- **issues:** trust building, work procedure, requirements

High level interactivity in a Problem-Based Learning (PBL) setup at a distance

- **regular browser** used to exchange text, formulas (TEX) and programs (Java)
- **automatic feed-back** from applets improves the supervision quality & efficiency: large classes are needed to make (high quality) PBL cost effective!
- **evaluation** from previous students is good / excellent, despite large dropout rates

Future projects for 2005–2006

- revise the material to better fit the Masters program (collaboration with Adelaide)
- virtual tutor for automatic correction (collaboration with Stanford)
- sell the course directly to professionals (Stockholm stock exchange, banks)