Software Economics – Fall 2014

Workshop 2-3: Function Point Analysis

Dietmar Pfahl & Marlon Dumas

(slides partly based on FPA Manual by David Longstreet)
Function Point Analysis

- Function point is a measure of the amount of business functionality in a software application.
  - The larger number of FPs the more functionality.

- Function Point Analysis is based on breaking down applications into very small components and measuring their size individually.
Scope & Limitations of FPA

- FPA is largely geared towards “form-based” or “record-oriented” applications

- Might not be suitable for applications involving:
  - Complex algorithms, e.g. image/video/audio processing, text or data mining, simulation, optimization, strategy games
  - Complex multimedia apps, 3D animation
  - Real-time embedded software
  - Very large-scale data management
FPA – Basic Principles

Software applications are treated as a combination of:

- **Data in motion = Transactions**
  - Moving data from application to outside or from outside to application

- **Data at rest**
  - Data sources that need to be accessed by the application
FPA – Basic Principles

Three types of transactions:
- Input – data is fed into the system
- Enquiry – data is retrieved from the system
- Output – data is retrieved and enriched

And two types of data sources
- Internal files
- External files

Note: “files” means “bucket of logically-related records”, not “files” in the Unix sense.
Function Points – Context

1. Identify Application Boundaries
   - Count Transactional Functions
   - Count Data Functions
2. Determine Unadjusted FP Count
3. Determine Adjusted FP Count
Function Points – Context

Identify Application Boundaries
Application Boundary

- Border between application being measured and external applications
Scenario

- Assume we are building a web application that aggregates and displays stream of events in a software development team:
  - Anton fixed a bug
  - Mark added new task
  - Anton committed new code change
- Everybody can sign-up
- Create new streams
- Data is stored in database
What functionality is part of application?
Scenario: Within Boundaries or Not?

- Authentication
- Configuration of connections to tools team is using (bug&task tracking, code management)
- Organization/optimization of database files
- Forwarding events to Twitter/Facebook
- Sending HTML/JS/CSS over HTTP to browser
Example – Application Boundary

www.blanklabel.com

Blank Label Application

Browse Fabrics
Shirt Collection
Customize Shirt
Order Sample of Fabrics
Order Gift Cards

Create Account
Sign In
Reset Password

Add and manage Cart Purchase
Newsletter
Contact

Customer

Administrator

Payment Gateway
Exercise

Let’s define application boundaries to analyze www.doodle.com
FPA – Components

- **Transactions (Transactional Components)**
  - External Inputs (information input)
  - External Inquiries (no derived data, data retrieval):
    - External Outputs (derived data, algorithms):
- **Data at rest (Data components)**
  - Internal Logical Files (maintained internally)
  - External Interfaces Files (maintained by external apps)
FPA – Components
Components

- Each component rated as Low, Average or High
  - Based on (perceived) complexity
- Points are assigned based on the rating
- Question: How to evaluate complexity?
Break things up into even smaller pieces!

- Transaction
  - Dependent on data transferred
  - Dependent on data stored

- Data at rest
  - Dependent on data stored
  - Independent of data transferred
Smaller Pieces

- **Data Element Type (DET)**
  - Dynamic user recognizable fields
  - Controls (things that invoke actions)
  - Used to estimate complexity of both transactions and data
Data Element Type – Examples

Sign up to:
- Import papers from other sites
- Share resources with fellow researchers
- Network to find new contacts
- Synchronise your library across computers
- Manage your research library online

If you really don’t want a Mendeley Web account, you can still download Mendeley Desktop

First Name: Anton
Last Name: Litvinenko
E-mail: anton.li
Password: [blank]
Confirm Password: [blank]
Research Field: Main discipline...
Data Element Type – Examples

Repeated DET-s. Count only once
Data Element Type – Examples

- Articles
  - Title
  - Year
  - Abstract
  - Notes

- Tags
  - Keyword

- Authors
  - First Name
  - Last Name
Data Element Type – Examples

Articles
- Title
- Year
- Abstract
- Notes

Tags
- Keyword

Authors
- First Name
- Last Name

DET-s
Exercise

• Design a simplified data model of doodle.com (given the application boundaries you chose).
• Count DETs for the “poll” type.
Smaller Pieces

