

# Fundamentals of Bioinformatics (FoB) 2012-2013

This course runs at the same time as Introduction to Systems Biology (InSB). Together these two courses are the entry-point into the Master Bioinformatics and Systems Biology. Because most students will follow both courses, the schedules are carefully aligned, but please let us know if workload, deadlines or tests badly clash.

## Weekly Schedule:

|             | Mon-Tue           | Wed-Thu                                      | Fri                                   |
|-------------|-------------------|--|---------------------------------------|
| 9.00-11.00  | Lecture           | <i>Introduction to Systems Biology</i>       | Class biology<br>UvA,<br>Science Park |
| 11.00-12.00 | Project           | Class mathematics<br>(theory plus exercises) |                                       |
| 12.00-13.00 | – lunch –         |  |                                       |
| 13.00-14.00 | Project           | – lunch –                                    |                                       |
| 14.00-16.00 | Class Programming | <i>Introduction to Systems Biology</i>       |                                       |

## Lectures: 9.00-11.00

Theoretical introduction to various bioinformatics topics, including discussion of and questions on reading material (chapters and papers).

The course book is Zvelebil & Baum *Understanding Bioinformatics*, Garland Science 2008 ISBN-10: 0-8153-4024-9; this is required reading.

Recommended reading: Larry Hunter's "Molecular biology for computer scientists". This is a nice and concise description of the most important concepts in molecular biology, explained with the non-biologist in mind. It is a useful document for revising your knowledge.

<http://compbio.ucdenver.edu/Hunter/01-Hunter.pdf>

## Project: 11.00-12.00, 13.00-14.00

Practical to get first-hand experience and awareness of common problems in Bioinformatics. The main theme is homology detection in proteins, which we address by benchmarking BLAST homology searches. The Proj. is done in groups of 3-4 students. Within each group, we will aim to have a diverse set of backgrounds: someone with programming experience, someone with biological knowledge, and someone with lab experience; also a mix of vocational/science (HBO/WO) bachelor.

## Classes: 14.00-16.00

**week 1: short questionnaire to identify entry level in Biology, Programming and Mathematics**

As part of the course (FoB), you will be assigned to one of the three classes depending on your background. As part of Introduction to Systems Biology, you will be assigned to another one.

**weeks 1-6: twice weekly sessions**

*Programming (Mondays and Tuesdays):*

- Python; leading up to the scripting work for the practicals

*Mathematics (Wednesdays and Thursdays):*

- Mathematica, analytical functions, differential equations, linear algebra

*Biology (Fridays, at UvA):*

- metabolism, signalling, genomes and gene regulation, cell biology

## Detailed Schedule:

| Date          | Loc. | Room    | Time               | Lecturer | Type    | Topic                                | Contents   | Reading [#pages]                         | Deadlines and Assignments     |
|---------------|------|---------|--------------------|----------|---------|--------------------------------------|--|--|-------------------------------|
| <b>Week 1</b> |      |         |                    |          |         |                                      |  |  |                               |
| Mon 3/9       | VU   | WN-M143 | 9h-11h             | JH+SA+AF | Lect.   | 1a. Introduction<br>1b. Evolution    | MSc Bioinformatics and Systems Biology mutations, selection, sex orthologs, introns, exons |  |                               |
| Mon 3/9       | VU   | WN-P337 | 11h-12h<br>13h-14h | AF+PB/AM | Project | Practical stuff and Intro to Project | Questionnaire & Sorting & Practical Issues (Accounts etc.)                                 |  |                               |
| Mon 3/9       | VU   | WN-P337 | 14h-16h            | AF+ME    | Class   | Programming 1                        | Intro to Linux   |  |                               |
| Tue 4/9       | VU   | WN-M607 | 9h-11h             | JH       | Lect.   | 2. BLAST                             | BLAST, databases, e-values   | Hunter ch 1 [10]                         |                               |
| Tue 4/9       | VU   | WN-P337 | 11h-12h<br>13h-14h | AF+PB/AM | Project | Find Protein(s) and start Blast      |  |  |                               |
| Tue 4/9       | VU   | WN-P337 | 14h-16h            | ME/AF    | Class   | Programming 2.                       | python shell; print, operator, types, if exercise. 'calculation' script                    |  |                               |
| Fri 7/9       | UvA  |         | 9h-12h             |          | Class   | Biology                              |  |  | deadline 'calculation' script |
| <b>Week 2</b> |      |         |                    |          |         |                                      |  |  |                               |
| Mon 10/9      | VU   | WN-C121 | 9h-11h             | SA       | Lect.   | 3. Domains                           | Genetic, Functional, Structural, Sequence  | UB Ch. 2 [21] / EB Ch. 12                |                               |
| Mon 10/9      | VU   | WN-P337 | 11h-12h<br>13h-14h | PB       | Project | Blast, start PSI-blast               |  |  |                               |
| Mon 10/9      | VU   | WN-P337 | 14h-16h            | NB       | Class   | Programming 3.                       | for/while, arrays exercise. sum i over n; n!   |  |                               |
| Tue 11/9      | VU   | WN-C147 | 9h-11h             | SA       | Lect.   | 4. PSI-Blast                         | Blast, dynamic programming, PSI-blast  | Needleman-Wunsch Wikipedia + Example MSA |                               |
| Tue 11/9      | VU   | WN-P337 | 11h-12h<br>13h-14h | PB       | Project | Blast & PSI-Blast.                   | Find putative homologs using (PSI-)Blast. Start finding reference data (GO, SCOP, Pfam)    |  |                               |
| Tue 11/9      | VU   | WN-P337 | 14h-16h            | ME       | Class   | Programming 4. Functions             | scope, namespace, import (libraries); exercise. guessing game; n! with recursion (bonus)   |  |                               |
| Fri 14/9      | UvA  |         | 9h-12h             |          | Class   | Biology                              |  |  |                               |
| <b>Week 3</b> |      |         |                    |          |         |                                      |  |  |                               |

