Here’s a detailed solution to **Exercise 1: Estimating Activity Durations for the City Park Revitalization Project**, covering all the requested estimation techniques and questions.

**1. Expert Judgment**

**Estimate Durations for Activities A, B, and C:**

* **Activity A: Remove old playground equipment**  
  Expert estimate: **3–5 days**  
  → Reasonable estimate (mid-range): **4 days**
* **Activity B: Install new playground equipment**  
  Expert estimate: **Approximately 6 days**  
  → Duration: **6 days**
* **Activity C: Lay walking paths**  
  Park area: **30,000 sq ft**  
  Rate: **5 days per 10,000 sq ft**  
  → 30,00010,000×5=15\frac{30,000}{10,000} \times 5 = 15 days  
  → Duration: **15 days**

**Limitations of Expert Judgment:**

* Subjectivity and potential bias.
* Over-reliance on past experience that may not align with current project conditions.
* Inconsistency between experts' opinions.
* Lack of data-backed validation.

**2. Analogous Estimating**

**Activity D: Construct central fountain**  
Comparable project: **15 days**  
→ Duration: **15 days**

**Activity E: Implement irrigation system**  
Previous: 10 days for **5 acres**  
Current: **7.5 acres**  
→ 7.55×10=15\frac{7.5}{5} \times 10 = 15 days  
→ Duration: **15 days**

**Assumptions Made:**

* Scope and complexity of both projects are equivalent.
* Productivity and resource efficiency remain constant.
* Site conditions are similar.

**Impact on Accuracy:**

* If any assumption fails, the estimate could be off.
* Doesn’t account for unique aspects of the current project.

**3. Parametric Estimating**

**Activity F: Landscape and plant greenery**  
Area: **25,000 sq ft**  
Rate: **5,000 sq ft per day**  
→ 25,0005,000=5\frac{25,000}{5,000} = 5 days  
→ Duration: **5 days**

**Accuracy Benefits:**

* Based on measurable units (area, rate).
* Scalable and repeatable for similar tasks.
* More objective than expert or analogous methods, provided data is accurate.

**4. Three-Point Estimates (Activity C)**

Estimates:

* **Optimistic (O)** = 10 days
* **Most Likely (M)** = 12 days
* **Pessimistic (P)** = 16 days

**a) Triangular Distribution:**

Expected Duration=O+M+P3=10+12+163=383≈12.67 days\text{Expected Duration} = \frac{O + M + P}{3} = \frac{10 + 12 + 16}{3} = \frac{38}{3} \approx 12.67 \text{ days}

**b) Beta (PERT) Distribution:**

Expected Duration=O+4M+P6=10+4(12)+166=10+48+166=746≈12.33 days\text{Expected Duration} = \frac{O + 4M + P}{6} = \frac{10 + 4(12) + 16}{6} = \frac{10 + 48 + 16}{6} = \frac{74}{6} \approx 12.33 \text{ days}

**More Realistic Estimate:**

* **Beta (PERT)** is generally more realistic as it weighs the **most likely** outcome more heavily and reduces skew from extremes.

**5. Bottom-Up Estimating (Activity E)**

Breakdown:

* Dig trenches: 3 days
* Lay irrigation pipes: 4 days
* Install sprinkler heads: 2 days

**Total Duration:**  
3+4+2=93 + 4 + 2 = 9 days

**Comparison to Other Techniques:**

* **Detail-oriented and task-specific**, providing high accuracy.
* Requires more effort and data than top-down methods.
* Useful for risk identification and resource planning.
* Can help uncover hidden dependencies or inefficiencies.

**Summary Table of Duration Estimates**

| **Activity** | **Estimation Technique** | **Duration (Days)** |
| --- | --- | --- |
| A | Expert Judgment | 4 |
| B | Expert Judgment | 6 |
| C | Expert Judgment / Parametric | 15 / 12.33 (PERT) |
| D | Analogous | 15 |
| E | Analogous / Bottom-Up | 15 / 9 |
| F | Parametric | 5 |

Let me know if you want a Gantt chart or activity network next!

**Exercise 1: Estimating Activity Durations for the City Park Revitalization Project**

**Expert Judgment**

* **Activity A (Remove old playground equipment):**
  + Expert data: 3-5 days.
  + Estimated Duration: We can choose a point within this range, e.g., **4 days**. This assumes a moderate level of complexity for the site.
* **Activity B (Install new playground equipment):**
  + Expert data: Approximately 6 days.
  + Estimated Duration: **6 days**.
* **Activity C (Lay walking paths):**
  + Expert data: 5 days for every 10,000 square feet. Park area is 30,000 square feet.
  + Calculation: (30,000 sq ft/10,000 sq ft)×5 days=3×5 days=15 days.

**Potential limitations of relying solely on expert judgment:**

* **Bias:** Experts may have optimistic or pessimistic biases based on their past experiences or personal preferences.
* **Availability of Experts:** The availability of true experts may be limited, and less experienced individuals might be consulted.
* **Lack of Documentation:** Expert judgment is often based on tacit knowledge, which can be difficult to document or replicate.
* **Variability:** Different experts might provide widely varying estimates, leading to inconsistencies.
* **Uniqueness of Project:** Even with similar projects, unique aspects of the current project might not be fully accounted for by past experience.
* **No Empirical Basis:** The estimates are not always based on measurable data, making it difficult to justify or track deviations.