- Data Element Type (DET)
  - Dynamic user recognizable field

- Record Element Type (RET)
  - User recognizable subgroup of data elements in internal logical file or external interface file
  - For relational databases typically one Internal Logic File (table) = one Record Element Type
Record Element Type – Examples

1 RET each
Record Element Type – Examples

2 RET-s
Record Element Type – Examples

Inheritance in object-oriented development

Table per object hierarchy in relational database
Record Element Type – Examples

2 RET-s
Smaller Pieces

- **Data Element Type (DET)**
  - Dynamic user recognizable field

- **Record Element Type (RET)**
  - User recognizable subgroup of data elements in internal logical file or external interface file

- **File Type Referenced (FTR)**
  - File type referenced by transaction (internal logical file or external interface file)
File Type Referenced - Examples

- Edit article details
  - Abstract
  - Tags
  - Notes

http://www.objectmentor.com/resources/articles/Principles_and_Patterns.pdf
FTR-s For Edit Article Details

- Articles
  - Title
  - Year
  - Abstract
  - Notes

- Tags
  - Keyword

- Authors
  - First Name
  - Last Name

Not referenced
File Type Referenced Examples

- How many FTR-s for “List of Articles”? 
  - Tables: Articles, Authors, Tags

<table>
<thead>
<tr>
<th>Authors</th>
<th>Title</th>
<th>Year</th>
<th>Published In</th>
<th>Added</th>
</tr>
</thead>
<tbody>
<tr>
<td>Longstreet, D</td>
<td>Function Points Analysis Training Course</td>
<td>2005</td>
<td>Consulting In...</td>
<td>Fri Sep 4 2009</td>
</tr>
</tbody>
</table>
Components
Components and DETs, RETs, FTRs
Function Points – Context

- Identify Application Boundaries
- Count Transactional Functions
External Inputs

- Information flows into the application
  - Online, user inserted, from other application
External Inputs – Examples

Abstract:
Enter the paper abstract here

Tag 1; Tag 2; ...
design; object-oriented; principles

Notes:
http://www.objectmentor.com/resources/articles/Principles_and_Patterns.pdf
External Inputs – Examples

EI

Get Mendeley

How it works

Blog

Sign up to:
- Import papers from other sites
- Share resources with fellow researchers
- Network to find new contacts
- Synchronise your library across computers
- Manage your research library online

If you really don't want a Mendeley Web account you can still download Mendeley Desktop

First Name: Anton
Last Name: Litvinenko
E-mail: anton.li
Password: 
Confirm Password: 
Research Field: Main discipline...
External Inputs

- Elementary process in which data or control information crosses the boundary from outside to inside
  - Data is maintained = added, changed or deleted
  - Application is controlled (manipulated, behavior is changed)

- Rated based upon Data Element Types and Files Type Referenced
# External Inputs → Function Points

<table>
<thead>
<tr>
<th>Files Referenced (FTR-s)</th>
<th>Data Elements (DET-s)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1 – 4</td>
</tr>
<tr>
<td>1</td>
<td>Low (3)</td>
</tr>
<tr>
<td>2</td>
<td>Low (3)</td>
</tr>
<tr>
<td>&gt; 2</td>
<td>Average (4)</td>
</tr>
</tbody>
</table>

- **Low** → 3 function points
- **Average** → 4 function points
- **High** → 6 function points
External Inputs – Examples

- External Inputs include error messages!
- All errors messages are counted as 1 Dynamic Element Type
External Inputs – Data Types

- **Business data**: customer name, number of credits for course, … → updates Internal Logical Files (ILF-s)

- **Control data**: printer port, number of copies, … → may or may not update ILF-s

- **Rules data**: number of days before registration closes, min amount eligible for free shipping → updates ILF-s
External Inputs

- Data element types for External Inputs
  - Fields, Controls, Messages (both error and confirmation)
  - Calculated values that are stored
- Cancel – not counted in EI
  - Data doesn't cross boundary – noting changed, edited or deleted
  - State or behavior of application is not changed
These are NOT External Inputs