| Date     | Loc. | Room    | Time               | Lecturer  | Type    | Topic  | Contents  | Reading [#pages]                               | Deadlines and Assignments                          |
|----------|------|---------|--------------------|-----------|---------|--|---|--|--|
| Mon 17/9 | VU   | WN-C121 | 9h-11h             | AF        | Lect.   | 5. Benchmarking                                    | ROC plots, TP, FP, TN, FN, gold standard  | Reick, Yeats & Orengo 2007 Blast vs. PSI-blast |  |
| Mon 17/9 | VU   | WN-P337 | 11h-12h<br>13h-14h | PB/<br>AM | Project | Reference data (GO, SCOP, Pfam)                    | Find reference data (GO, SCOP, Pfam) for your protein. Start Benchmarking + ROC plots.          |  |  |
| Mon 17/9 | VU   | WN-P337 | 14h-16h            | ME/<br>NB | Class   | Programming  | continue exercise. guessing game  |  | deadline 'guessing game'                           |
| Tue 18/9 | VU   | WN-C147 | 9h-11h             | PG        | Lect.   | 6. Semantic Web & Ontologies                       | Semantic Web & Ontologies, Gene Ontology database   | UB 3.2 [3] + UB 9.7 [7] / EB pp250-251         |  |
| Tue 18/9 | VU   | WN-P337 | 11h-12h<br>13h-14h | PB/<br>AM | Project | Benchmarking + ROC plots and finalize draft report |   |  | include ROC plots BLAST + PSI-BLAST and discussion |
| Tue 18/9 | VU   | WN-P337 | 14h-16h            | ME/<br>NB | Class   | Programming 5. Codon table/translation             | file I/O, dictionaries, string manipulation (e.g., split) Assignment. codon table & translation |  |  |
| Fri 21/9 | UvA  |         | 9h-12h             |           | Class   | Biology  |   |  | Project draft report deadline                      |

#### Week 4

|          |     |         |                    |                  |             |                                |  |   |   |
|----------|-----|---------|--------------------|------------------|-------------|--------------------------------|--|---|---|
| Mon 24/9 | VU  | WN-C121 | 9h-11h             | AF               | Lect.       | 7. Genomics                    |  | Bork & Serrano Metagenomics m. tuberculosis |   |
| Mon 24/9 | VU  | WN-P337 | 11h-12h<br>13h-14h | PB/<br>AM/<br>AF | Project     | Feedback on reports. PSI-BLAST |  |   |   |
| Mon 24/9 | VU  | WN-P337 | 14h-16h            | ME/<br>NB        | Class       | Programming                    | Continue assignment. codon table & translation |   |   |
| Tue 25/9 | VU  | WN-C121 | 9h-11h             | SA               | Lect.       | 8. Next Gen Sequencing         |  | Compeau et. al. on "de Bruijn graphs"       |   |
| Tue 25/9 | VU  | WN-P337 | 11h-12h<br>13h-14h | PB/<br>AM        | Project     | Project work                   |  |   |   |
| Tue 25/9 | VU  | WN-P337 | 14h-16h            | ME/<br>NB        | Class       | Programming                    | Continue assignment. codon table & translation |   | Deadline assignment codon table & translation |
| Wed 26/9 | VU  | WN-C624 | 11.00-13.00        |                  | <b>Exam</b> | <b>Math1</b>                   | (only when part of the math classes)           |   | Math1 test                                    |
| Fri 28/9 | UvA |         | 9h-12h             |                  | Class       | Biology                        |  |   |   |