**Analogous Estimating**

* **Activity D (Construct central fountain):**
  + Comparable project data: 15 days for a project of comparable scope.
  + Estimated Duration: **15 days**.
* **Activity E (Implement irrigation system):**
  + Comparable project data: 10 days for a 5-acre area. Current project covers 7.5 acres.
  + Calculation: (7.5 acres/5 acres)×10 days=1.5×10 days=15 days.

**Assumptions made and their impact on accuracy:**

* **Activity D (Construct central fountain):**
  + **Assumption:** The "comparable scope" of the previous project's central fountain construction is genuinely similar in complexity, size, and required resources to the current project's fountain.
  + **Impact on Accuracy:** If the previous fountain was significantly simpler or more complex, or if the current project has unforeseen challenges (e.g., difficult ground conditions), the 15-day estimate could be inaccurate, leading to schedule delays or early completion.
* **Activity E (Implement irrigation system):**
  + **Assumption:** The relationship between acreage and installation time is linear. Also, the terrain, soil conditions, and system complexity are similar between the past project and the current one.
  + **Impact on Accuracy:** If the current 7.5-acre area has more challenging terrain, requires more intricate piping, or necessitates more specialized equipment, the linear scaling might underestimate the duration. Conversely, if the new system is simpler despite the larger area, it might overestimate.

**Parametric Estimating**

* **Activity F (Landscape and plant greenery):**
  + Data: Workers can landscape 5,000 square feet per day. Park has 25,000 square feet of landscaping area.
  + Calculation: (25,000 sq ft/5,000 sq ft/day)=5 days.

**How this method improves accuracy compared to other techniques:**

Parametric estimating improves accuracy because it uses a statistical relationship between historical data and other variables (like square footage or units produced) to calculate an estimate. This method is:

* **Data-Driven:** It relies on quantifiable parameters and historical data, making it more objective than expert judgment or analogous estimating (which can be more subjective).
* **Scalable:** It allows for accurate scaling based on changes in project scope or size, as demonstrated with Activity F where the duration directly correlates with the landscaping area.
* **Less Prone to Bias:** While the initial parameters might have some expert input, the calculation itself is formulaic, reducing the impact of individual biases.
* **Easily Justifiable:** The basis of the estimate is clear and can be easily explained and defended with data.

**Three-Point Estimates**

* **Activity C (Lay walking paths):**
  + Optimistic (O): 10 days
  + Most Likely (ML): 12 days
  + Pessimistic (P): 16 days
* **Triangular Distribution:**
  + Expected Duration (ET​) = (O+ML+P)/3
  + ET​=(10+12+16)/3=38/3=12.67 days
* **Beta Distribution (PERT):**
  + Expected Duration (EB​) = (O+4×ML+P)/6
  + EB​=(10+4×12+16)/6=(10+48+16)/6=74/6=12.33 days

**Which method provides a more realistic estimate, and why?**

The **Beta distribution (PERT) method** generally provides a more realistic estimate. Here's why:

* **Weighted Average:** The PERT method gives more weight to the "Most Likely" estimate (by multiplying it by 4), acknowledging that the most probable outcome is often closer to the actual duration than the extreme optimistic or pessimistic scenarios.
* **Accounts for Uncertainty:** While both methods consider uncertainty, PERT's weighting system implicitly acknowledges that the distribution of actual durations is often skewed rather than perfectly symmetrical, as assumed by the triangular distribution.
* **Risk Management:** PERT also allows for the calculation of standard deviation, which provides a measure of the uncertainty or risk associated with the estimate, helping in better risk management and contingency planning.

**Bottom-Up Estimating**

* **Activity E (Irrigation System Installation):**
  + Dig trenches: 3 days
  + Lay irrigation pipes: 4 days
  + Install sprinkler heads: 2 days
  + Total Duration for Activity E = 3+4+2=9 days.

**How bottom-up estimating compares to other techniques in terms of detail and accuracy:**

* **Detail:** Bottom-up estimating is the most detailed technique. It requires breaking down activities into their lowest-level components (work packages or tasks) and estimating each component individually. This granular approach provides a comprehensive view of the work involved.
* **Accuracy:** Due to its detailed nature, bottom-up estimating is generally considered the **most accurate** estimation technique. By estimating each small piece of work, the cumulative error is often reduced, and it forces a thorough understanding of the activity's scope.

**Comparison with other techniques:**

* **Compared to Expert Judgment and Analogous Estimating:** Bottom-up is significantly more detailed and generally more accurate. Expert judgment and analogous estimating are high-level and can be quick, but they sacrifice detail and may miss specific nuances or complexities of the current project. Bottom-up requires more time and effort but yields a more reliable estimate.
* **Compared to Parametric Estimating:** While parametric estimating is accurate for activities that have a clear, measurable unit of work, it's not always applicable to all activities (e.g., highly unique tasks). Bottom-up can be applied to any activity, regardless of whether a historical parameter exists.
* **Compared to Three-Point Estimates:** Three-point estimates focus on incorporating uncertainty at the activity level. Bottom-up estimates can be combined with three-point estimates for each sub-task to further enhance accuracy and incorporate probabilistic thinking at a more granular level.

In summary, bottom-up estimating provides a highly detailed and generally the most accurate estimate, but it is also the most time-consuming and resource-intensive method. It is best suited for complex or critical activities where high accuracy is paramount.