- Login screens
  - Should be counted as External Inquiry
- (Static) menus, link, navigational screens
  - Usability, not functionality
External Inputs – Identification Rules

- Data is received from outside the app boundary
- Maintains data in Internal Logical Files
- Process is self contained and leaves the application in consistent state
- Typical vocabulary
  - Add, Change, Delete, Modify, Remove, Edit, Enable, Save, Store, Submit, ...
Exercise – Rate External Input
External Outputs

- Derived information flows from the application
  - Algorithms, calculations
  - Reports, graphs, charts
Exercise

• Identify and rate EIs in the doodle system
Function Points – Context

- External input (EI)
- External output (EO)
- External enquiry (EQ)

Identify Application Boundaries

Count Transactional Functions
Derived Information
External Outputs – Examples

**Articles added and downloadable:**

- 3,989,644 added overall
- 19,455 downloadable overall for free
- 512,265 added in *Computer and Information Science*
- 3,149 downloadable for free in *Computer and Information Science*

**Most read authors overall (updated daily):**

1. Duncan Hull - 231 readers
2. Douglas B. Kell - 219 readers
3. Steve R. Pettifer - 200 readers
4. Geoff Cumming - 186 readers
5. Fiona Fidler - 180 readers
External Output

- Elementary process in which derived data passes across the boundary from inside to outside
  - Based on internal logical files and/or external interface files
  - Data processed beyond direct retrieval and editing from internal logical files or external interface files

- Rated based upon Data Element Types and Files Type Referenced
## External Outputs → Function Points

<table>
<thead>
<tr>
<th>Files Referenced (FTR-s)</th>
<th>Data Elements (DET-s)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1 – 5</td>
</tr>
<tr>
<td>1</td>
<td>Low (4)</td>
</tr>
<tr>
<td>2 – 3</td>
<td>Low (4)</td>
</tr>
<tr>
<td>&gt; 3</td>
<td>Average (5)</td>
</tr>
</tbody>
</table>

- **Low** → 4 function points
- **Average** → 5 function points
- **High** → 7 function points
External Outputs

- **Notification messages** – result of processing = calculation

- **Data element types for External Outputs**
  - Error messages
  - Calculated values on reports
  - Values on reports retrieved from application
  - Recursive DET-s counted only once!

- **External Outputs can have input side**
  - Report configuration, ...
These are NOT External Outputs

- Error message, confirmation message
  - Parts of External Outputs or other transactions
- Reports without derived data
  - External Inquiries
External Outputs – Identification Rules

- Data is sent from the app boundary to outside
- Process is self contained and leaves the application in consistent state
- Typical vocabulary
  - Browse, Display, Query, Report, View, Select, Request, Retrieve, Aggregate, Calculate
External Outputs – Identification Rules

- Data ordering produces the same external output $\rightarrow$ counted only once!
External Outputs – Identification Rules

- Different derived data from the same data $\rightarrow$ different external outputs!
## Example – Rate External Output

### Most read authors overall (updated daily):

<table>
<thead>
<tr>
<th>Rank</th>
<th>Author</th>
<th>Readers</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Duncan Hull</td>
<td>231</td>
</tr>
<tr>
<td>2</td>
<td>Douglas B. Kell</td>
<td>219</td>
</tr>
<tr>
<td>3</td>
<td>Steve R. Pettifer</td>
<td>200</td>
</tr>
<tr>
<td>4</td>
<td>Geoff Cumming</td>
<td>186</td>
</tr>
<tr>
<td>5</td>
<td>Fiona Fidler</td>
<td>180</td>
</tr>
</tbody>
</table>
Exercise

• Identify and rate EOs in the Doodle system
External Inquiries

- Information flows from the application
  - Existing, already stored data
  - Input side and output side
  - Reports, graphs, charts,
External Inquiries

- Existing data + Input and output sides
External Inquiries

- Elementary process with both input and output components that result in data retrieval from one or more internal logical files and/or external interface files
  - Does not maintain any internal logical files
  - Does not contain derived information

- Rated based upon Data Element Types and Files Type Referenced
External Inquiries – Examples

- **Input**: customer name in the search field
- **Output**: list of customers by name

- **Input**: click on the document title
- **Output**: document details
External Inquiries – Examples