#### Week 5

|          |    |         |                    |                         |         |  |  |               |  |
|----------|----|---------|--------------------|-------------------------|---------|--|--|---------------|--|
| Mon 1/10 | VU | WN-C121 | 9h-11h             | JH/<br>AF/<br>NB/<br>ME | Lect.   | 9. Research Highlights (3x 20 minutes) | - petri nets (NB)<br>- domain boundary prediction (JH)<br>- network alignment (ME) | 3 x Abstracts |  |
| Mon 1/10 | VU | WN-P337 | 11h-12h<br>13h-14h | PB/<br>AM/<br>AF        | Project | <b>Question Hour</b>                   |  |               |  |

| Date     | Loc. | Room    | Time               | Lecturer   | Type    | Topic                              | Contents  | Reading [#pages]  | Deadlines and Assignments |
|----------|------|---------|--------------------|------------|---------|------------------------------------|---|-------------------|---------------------------|
| Mon 1/10 | VU   | WN-P337 | 14h-16h            | NB/ME      | Class   | Programming 6. Regular expressions | Regular expressions Assignment. GO parsing            |                   |                           |
| Tue 2/10 | VU   | WN-M607 | 9h-11h             | JH (AF/SA) | Lect.   | 10. Outlook                        | NGS applications, unsolved problems in bioinformatics | Economist Article |                           |
| Tue 2/10 | VU   | WN-P337 | 11h-12h<br>13h-14h | PB/AM/AF   | Project | Finalizing report                  | (Assign discussion groups)                            |                   |                           |
| Tue 2/10 | VU   | WN-P337 | 14h-16h            | ME/NB      | Class   | Programming                        | Continue assignment. GO parsing                       |                   |                           |
| Fri 5/10 | UvA  |         | 9h-12h             |            | Class   | Biology                            |   |                   | Deadline Project report   |

### Week 6

|           |     |         |                    |          |             |                                |  |  |                                |
|-----------|-----|---------|--------------------|----------|-------------|--------------------------------|--|--|--------------------------------|
| Mon 8/10  | VU  | WN-C121 | 9h-11h             | SA/AF/JH | Lect.       | <b>Question Hour</b>           |  |  |                                |
| Mon 8/10  | VU  | WN-P337 | 11h-12h<br>13h-14h | PB/AM/AF | Project     | Discussion groups              | Integrating results  |  |                                |
| Mon 8/10  | VU  | WN-P337 | 14h-16h            | ME/NB    | Class       | Programming                    | Continue assignment. GO parsing  |  |                                |
| Tue 9/10  | VU  | WN-M607 | 9h-11h             |          | Lect.       | < breathing space >            |  |  |                                |
| Tue 9/10  | VU  | WN-P337 | 11h-12h<br>13h-14h | PB/AM/AF | Project     | Discussion groups              | Integrating results  |  |                                |
| Tue 9/10  | VU  | WN-P337 | 14h-16h            | ME/NB    | Class       | Programming 8. Advanced issues | Advanced issues. classes, documentation. Continue assignment. GO parsing |  |                                |
| Thu 11/10 | VU  | WN-P631 | 11h-13h            |          | <b>Exam</b> | <b>Math2</b>                   | (only when part of the math classes)                                     |  | Math2 test                     |
| Fri 12/10 | UvA |         | 9h-12h             |          | <b>Exam</b> | <b>Biology</b>                 | (only when part of the bio classes)                                      |  | Biology exam                   |
| Fri 12/10 | VU  |         |                    |          |             |                                |  |  | Deadline assignment GO parsing |

### Week 7

|           |    |         |                    |          |             |                      |                                      |  |               |
|-----------|----|---------|--------------------|----------|-------------|----------------------|--------------------------------------|--|---------------|
| Mon 15/10 | VU | WN-P337 | 11h-12h<br>13h-14h | PB/AM/AF | Project     | <b>Question Hour</b> | Integrating results                  |  |               |
| Wed 17/10 | VU | WN-P631 | 9h-11h             |          | <b>Exam</b> | <b>Math2</b>         | (only when part of the math classes) |  | Math2 re-test |

### Week 8

|           |      |      |            |          |             |                                  |  |  |  |
|-----------|------|------|------------|----------|-------------|----------------------------------|--|--|--|
| Mon 22/10 | VU   |      | 8.45-11.30 | JH/AF/SA | <b>Exam</b> | <b>Oral and/or written exams</b> |  |  | Exam   |
| Fri 26/10 | ???? | ???? | 9h-17h     |          |             | <b>Presentations</b>             |  |  | Group presentation & individual report of literature subject |

#### Acronym Lecturer

JH Jaap Heringa  
 AF Anton Feenstra  
 SA Sanne Abeln  
 PG Paul Groth

#### Acronym Lecturer

NB Nicola Bonzanni  
 PB Punto Bawono  
 ME Mohamed El-Kebir  
 AM Ali May