1 EI
## External Inquiries → Function Points

<table>
<thead>
<tr>
<th>Files Referenced (FTR-s)</th>
<th>Data Elements (DET-s)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1 – 5</td>
</tr>
<tr>
<td></td>
<td>6 – 19</td>
</tr>
<tr>
<td></td>
<td>&gt; 19</td>
</tr>
<tr>
<td>1</td>
<td>Low (3)</td>
</tr>
<tr>
<td></td>
<td>Low (3)</td>
</tr>
<tr>
<td></td>
<td>Average (4)</td>
</tr>
<tr>
<td>2 – 3</td>
<td>Low (3)</td>
</tr>
<tr>
<td></td>
<td>Average (4)</td>
</tr>
<tr>
<td></td>
<td>High (6)</td>
</tr>
<tr>
<td>&gt; 3</td>
<td>Average (4)</td>
</tr>
<tr>
<td></td>
<td>High (6)</td>
</tr>
<tr>
<td></td>
<td>High (6)</td>
</tr>
</tbody>
</table>

- Low → 3 function points
- Average → 4 function points
- High → 6 function points
External Inquiries – Data Types

- **Pagination**: NEXT and BACK buttons – recursive information, counted as the *same* function

- **Messages are DET-s!**
  - “data *not found*” = 1 DET-s
These are NOT External Inquiries

- Error message, confirmation message
  - Parts of External Inquiries or other transactions

- Screens with derived data
  - External Outputs
External Inquiries – Identification Rules

- **Request enters** the boundaries, **result exits** the boundaries
- **Data retrieval**, no derived data
- Input and Output together form an elementary process
- **Data is not maintained** (but can be updated)
- **Typical vocabulary**
  - Browse, Display, Fetch, Find, List, Drop-down, Select, View, Query, Report, ...
Exercise

• Identify and rate EQs in the Doodle system
Function Point Analysis

Identify Application Boundaries

Count Transactional Functions
- External Input (EI)
- External Output (EO)
- External Inquiry (EQ)

Count Data Functions
- Internal Logical File (ILF)
- External Interface File (EIF)
How it all fits together
Transactional Components Quiz

- For which components is true:
  - DET-s are retrieved from FTR-s
  - Updates ILF
  - Maintains ILF
  - Contains derived data
  - Information flows from outside to inside
  - Never contains derived data
  - Information flows from inside to outside
  - At least on FTR is referenced
Internal Logical Files

- Data that resides within app. boundaries
  - Business data, control data, rules based data
Internal Logical Files – Examples

3 ILF-s
Internal Logical Files – Data Types

- **Business data**: course name, address, student
- **Control data**: printer port, copies, database url
- **Rules based data**: registration criteria, grading scheme
Internal Logical Files – Examples

- Application configuration stored on hard drive
  - If maintained through the application
- Log files
Internal Logical Files

- Group of logically related data residing entirely within application boundary
  - Maintained by External Inputs
  - Has at least one Record Element Type

- Rated based upon Data Element Types and Record Element Types
## Internal Logical Files → FP-s

<table>
<thead>
<tr>
<th>Record Elements (RET-s)</th>
<th>Data Elements (DET-s)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1 – 19</td>
</tr>
<tr>
<td>1</td>
<td>Low (7)</td>
</tr>
<tr>
<td>2 – 5</td>
<td>Low (7)</td>
</tr>
<tr>
<td>&gt; 5</td>
<td>Average (10)</td>
</tr>
</tbody>
</table>

- **Low** → 7 function points
- **Average** → 10 function points
- **High** → 15 function points
Internal Logical Files – Identification Rules

- User identifiable logical grouping
- Data is maintained within application boundaries
- Data is modified via one or more External Inputs
Exercise – Rate ILF-s
Exercise – Rate ILF

Person

First Name
Last Name
Birthday
Email
Username
Password
City
Country
AddressLine
Exercise

• Identify and rate ILFs in the Doodle system
External Interface Files

- Data that resides outside app. boundary
  - Internal data of other application
External Interface Files – Examples

Google Scholar is EIF
External Interface Files

- Group of logically related data residing entirely outside application boundary
  - Maintained by another application
  - Data is retrieved during External Output or External Inquiry

- Rated based upon Data Element Types and Record Element Types
External Interface Files $\rightarrow$ FP-s

<table>
<thead>
<tr>
<th>Record Elements (RET-s)</th>
<th>Data Elements (DET-s)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1 – 19</td>
</tr>
<tr>
<td></td>
<td>20 – 50</td>
</tr>
<tr>
<td></td>
<td>&gt; 50</td>
</tr>
<tr>
<td>1</td>
<td>Low (5)</td>
</tr>
<tr>
<td>2 – 5</td>
<td>Low (5)</td>
</tr>
<tr>
<td></td>
<td>Average (7)</td>
</tr>
<tr>
<td>&gt; 5</td>
<td>Average (7)</td>
</tr>
<tr>
<td></td>
<td>High (10)</td>
</tr>
<tr>
<td></td>
<td>High (10)</td>
</tr>
</tbody>
</table>

- Low $\rightarrow$ 5 function points
- Average $\rightarrow$ 7 function points
- High $\rightarrow$ 10 function points
External Interface Files – Identification Rules

- User identifiable **logical grouping** of information
- Data **external** to application
Exercise – Rate EIF

These details need reviewing. You can mark them as correct, or search by title on Google Scholar.

- Details are Correct
- Search by title

**Type:** Journal Article

**Title:** An introduction to game theory

**Authors:** Ricardson

**Journal:** Quality

**Volume:**

**Issue:**

**Pages:**

**Year:** 2003
Function Points – Context

Identify Application Boundaries

Count Transactional Functions

Count Data Functions

Determine Unadjusted FP Count
Value-Adjustment Factor (VAF)

VAF is a “factor” that takes into account non-functional requirements, e.g.:

- Required performance (transaction rate)
- Required reliability
- Required usability (end-user efficiency)
- Etc.

Not always used because all this is usually part of the cost estimation model (cf. next week)

We will only deal with unadjusted FPs (UFPs)
Shortcomings of FPA

- Suitable mostly for form-based database apps
- Requires experience
  - Experienced FP raters have variance of +/- 10%
  - Less experienced ones +/- 20%
- Requires detailed reqs & high-level design
- Time-consuming
  - “Dutch Method”: for each ILF, 3 EIs, 2 Eos, 1 EQ; for each EIF, 1 EO and 1 EQ
  - $UFP = 35 \times ILF + 15 \times EIF$
- Impractical for very large projects (> 10K FPs)
Extensions of FPs

• We have seen FP definitions of the Intl. Function Point User Group (IFPUG)

• Alternatives
  • Story points (agile – more next week)
  • COSMIC FPs – finer-grained; based on continuous size scale rather than discrete
  • OMG Automated Function Points – similar to IFPUG but strictly defined; meant for measuring (not estimating) already developed software
    • “per-FP” software pricing models
    • Measuring defects-per-FP for contract penalties
Is this stuff used at all?

- Surely yes judging by
  - User groups worldwide
  - Project databases, e.g. ISBSG documents 5000+ projects counted using FPs
  - 50K+ projects counted according to IFPUG + others by COSMIC
  - Several commercial tools
- Not universal though…
  - Makes more sense in organizations with large portfolios of projects
FP Tools

• Many tools can speed up/automate some FP count
  • SPR KnolwedgePLAN
  • PRICE Systems TruePlanning
  • SCOPE
  • Others check “Software Parametric Models” in Wikipedia

Also – many FP Excel templates, see link below today’s slides on course web site
Homework 1

- Team assignment (2-4 members per team)
- See https://courses.cs.ut.ee/2014/softeco/

- Why not form teams now, select a system and post it on the message board?

- And why not start the homework now…
Final exercise

• FP Analysis of the following address book example:
  • [http://www.cs.gordon.edu/courses/cs211/AddressBookExample/](http://www.cs.gordon.edu/courses/cs211/AddressBookExample/)
References

- D. Longstreet, Function Points Analysis Training Course
- Alvin Alexander: How to Determine Your Application Size Using Function Points. BorCon 2004 Proceedings
  - http://tinyurl.com/8mbofd8